

**MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF BRIDGES AND STRUCTURES**

BRIDGE ANALYSIS GUIDE

2026 Edition



 Michigan Department
of Transportation
Bureau of Bridges and Structures

PREFACE

Accessibility

If you require assistance accessing this information or require it in an alternative format, contact the Michigan Department of Transportation's (MDOT) Americans with Disabilities Act (ADA) coordinator at Michigan.gov/MDOT-ADA.

Engineering Manual Preamble

This manual provides guidance to administrative, engineering and technical staff. Engineering practice requires that professionals use a combination of technical skills and judgment in decision-making. Engineering judgment is necessary to allow decisions to account for unique site-specific conditions and considerations to provide high-quality products, within budget, and to protect the public health, safety and welfare. This manual provides the general operational guidelines; however, it is understood that adaptation, adjustments and deviations are sometimes necessary. Innovation is a key foundational element to advance the state of engineering practice and develop more effective and efficient engineering solutions and materials. As such, it is essential that our engineering manuals provide a vehicle to promote, pilot or implement technologies or practices that provide efficiencies and quality products while maintaining the safety, health and welfare of the public. It is expected when making significant or impactful deviations from the technical information from these guidance materials that reasonable consultations with experts, technical committees and/or policy-setting bodies occur prior to actions within the timeframes allowed. It is also expected that these consultations will eliminate any potential conflicts of interest, perceived or otherwise. MDOT leadership is committed to a culture of innovation to optimize engineering solutions.

The National Society of Professional Engineers Code of Ethics for Engineering is founded on six fundamental canons. Those canons are provided below.

Engineers, in the fulfillment of their professional duties, shall:

1. Hold paramount the safety, health and welfare of the public.
2. Perform services only in areas of their competence.

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3. Issue public statements only in an objective and truthful manner.
4. Act for each employer or client as faithful agents or trustees.
5. Avoid deceptive acts.
6. Conduct themselves honorably, reasonably, ethically and lawfully so as to enhance the honor, reputation and usefulness of the profession.

Purpose

The Michigan Bridge Analysis Guide (BAG) has been developed to promote uniformity and assist engineers in the analysis of highway bridges for load carrying capacity. This manual provides guidance through the process of preparing a bridge load capacity analysis, which includes collecting design and inspection data, selecting appropriate truck configurations, calculating live load distribution factors and performing the final load rating analysis. The BAG intends to inform and lead the user through the analysis process with example calculations and references to be used for additional information.

The 2026 Edition of the BAG is intended as a transitional document. The National Bridge Inspection Standards (NBIS) were updated in the Federal Register on May 6, 2022. Data reported to the National Bridge Inventory (NBI) had, under the previous NBIS Standard, followed the guidance of the *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* (Coding Guide). This document has been replaced with the *Specifications for the National Bridge Inventory* (SNBI).

The BAG has been updated to help ease this transition by providing content to reflect changes in the NBIS and relevant information from both the Coding Guide and the SNBI to assist agencies as they transition into SNBI reporting. Content related to the Coding Guide is prefaced with the identifier “Coding Guide:”, written in small caps, and bound by two horizontal lines.

Additional resources may be found in the current American Association of State Highway and Transportation Officials (AASHTO) Manual for Bridge Evaluation.

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Goals/Objectives of this Manual

The purpose of the BAG is to reinforce the policies and procedures of MDOT, ensure statewide consistency with reference to completing and documenting load ratings, and to improve and maintain compliance with applicable federal laws, regulations and policies.

The specific objectives of this manual include:

- Ensuring the safety of the traveling public.
- Providing general instructions to load rate for changes in condition, construction, changes in dead or live loads, overload permits, and posting for weight limits.
- Improving the quality and consistency of load rating procedures.
- Providing guidance to comply with federal laws, regulations and policies.
- Increasing overall knowledge of the MDOT load rating policies and procedures.

Additional Resources

The Manual for Bridge Evaluation, 3rd Edition, 2018 with 2018 Errata, 2019 and 2022 Interim Revisions. American Association of State Highway Transportation Officials (AASHTO) Washington, D.C.

AASHTO LRFD Bridge Design Specifications, 9th Edition, 2020. American Association of State Highway Transportation Officials (AASHTO) Washington, D.C.

Standard Specifications for Highway Bridges, 17th Edition, 2002 with 2003 Errata. American Association of State Highway Transportation Officials (AASHTO) Washington, D.C.

National Bridge Inspection Standards, May 6, 2022, A Rule by the Federal Highway Administration (FHWA), US Department of Transportation, Washington, D.C.

Specifications for the National Bridge Inventory, March 2022, Publication No. FHWA-HIF-22-017, Federal Highway Administration (FHWA), US Department of Transportation, Washington, D.C.

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Chapter 1

PROGRAM REQUIREMENTS

1.01 Purpose

The National Bridge Inspection Standards (NBIS), Code of Federal Regulations: 23 CFR §650 Subpart C, require each state transportation department to inspect, or cause to be inspected, all structures defined as highway bridges located on all public roads, on and off federal-aid highways, including tribally owned and federally owned bridges, private bridges that are connected to a public road on both ends of the bridge, temporary bridges and bridges under construction with portions open to traffic.

Michigan has a decentralized bridge inspection program that delegates inspection responsibilities to the MDOT regions and local agencies throughout the state. For a complete list of the roles and responsibilities within the state of Michigan with regard to bridge inspection, please refer to the Michigan Structure Inspection Manual.

1.02 Organization and Responsibilities

The NBIS, 23 CFR §650.307, defines that the state's transportation department is responsible for establishing policies and procedures, completing quality assurance and quality control, and preparation and maintenance of the bridge inventory. The transportation department is also responsible for ensuring the completion of bridge inspections, reports, load ratings and other requirements as established by the NBIS. The provisions of the NBIS allow portions of these requirements to be delegated but such delegation does not relieve the state's transportation department of overall responsibility.

MDOT, the County Road Association (CRA) of Michigan and the Michigan Municipal League (MML) have initiated a program to contract out and manage bridge inspection and load rating responsibilities in accordance with the NBIS for all Act 51 local agencies for five years. Beginning in 2026, MDOT will manage consultant contracts to perform load ratings and load rating updates of local agency bridges in accordance with the NBIS in collaboration and coordination with local agency owners under the guidance and supervision of MDOT. Bridge owners are still responsible for erecting posting signs, placing

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traffic control barriers to restrict lanes or close the bridge when needed, addressing critical findings, maintenance activities and analyzing permit requests on their structures.

Federal Highway Administration

The Federal Highway Administration (FHWA) developed and implemented the current review process to evaluate a state's bridge inspection program for compliance with the NBIS in 2011 as required by United States Code: 23 USC §144(h)(4)(A). Each FHWA division office annually assesses the state's compliance with 23 individual metrics that are directly aligned with the existing NBIS regulation. The metrics, or measures, are designed to assess the quality and performance of each state's bridge inspection program and, collectively, the national program that has been established to assure highway bridge safety.

The risk-based assessment process followed during this annual assessment utilizes objective data, employs statistical sampling of data and inspection records, and includes defined criteria for compliance for each metric. Refer to the FHWA National Bridge Inspection Program Compliance Review Manual for detailed information regarding the compliance review and timeline. This document also describes the criteria for evaluating the inspection program. Metrics specifically addressing load rating include:

Metric 13 - Inspection procedures - **Load Rating** (23 CFR §650.313(k))

Metric 14 - Inspection Procedures - **Post or Restrict** (23 CFR §650.313(l),(m))

MDOT Bureau of Bridges and Structures

The MDOT Bureau of Bridges and Structures serves as a statewide resource to achieve and maintain alignment on all field-related bridge issues and provides technical guidance for construction, maintenance and safety inspection of bridges and structures.

The MDOT load rating program is administered by the Bridge Load Rating Unit. The program is responsible for ensuring that all bridges are load rated to verify their safe load carrying capacity in accordance with the NBIS. The unit is also responsible for developing and maintaining load rating guidance for assessing bridges within the

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state of Michigan for maximum legal loads and permit loads and coordinates the scheduling of load rating workshops and training.

The Bridge Load Rating Unit is responsible for ensuring that all load analyses are completed or reviewed by a professional engineer registered in the state of Michigan. The Bridge Load Rating Unit performs load capacity evaluations of complex bridges, truss bridges, movable bridges and all other structures within the state-owned inventory. The unit also serves as the technical consultant to MDOT divisions, regions and local agencies, and is responsible for assisting in FHWA NBIS Metric evaluations.

State and Non-State Bridge Owners

The primary role of the bridge owner is to ensure that timely and accurate bridge safety inspections and load rating analyses are completed for all structures within their jurisdiction.

State-owned Structures

MDOT Statewide Bridge Owners: Large deck, unique and movable bridges are owned by the Bureau of Bridges and Structures. Due to the complex nature of these structures, maintenance and management oversight from the central office allows for efficient diagnosis of issues that arise by a team of specialists, including the statewide bridge repair crew.

MDOT Region Bridge Owners: All region bridge engineers serve as the bridge owner of structures meeting NBIS length requirements on state-owned routes within their jurisdiction except those owned by the MDOT Bureau of Bridges and Structures.

Bridge Authorities: Two bridge authorities exist within the state of Michigan to manage two of the most well-known structures in the area. The Mackinac Bridge Authority preserves and maintains the longest suspension bridge in the Western Hemisphere, connecting the two peninsulas of the state. The International Bridge Authority joins northern Michigan to Ontario, Canada, creating a vital corridor for international trade and tourism within the region.

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Non-state-owned Structures

Local Agency Bridge Owners: County, city, village and township managers serve as the bridge owners within their designated unit of local government.

Private Bridge Owners: The individual or company with ownership of a structure that has public roadways at each end of the bridge.

Load Rating Engineer

Load rating engineers are responsible for load rating bridges to verify their safe loadcarrying capacity in accordance with the NBIS.

Qualifications

Load ratings must be performed by, or under the direct supervision of, a registered professional engineer in the state of Michigan. It is recommended that this individual has a minimum of five years of bridge design and/or inspection experience. The engineering skills and knowledge necessary to properly evaluate bridges may vary widely depending on the complexity of the bridge involved. The specialized skills and knowledge of other engineers may be needed to ensure proper evaluation.

MDOT requires that load rating engineers be trained in the use of AASHTOWare Bridge Rating (BrR) software and/or load rating software capable of analyzing steel, reinforced concrete and prestressed concrete bridges and culverts.

Load rating engineers should also have access to and be knowledgeable in the use of the MDOT BAG, AASHTO Manual for Bridge Evaluation, AASHTO LRFD Bridge Design Specifications, AASHTO Standard Specifications for Highway Bridges, Specifications for the National Bridge Inventory, and the Michigan Structure Inventory and Appraisal Coding Guide/Michigan Specifications for the National Bridge Inventory.

There is no recurrent training requirement; however, MDOT highly recommends that load rating engineers stay up to date with requirements of the NBIS, as well as current practices and procedures. It is the responsibility

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of the load rating engineer to rate each bridge to its safe load carrying capacity in accordance with the NBIS.

Consultants interested in service contracting with MDOT must have the relevant prequalifications to perform the work. See MDOT's consultant prequalification application instructions for additional staff education and experience requirements.

Chapter 2

LOAD RATING INTRODUCTION

2.01 What Is Load Rating?

A load rating is a measure of the safe load carrying capacity of a bridge. The primary purpose of load rating is to ensure the safety of the traveling public by verifying that every bridge in the Michigan inventory can carry all Michigan legal vehicles and if restrictions are necessary for overweight permit loads. Bridges with insufficient load capacity are to be posted for restricted loads, or in some circumstances may be closed. Load rating analyses are required to satisfy federal regulations, evaluate overweight vehicles and aid in design-related decisions.

Definitions for load rating terminology:

Inventory Load Rating: The inventory rating represents the maximum load that can safely be carried by the structure indefinitely and corresponds to the design level of reliability. This is represented with an inventory level live load factor of 1.75 for load and resistance factor rating (LRFR) and 2.17 for load factor rating (LFR) (MBE Table B6A.1 and 6B.4.3, respectively). It uses current load distribution factors, reflects the existing member condition (including any noted deterioration), and is expressed as a rating factor. The inventory rating is calculated using LRFR, LFR, or, for timber and masonry bridges only, the allowable stress rating (ASR) method.* The applied live load is the AASHTO HL-93 loading configuration for LRFR and the HS-20 loading configuration for LFR and ASR. The inventory load rating factor is reported according to B.LR.05 of the SNBI.

Operating Load Rating: The operating rating represents the maximum permissible live load to which the bridge may be subjected. This is accomplished with a lower live load factor than what is used for inventory rating, with an operating level live load factor of 1.35 for LRFR and 1.3 for LFR (MBE Table B6A.1 and 6B.4.3, respectively). Like the inventory rating, it reflects the existing member condition (including any noted deterioration), and is expressed as a rating factor. It is calculated using LRFR, LFR, or ASR (for timber and masonry bridges only).* The applied live load is the AASHTO HL-93 loading configuration for LRFR and the HS-20

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loading configuration for LFR and ASR. The operating rating is reported according to B.LR.06 of the SNBI.

Legal Load Rating: The legal load rating represents the maximum permissible legal load to which the bridge may be subjected. The legal load rating uses the operating level live load factor; however, the live load factor for Michigan trucks varies per vehicle and is based on ADTT when using LRFR (see Tables 4a-1 through 4a-6) and is 1.3 for LFR (MBE 6B.4.3). The legal load rating reflects the existing member condition (including any noted deterioration), and is expressed as a rating factor. The legal load rating can be calculated using LRFR, LFR, or ASR (for timber and masonry bridges only). * MBE 6A.2.3.1 and Section 5 of the SNBI identify the applicable live loads that consists of 25 Michigan legal vehicle configurations, three AASHTO routine commercial legal vehicle configurations (Type 3, 3S2 and 3-3) along with the AASHTO specialized haul vehicle configurations (SU4, SU5, SU6, and SU7), and the FHWA emergency vehicle configurations (EV2 and EV3). These rating vehicle configurations are discussed in Chapter 3. Chapter 3 also describes MDOT policy on excluding some of the vehicles identified in this section through research comparing the load effects of these vehicles to Michigan legal vehicles. The legal load rating is reported according to B.LR.07 of the SNBI.

Load Posting: When a load rating analysis concludes that a structure cannot safely carry all legal loads at the operating level, the structure must be posted for weight limits. To extend the life of a structure, agencies may elect to post a bridge for less than the calculated capacity, or at the inventory rating level. See Chapter 7 for additional load posting guidance. The status of load postings is recorded in B.PS.01 of the SNBI.

Permit Loads: Occasionally, vehicles that have axle configurations or axle loads prohibited by Michigan law may need to use the highway system. These vehicles are required to obtain a permit from the agency owning the highway and bridges in question. It is critical to analyze the capacity of the bridges to be crossed for their ability to safely carry the permit vehicle configuration. Permit load analysis is typically performed at the operating level, though agencies may elect to analyze permit loads at the inventory level to extend the life of the structure. Permits should be issued or denied based on the load rating analysis. Chapter 8 discusses permit load analysis further.

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Routine Permit Loads: These are sometimes referred to as annual permits and are defined as a live load that has a gross weight, axle weight or distance between axles not conforming with state statutes for legally configured vehicles, authorized for unlimited trips over an extended period of time to move alongside other heavy vehicles on a regular basis (NBIS 650.305). The ability for a bridge to carry or restrict routine permit loads is reported in B.LR.08 of the SNBI.

* Clarification of the FHWA policy on appropriate methodologies was provided in a memo “Information: Bridge Load Ratings for the National Bridge Inventory” issued Oct 30, 2006.

2.02 When to Perform a Load Rating

The requirement to perform load ratings on NBI highway bridges stems from federal law and can be found in the NBIS within the Code of Federal Regulations. Specifically, Title 23, Chapter 1, Subchapter G, Part 650, Subpart C, 650.313(k) Inspection Procedures/Load Rating reads:

- (1) Rate each bridge as to its safe load capacity in accordance with Sections 6 and 8, excluding the 3rd paragraph in Section 6B.7.1, AASHTO Manual (incorporated by reference, see § 650.317).
- (2) Develop and document procedures for completion of new and updated bridge load ratings. Load ratings must be completed as soon as practical, but no later than three months after the initial inspection and when a change is identified that warrants a re-rating such as, but not limited to, changes in condition, reconstruction, new construction or changes in dead or live loads.
- (3) Analyze routine and special permit loads for each bridge that these loads cross to verify the bridge can safely carry the load.

Generally, a load rating analysis is required under the circumstances of one of the following:

New Construction: New bridges must be load rated to comply with the Code of Federal Regulations requirements previously cited. The load rating must be updated in the inventory within three months of the bridge opening to traffic.

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Rehabilitation: A load rating is required when a bridge element has been repaired, rehabilitated, reconstructed or altered in a way that may affect the load carrying capacity of the bridge. Examples include deep and shallow concrete overlays, bituminous overlays, barrier replacements, deck replacement or widening, adding or removing sidewalk or median, pin and hanger replacement, and superstructure replacement. The load rating engineer must incorporate all changes that result from the work performed. The load rating must be updated in the inventory within three months of the bridge opening to traffic.

Damage: A load rating is required when a bridge has incurred damage that affects its capacity. Generally, this results from an incident in which a vehicle strikes a beam or substructure unit, causing significant damage. An inspection may be necessary to determine the nature and extent of the damage to include in the updated load rating. The load rating must be updated in the inventory within three months of verifying the nature and extent of the damage to include in the load rating.

Change in Field Condition: A new or updated load rating is required if a field inspection indicates that one or more key elements have deteriorated such that the previous load rating is no longer representative of the structure's condition. Examples include beam flange or web section loss, deck deterioration and substructure section loss or misalignment. A detailed inspection may be necessary to determine the location(s), measurement(s) and extent of the deterioration to include in the updated load rating. The load rating must be updated in the inventory within three months of verifying the structure condition with enough detail to perform the load rating.

Permit Request (routine or single trip): A load rating analysis is required when a permit application is submitted for a vehicle exceeding Michigan legal loads to travel over a bridge or series of bridges. A load rating must be performed to verify the capacity of the bridge(s) to safely carry the permit vehicle before the permit application can be approved or rejected.

There are certain situations that may require a load rating analysis, such as the introduction of new legal vehicles or other policy changes.

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All load ratings must be performed based on the field findings of the most recent bridge inspection. In addition, the design and/or shop drawings and as-built plans for the structure must be reviewed, if available.

2.03 What to Load Rate

Structural elements in the direct load path (transferring vehicle loads to supporting earth) are the subject of bridge load ratings. Load ratings are typically performed for the primary load carrying elements within the superstructure. Investigation of decks or substructures are performed when justified by the engineer, usually in response to deterioration. Secondary elements, defined in the following for each superstructure type, may be load rated if deterioration is believed to have lowered the element design capacity.

A load rating usually includes analysis of the following typical items:

Superstructures

Superstructure components (girders, beams, arches, trusses, floorbeams, stringers, etc.) must always be load rated. This includes slab bridges. The load rating must be consistent with the current inspected condition of the bridge. Inspectors must be aware of, monitor and report the condition of critical elements on a bridge.

Steel girder structures: Primary elements for rating include interior and exterior girders, floorbeams and stringers (if present), and the concrete deck (as it relates to composite action with the girders and for negative moment applications). Diaphragms or cross frames in a curved girder structure and pin-and-hanger assemblies are also considered primary elements.

Secondary elements include bolted web or flange splices, diaphragms and/or cross frames in a straight non-curved girder, stringer-to-floorbeam and floorbeam-to-girder connections (if present), and bearings.

Prestressed concrete structures: Primary elements for rating include interior and exterior girders and the concrete deck (as it relates to composite action with the girders and for negative moment applications).

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Secondary elements include diaphragms.

Concrete slab structures: Primary elements include the structural concrete slab for both interior and exterior slab strips. If present, an integral concrete pier cap or increased transverse reinforcement at the pier would be considered primary elements.

Steel truss structures: Primary elements consist of truss chord and diagonal members, gusset plates connecting truss chord or diagonal members, floorbeams and stringers (if present). If panel points were designed as braced, bracing members and connections may be considered primary.

Secondary elements include splices, stringer-to-floorbeam and floorbeam-to-truss connections, lateral bracing and gusset plates used to connect secondary elements.

Timber girder or slab structures: Primary elements include timber girders or glue/nail laminated timber panels. Secondary elements include diaphragms (solid sawn or cross bracing), stiffener beams or any tie rods that are present.

Decks

In general, stringer-supported concrete or metal decks do not control the load rating except in special cases as noted in section 6.1.5.1 of the MBE. Timber decks that exhibit excessive deformation or deflections under normal traffic loads should be considered for further evaluation. See MBE C6.1.5.1 for more information on why decks generally do not control a rating.

Decks generally do not control the load rating because the maximum axle load of the HL-93 or HS-20 design vehicle is 32 kips compared to the maximum normal legal axle load of 18 kips or the maximum special designated legal axle load of either 20 kips or a 34-kip tandem (32-kip axle in design truck mimics this). In addition, bending in two directions (plate action) is a known behavior of deck slabs that may have been excluded in the original design but does have a significant effect on the capacity of the slab.

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It is MDOT policy to load rate decks originally designed for H-10 and H-15 loading as these decks may be overloaded by the tandem axles of the designated and special designated legal vehicles. AASHTO Standard Specifications section 3.24.3.1 is based on a spread of the effect of individual wheel loads. Based on a study of this method, for bridges with typical beam spacing, the moment effect of the wheels of tandem axles spaced at 3 feet, 6 inches will overlap, creating an additive effect. Therefore, it is appropriate to load rate decks originally designed for H-15 loading for the legal load rating when they are subject to designated or special designated loading.

Substructures

Substructures are not normally considered during a routine load rating. Substructure elements such as timber or steel pier caps and columns should be checked if an engineer decides a load rating is necessary. Examples of situations in which a substructure might be rated are:

- Significant additional loads are added to the bridge.
- Damage, deterioration or instability is found.
- Increase in unbraced column length (caused by rehab, repair or scour).
- Any situation where the capacity for legal and permit traffic is questioned.

MBE section 6.1.5.2 provides guidance on application of loads during an analysis consisting of all permanent loads and loads due to braking and centrifugal forces.

Buried Structures

Buried structures are required to be rated.

2.04 Primary Reference Manuals

2.04.01 AASHTO Manuals

Manual for Bridge Evaluation, current edition with interim revisions

The purpose of this manual is to aid bridge owners with inspection procedures and evaluation practices in accordance with the NBIS. The information contained in this MDOT BAG is based largely on information available in this AASHTO manual.

LRFD Bridge Design Specifications, current edition

This manual was first published in 1994 and became the design requirement of all new bridges with preliminary engineering initiated after Oct. 1, 2007.

Standard Specifications for Highway Bridges, 17th Edition

This AASHTO manual has been sunset for new design but may be relevant in understanding historical aspects of existing bridges designed and built under these specifications. Both allowable stress design and load factor design are covered in the standard specifications.

Guide Specifications for Horizontally Curved Steel Girder Highway Bridges, 2003

This manual guides the user in design specifications and evaluation of horizontally curved steel girder structures.

Guide Specifications for Distribution of Loads for Highway Bridges, 1994

This manual introduced a new load distribution equation resulting from NCHRP project 12-26. The new equation is based on parametric studies and finite element analysis to replace the $S/\#$ equations developed in the 1930s.

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2.04.02 FHWA Manuals

Specifications for the National Bridge Inventory, 2022

The SNBI is incorporated by reference in the NBIS and provides the specifications for reporting data for highway bridges to the FHWA for inclusion in the National Bridge Inventory (NBI).

2.04.03 MDOT Manuals

Bridge Design Manual, current and historic editions

When existing plans of the subject bridge are unavailable, the MDOT Bridge Design Manual may provide useful information regarding the design techniques/criteria common to the year the bridge was built.

Bridge Design Guides, current and historic editions

The MDOT Bridge Design Guides contain drawings and cross-sectional properties for a variety of common prestressed concrete beams used in Michigan. When existing plans of the subject bridge are unavailable, the MDOT Bridge Design Guides may provide useful information regarding the design techniques/criteria common to the year the bridge was built.

Standard Specifications for Construction, current and historic editions

Current and past editions of the MDOT Standard Specifications for Construction may be helpful in understanding the construction specifications at the time a bridge was built or modified. These specifications provide information useful in determining the original material properties of concrete, structural steel and steel reinforcement.

Specifications for Design of Highway Bridges, historic editions

A complete description of bridge design practice at MDOT in 1958. Similar content exists from 1936 and within the general specifications from 1914-1922.

Historic Road and Bridge Standard Plans

Similar to the Bridge Design Manual and Bridge Design Guides, older standard plans may also provide helpful information. Standard plans may contain details for bridge

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railings and other appurtenant structures as well as detailed information for standard bridge and culvert designs.

Structure Inventory and Appraisal Coding Guide

This guide is intended to aid local agencies in completing and submitting the structure inventory and appraisal forms for all bridges in their jurisdiction. It will be replaced when the SNBI (see previously mentioned FHWA manuals) goes into effect.

2.04.04 Other Resources

Steel Construction Manual, current edition

The Steel Construction Manual is published by the American Institute of Steel Construction (AISC) and contains material and cross-sectional properties for common steel shapes.

PCI Bridge Design Manual, current edition

The Precast/Prestressed Concrete Institute publishes the PCI Bridge Design Manual. The manual provides further explanation on bridge design with regard to precast/prestressed components and information on standard beams.

ACI 318: Building Code Requirements for Structural Concrete and Commentary, current edition

The American Concrete Institute's building code provides technical information on concrete design.

NCSPA Design Data Sheet No. 19: Load Rating and Structural Evaluation of In-Service, Corrugated Steel Structures

The National Corrugated Steel Pipe Association provides a design data sheet to assist in load rating corrugated steel pipe culverts.

Chapter 3

LOAD RATING METHODOLOGY

A load rating analysis may be performed using either analytical methods or empirical methods, such as load testing or field evaluation and documented judgment rating.

3.01 Analytical Methods

There are three primary analytical methods used for load rating: LRFR, LFR and allowable stress rating (ASR).

Structures designed using load and resistance factor design (LRFD) and/or built after October 2010 shall be rated in LRFR. Existing structures designed in load factor design (LFD) or allowable stress design (ASD) may be rated with either LRFR or LFR. Timber or masonry bridges may be rated in LRFR or ASR. See FHWA memo “Information: Bridge Load Ratings for the National Bridge Inventory” dated Oct. 30, 2006, for more detailed information regarding analytical methods applicable for a specific situation.

Ratings are calculated generally assuming one standard truck per lane for each span, with the number of lanes loaded to produce the maximum load effect. Lane loadings may be continuous or discontinuous. See the appendix for a complete listing of maximum moments and shears produced by legal loads for all span lengths between 5 feet and 300 feet.

3.01.01 Load and Resistance Factor Design/Rating

LRFD was implemented in the 1990s for design and analysis of highway structures. This method is an extension of the LFD theory. LRFD is more refined in terms of the use of probability and statistical data for both loads and member capacities. New live load configurations were developed and equations were rewritten to include relevant research.

The AASHTO LRFD Specifications define the design vehicular live load as the design vehicle **or** design tandem **and** the design lane load. This is referred to as the HL-93 loading. These live load configurations are shown in Chapter 4.

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There are four categories of bridge rating under LRFR. The three that apply to legal loads are shown in the following; for permit loads, see Chapter 8.

Inventory Load Rating

1. HL-93 loading.
2. As many lanes may be loaded as is required to produce the maximum desired effect.
3. Reported as a rating factor in SNBI B.LR.05.

Operating Load Rating

1. HL-93 loading.
2. As many lanes may be loaded as is required to produce the maximum desired effect.
3. Reported as a rating factor in SNBI B.LR.06.

Legal Load Rating

The purpose of the legal load rating is to provide a uniform performance measure of a structure's load carrying capacity relative to the unique legal loads in Michigan at the operating level.

1. The federal legal load rating vehicles are described in *MBE 6A.4.4.2 - Live Loads and Load Factors*. Michigan legal load rating vehicles are described in Chapter 4. The live loads identified in these resources consist of 25 Michigan legal vehicles, three AASHTO routine commercial legal vehicles (Type 3, Type 3S2, Type 3-3), four AASHTO specialized hauling vehicles (SU4, SU5, SU6 and SU7), and two FHWA emergency vehicles (EV2 and EV3).
 - a. MDOT research has shown that for typical span lengths (greater than 35 feet), the moment and shear load effects for the AASHTO specialized hauling vehicles and the FHWA emergency vehicles are enveloped by the maximum load effects from the 25 state legal vehicles and the AASHTO routine commercial legal vehicles Type 3, Type 3S2, and Type 3-3 (*AASHTO Special Haul Vehicle (SHV) Comparison with Michigan Legal Loads (2013) and FAST Act Emergency Vehicle (EV) Load Effect Comparison with AASHTO and*

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Michigan Legal Loads (2017)). As such, it is MDOT policy to not include the AASHTO specialized hauling vehicles or the FHWA emergency vehicles when completing load rating calculations. If, however, the rating factor for any of the Michigan and AASHTO routine commercial legal vehicles is less than 1.0, the AASHTO specialized hauling vehicles and the FHWA emergency vehicles must be included when determining the posted weight limits.

- b. All truck configurations used for the load rating analysis must be recorded in SNBI B.EP.01.
2. The live load factor, γ_{LL} , for the Strength I and II limit states varies based on the average daily truck traffic (ADTT) of the structure and the weight of the truck being analyzed. See Chapter 6, Tables 6.1 - 6.3.
3. The live load factor for the Service II limit state varies based on the weight of the truck being analyzed (MBE Table 6A.4.2.2-1 and MDOT Research Report R-1511).
 - a. Trucks with a gross vehicle weight (GVW) less than or equal to 100 kip use a load factor of 1.3.
 - b. Trucks with a GVW greater than 100 kip use a load factor of 1.0.
4. The loading configurations vary according to span length GVW. Table 3.1 summarizes the loading configurations required to analyze legal loads.
 - a. For span lengths less than 200 feet:

Positive moment, shear, and reactions at exterior supports: Vehicles (truck plus impact) shall be applied one per lane, with as many lanes loaded as required to produce the maximum desired effect.

Negative moment and reactions at interior supports: The AASHTO MBE 6A.4.4.2 states that for negative moments and reactions at interior supports, a lane load of 0.2 klf combined with two AASHTO Type 3-3 vehicles or state legal loads multiplied by 0.75 heading in the same direction separated by 30 feet should be considered. See Table 3.1 for legal-heavy trucks (GVW greater than 100,000).
 - b. For span lengths between 200 feet and 400 feet:

Positive moment, shear, and reactions at exterior supports: Vehicles (truck plus impact) shall be applied one per lane, with as many lanes loaded as required to produce the maximum desired effect.

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Negative moment and reactions at interior supports: The AASHTO MBE 6A.4.4.2 states that for negative moments and reactions at interior supports, a lane load of 0.2 klf combined with two AASHTO Type 3-3 vehicles or state legal loads multiplied by 0.75 heading in the same direction separated by 30 feet should be considered. See Table 3.1 for legal-heavy trucks (GVW greater than 100,000).

- c. For spans greater than 400 feet: Site-specific analysis is required.

Table 3.1: LRFR Loading Configurations for Legal, Legal-Heavy (Greater than 100,000)

Span Length	Load Effect	Legal Trucks GVW ≤ 100 kips	Legal-Heavy Trucks GVW > 100 kips
L \leq 200 feet	Positive moment, shear and reactions at exterior supports	Truck + Impact	Truck + Impact
	Negative moment and reactions at interior supports	0.75* (Two trucks spaced 30 feet apart + Impact) + 0.2 klf	(Truck + Impact) + 0.2 klf
200 feet $<$ L \leq 400 feet	Positive moment, shear and reactions at exterior supports	0.75* (Truck + Impact) + 0.2 klf	(Truck + Impact) + 0.2 klf
	Negative moment and reactions at interior supports	0.75* (Two trucks spaced 30 feet apart + Impact) + 0.2 klf	(Truck + Impact) + 0.2 klf

- 5. Reported as a rating factor in SNBI B.LR.07

Permit Load Rating

This capacity rating is used when a request has been made to transport a load that does not conform with state statutes for legally configured vehicles.

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There are two levels of permits identified in LRFR. See Table 6A.4.5.4.2a-1 of the *AASHTO Manual for Bridge Evaluation* (MBE) for more information.

1. Routine permits are annual or unlimited permits that are allowed to mix with traffic.
 - a. Routine permits use the Strength II limit state live load factors, γ_{LL} , as identified in Tables 6.4 - 6.6, based on ADTT and GVW. These permits are based on as many lanes loaded as would produce the maximum effect.
 - b. The ability of a bridge to carry a routine permit load is reported in SNBI B.LR.08.
2. Special or limited crossings are limited to less than 100 crossings and may or may not be escorted to prevent other vehicles on the structure.
 - a. Special or limited crossing permits may use the strength limit state live load factors given in Table 6A.4.5.4.2a-1 of the MBE. These permits are based on single-lane loading.
 - b. There is no item in the SBNI for reporting special or limited crossing permits.
3. The live load factor used for the Service II limit state is 1.0 for permit vehicles (MBE Table 6A.4.2.2-1).
4. The loading configuration of permit loads varies for moments and shear at interior supports as well as for span lengths greater than 200 feet. Table 3.2 summarizes the loading configurations required to analyze permit loads. Spans greater than 400 feet require site-specific analysis.

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Table 3.2: LRFR Loading Configurations for Permit Loads

Span Length	Load Effect	Permit Trucks
$L \leq 200$ feet	Positive moment, shear and reactions at exterior supports	Truck + Impact
	Negative moment and reactions at interior supports	(Truck + Impact) + 0.2 klf
$200 \text{ feet} < L \leq 400$ feet	Positive moment, shear and reactions at exterior supports	(Truck + Impact) + 0.2 klf
	Negative moment and reactions at interior supports	(Truck + Impact) + 0.2 klf

3.01.02 Load Factor Design/Rating

LFD was implemented by AASHTO in the early 1970s. In the LFD methodology, various factors are applied to the loads to increase them based on the predictability of each load type. Load factors for live loads are higher than for dead loads because dead loads can be calculated fairly accurately, whereas live loads are more unpredictable. In addition, reduction factors are applied to the strength of each structural member. These reduction factors lower the strength of the member based on the probabilities of achieving the design material properties and dimensional accuracy of the member, among other potential variables. LFD is also based on the knowledge that members continue to gain capacity beyond the linear stress versus strain stage.

The HS-20 truck and lane load (LFR) is used to calculate the inventory and operating rating for each structure. These live load configurations are shown in Figure 4.01.01.

The HS-20 truck load typically controls shorter span lengths while the lane load controls longer span lengths. Ratings are calculated assuming one standard truck per lane for each span, with the number of lanes loaded to produce the maximum load effect. Lane loadings may be continuous or discontinuous. See the appendix for a complete listing of maximum moments and shears for all span lengths between 5 and 300 feet.

There are four categories of bridge rating under LFR. The three that apply to legal loads are shown in the following; for permit loads, see Chapter 8.

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Inventory Load Rating

1. HS-20 truck or lane load.
2. For continuous structures, lane loadings may be continuous or discontinuous. See AASHTO Standard Specifications Section 3.11.3 for application of an additional concentrated load for negative moment determination.
3. As many lanes may be loaded as is required to produce the maximum desired effect.
4. Reported as a rating factor in SNBI B.LR.05.

Operating Load Rating

1. HS-20 truck or lane load.
2. For continuous structures, lane loadings may be continuous or discontinuous. See AASHTO Standard Specifications Section 3.11.3 for application of an additional concentrated load for negative moment determination.
3. As many lanes may be loaded as is required to produce the maximum desired effect.
4. Reported as a rating factor in SNBI B.LR.06.

Legal Load Rating

The purpose of the legal load rating is to provide a uniform performance measure of a structure's load carrying capacity relative to the unique legal loads in Michigan.

1. The legal load rating vehicles are described in MBE 6B.6.2.2 - Truck Loads and 6B.7.2 - Posting Loads. Michigan legal load rating vehicles are described in Chapter 4. The live loads identified in these resources consist of 25 Michigan legal vehicles, three AASHTO routine commercial legal vehicles (Type 3, Type 3S2, Type 3-3), four AASHTO specialized hauling vehicles (SU4, SU5, SU6 and SU7), and two FHWA emergency vehicles (EV2 and EV3).
 - a. MDOT research has shown that for typical span lengths, the moment and shear load effects for the AASHTO specialized hauling vehicles and the FHWA emergency vehicles are enveloped by the maximum load effects from the 25 state legal vehicles. For LFR analysis, where the live load factors are constant across all Michigan legal vehicles, MDOT has a practice to analyze using Michigan legal vehicles 5DL,

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17DL, 18DL and 23DL. If the rating factor is less than 1.05 for any of the four vehicles then all 25 Michigan legal loads and the AASHTO routine commercial legal vehicles Type 3, Type 3S2 and Type 3-3 must be run. It is MDOT policy to not include the AASHTO specialized hauling vehicles or the FHWA emergency vehicles when completing load rating calculations. If, however, the rating factor for any of the Michigan and AASHTO routine commercial legal vehicles is less than 1.0, the AASHTO specialized hauling vehicles and the FHWA emergency vehicles must be included when determining the posted weight limits (see Chapter 7).

- b. All truck configurations used for the load rating analysis must be recorded in SNBI B.EP.01.
2. For spans less than or equal to 200 feet in length, the vehicles shall be applied one per lane, with as many lanes loaded as is required to produce the maximum desired effect.

For spans 200 feet and greater, one lane shall be occupied by a train of any of the legal vehicles described above with a nose to tail spacing of 30 feet. This train can be idealized as a distributed load specific to each vehicle type. See Figure 2.2 for distributed load values of the equivalent train load for each vehicle. Additional lanes shall be loaded with one legal vehicle (the same legal vehicle as is used for the equivalent train load) per lane, with as many lanes loaded as is required to produce the maximum desired effect. For the circumstance where live load varies between adjacent lanes, standard live load distribution factors (LLDF) for interior beams are not applicable. See Chapter 5 for live load distribution for this circumstance.

3. Reported as a rating factor in SNBI B.LR.07.

3.01.03 Allowable Stress Design/Rating

ASD, sometimes referred to as working stress design, is the oldest of the three methods previously introduced. This was the design philosophy used in the earliest *Standard Specification for Highway Bridges*, issued by AASHTO in 1931. In this method, service (or unfactored) loads are applied to the structure and used to determine stresses. The relationship between stress and strain is always taken as linear. The calculated stresses are then compared to an allowable stress. The

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allowable stresses are determined by applying a factor of safety to the yield stress or ultimate stress of the material. In ASD, live load is treated with the same certainty as dead load. Only timber or masonry bridges may be load rated using ASR.

3.02 Empirical Methods

3.02.01 Field Evaluation and Documented Engineering Judgment Ratings

For bridges where necessary details are not available from plans, design calculations, or shop drawings and that information cannot be obtained from field measurement or other means, an approximate but conservative load rating based on a physical inspection, field measurements and rational criteria may be produced by a qualified engineer. Every effort should be made to locate the structure plans or obtain field data required to perform the analysis and load rating. Applicability is limited to reinforced and prestressed concrete structures or other structures under special circumstances as determined by the engineer and approved by MDOT and FHWA.

The appropriate rating(s) shall be determined by the engineer upon careful consideration of all available information including but not limited to:

1. Comparable structures with era-appropriate designs may be used to conservatively approximate the capacity of a structure with unknown components. The date of the comparable structure's plan should pre-date the structure in question. The factors considered to determine the structures are comparable shall be documented.
2. Material properties may be estimated using the year built and an appropriate reference, such as Tables 10.25-10.29. The reference used and the assumed material properties shall be documented.
3. The design vehicle and/or loading may be assumed from the year built. A history of Michigan design loads is included in Chapter 4.
 - a. The observed performance of the structure under traffic shall be noted. Based on field observations and route ADTT information, consider the likelihood that the bridge has been subjected to full legal loads. For

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example, if a bridge is on a low volume rural roadway with little or no truck traffic, it may not have been designed for, nor ever subjected to, full legal loads. In such cases, posting may be necessary to prevent overload of the structure even if it does not show signs of distress.

4. Condition of load carrying components shall be documented in detail and any observed conditions that could affect structural capacity shall be noted and accounted for in all judgment ratings. For example, the presence of vertical cracks near the middle of the span or diagonal cracks near the supports may indicate overstress of a concrete member, and posting may be necessary.
 - a. In the absence of measurable loss that would require a detailed section loss calculation, the capacity of structures shall be adjusted in accordance with the condition factors set forth in the AASHTO MBE Table 6A.4.2.3-1.
5. Modifications to the structure since the original construction, including structural and non-structural modifications, can increase or decrease member capacities. Any observed modifications shall be documented and effects to the structure noted.
6. The capacity of structures with limited redundancy may be adjusted in accordance with the system factors set forth in AASHTO MBE Table 6A.4.2.4-1.
7. All the information gathered or missing should be documented along with any other assumptions used to complete the analysis.

Common Judgment Rating Methods

1. Field measured values, assumed material properties, and reinforcing and/or prestressing details may be used to complete a load rating using a rational method of analysis. All assumptions used in the analysis must be justified.
 - a. For example: “Plans for structure XYZ, which is a similar structure type and was built around the same time as the structure in question, shows #N bars at S-in spacing. Therefore, #N bars at S-in spacing is assumed in the analysis of this structure.”
2. Moment and shear tables for various vehicles/spans from the appendix may be used to complete a judgment rating analysis.

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- a. Compare the live load moments and shears between the design vehicle (assumed from year built) and the AASHTO HL-93 or HS-20 loading (as applicable based on the design method) and the Michigan legal and overload vehicles.
- b. The structure may be assumed to have a remaining capacity equal to an inventory rating of 1.0 for the design load at critical locations before consideration of deterioration or damage. Since the remaining capacity can be assumed to be constant, the ratio of the load effects (moment/shear) between the assumed design vehicle and the rating vehicle will be the rating vehicle's rating factor, adjusting for live load factors and impact between different specifications.
- c. Example: Given a structure in good condition with no observable sectional changes along the span with a critical load effect of moment at midspan and considering moment effects for a 30-foot span and the Michigan 1-unit trucks (similar for other vehicles and load effects), a judgement rating may be established as shown in Table 3.3. In this example rating factors for legal vehicles were scaled from the rating factor of the design load (HS-20) with the moment ratios at midspan. Note that load effect ratios vary with the section and load effect investigated. Therefore, it is important to identify the critical assumption used in this scaling.

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Table 3.3 Judgement Rating Procedure Example

Vehicles	Moments for a 30-foot span from tables in Appendix A (ft*k)	LFR Load Factors (A ₂) (MBE 6B.4.3)	Judgment Rating Factors*	Rating Level
Assumed Design Vehicle - H20 **	247	2.17	1.00	Inventory
AASHTO HS-20 or HL-93 loading	282	2.17	0.88	Inventory
AASHTO HS-20 or HL-93 loading	282	1.3	1.46	Operating
Truck #1	186	1.3	2.22	Operating
Truck #2	259	1.3	1.59	Operating
Truck #3	272	1.3	1.52	Operating
Truck #4	319	1.3	1.29	Operating
Truck #5	276	1.3	1.49	Operating

* (Inventory level load factor * assumed design vehicle moment) / (Desired rating level load factor (A₂) * rating vehicle moment)

** A rating of 1.0 for the Assumed Design Vehicle is indicative of a structure with no deterioration (structure condition is as designed)

3. AASHTOWare BrR may be used to aid in determining assumed reinforcing and/or prestressing details and complete a judgment rating analysis.
 - a. Model the structure in BrR and adjust the reinforcing and/or prestressing details until the design vehicle (assumed from year built) produces an inventory rating of 1.0 prior to inclusion of any deterioration into the model.
 - b. Assume this reinforcing for the member and re-run the model, including deterioration, using the AASHTO HL-93 or HS-20 loading (as applicable based on the rating method) and the Michigan legal and overload vehicles to determine the appropriate inventory, operating and legal rating factors and posted loads, if required.
 - c. Clearly identify the model as a “judgment rating” in the AASHTOWare BrR description field and summarize all assumptions made on the load rating assumptions form.

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4. Additional methods may be applicable. For example, axial/moment/shear interaction may be used for arch/frame structures.

If the strength of concrete or reinforcement is in question, material samples may be taken from the structure and tested. Material sampling shall be performed in accordance with Section 5 of the AASHTO MBE.

3.02.02 Assigned Load Ratings

Load ratings may be assigned based on the design loading provided the following conditions are met (FHWA Memo Action: Assigned Load Ratings dated Sept. 29, 2011):

1. Bridge was designed and checked using AASHTO LRFD or LFD methods for HL-93 or HS-20 loads, respectively.
2. Bridge was built per design plans.
3. No changes to the loading or structure conditions have occurred that could reduce the inventory rating below design load levels.
4. An evaluation has been completed and documented determining that the force effects from state legal or permit loads do not exceed those from the design load.
5. The checked design calculations must be accessible and referenced in the bridge records.

If complete design files have not been retained for an existing bridge, design plans that clearly identify the loading as at least HL-93 or HS-20 and bear the stamp of a licensed professional engineer may be used by the individual responsible for load rating as the basis for an assigned load rating. The approved design plans need to be documented as the basis for the assigned rating and become part of the official bridge records. This information demonstrates satisfaction of conditions (1) and (5). Conditions (2), (3) and (4) still need to be met.

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3.02.03 Load Testing

Producing a bridge or culvert load rating through the use of nondestructive load testing may be necessary in unique cases where conventional theoretical load rating calculations cannot be performed. This may be due but not limited to bridges where necessary details (such as reinforcement in a concrete bridge) are unavailable or the boundary conditions necessary for theoretical calculations are not satisfied.

Load tests can be broken into two classifications based on the objectives of the load test being conducted. In *diagnostic load testing*, loads of known magnitude (typically a small fraction of the design load) are applied to the structure to facilitate a comparison via extrapolation between an analytically predicted structural response and actual measured structural response. Note that in diagnostic load testing, care should be given to apply a load large enough to generate a measurable response. In *proof load testing*, a target load, based on Michigan legal loads defined in the Michigan BAG are applied to the structure. Guidance on determining the target load can be obtained from Section 8.8.3.3 of the AASHTO MBE. During a proof load test, careful consideration shall be given to measuring and observing structural response(s) to ensure the structure does not exceed the limit for linear elastic conditions as well as ensuring the structure does not exhibit signs of structural distress.

MBE Section 8: Nondestructive Load Testing provides guidance on recommended procedures and applications of load testing. MBE Appendix A8 - General Load Testing Procedures provides a step-by-step outline. Greater detail is provided in the NCHRP research article, “Manual for Bridge Load Rating through Load Testing.” Additional detailed guidance on performing a load test can be found in Transportation Research Circular E-C257.

The following additional documentation shall be produced and placed in the bridge file as part of conducting each of the steps outlined in MBE Appendix A8.

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Prior to conducting a load test:

- Rationale for performing nondestructive load testing as a method of analysis and statement of goals of the load test program.
- Engineering calculations or supporting documentation of the anticipated structural failure mode(s) and location(s) of the bridge or culvert to be load tested based on the existing condition of the structure.
- Assumptions made as part of establishing a load test program.

In developing and planning a load test program:

- The applied load magnitude, configuration and position.
 - For proof load testing, the target load shall be the legal load expected to generate the greatest structural response.
- Placement and type of instrumentation to be used.
 - At a minimum the following shall be documented:
 - Unit(s) of measurement (strain, displacement, rotation, etc.).
 - Allowable threshold of measured data in which a linear elastic response is no longer exhibited and proof load testing operations shall cease.
 - Type(s) and location of instrumentation to be used.
 - Data collection plan.
 - Engineering rationale for instrumentation plan related to the overall goals of the load test.

Execution of a load test:

- Date the load test was conducted.
- Summary of observed structural responses.

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Reporting and determining results:

- Summary of critical results.
- Calculations and method of determining the safe load carrying capacity of the structure.

When conducting a load test, ensuring the safety of those conducting the test as well as the public at-large is of greatest concern. Due diligence and caution shall be exercised when establishing and conducting a load test. As such, outlined in Section 8.6 of the MBE are conditions in which a structure may not be a quality candidate for load testing. A load test shall only be conducted under the supervision of a qualified engineer.

It is important to note that results generated from a nondestructive load test are only applicable to the conditions in which they were conducted. If events have occurred that alter the structural capacity (such as deterioration, changes to the applied loading or changes in support conditions), a load test must be reconducted to establish an updated rating factor for the structure.

Chapter 4

LEGAL LOADS

4.01 Federal Regulations

Federal involvement in truck size and weight (TS&W) regulation first occurred with the Federal-Aid Highway Act of 1956, which established limits for the interstate system based on an AASHTO (then known as the American Association of State Highway Officials) policy adopted in 1946. The setting of interstate TS&W limits was motivated by an increase of federal highway funding to the states in the years leading up to the 1956 act. The act established the following limits:

- Single-axle weight limit of 18,000 pounds.
- Tandem-axle weight limit of 32,000 pounds.
- GVW of 73,280 pounds.
- Maximum width limit of 96 inches.
- Alternate military loading of tandem axles spaced at 4 feet weighing 24,000 pounds each.

These limits were accompanied with a “grandfather clause” that allowed continued operation of heavier trucks on the new interstate system consistent with the state limits in effect prior to July 1, 1956.

In 1974, congress passed the Federal-Aid Highway Amendments Act. This act incorporated the findings of extensive pavement and bridge field tests, resulting in the following TS&W increases:

- Single-axle weight limit of 20,000 pounds.
- Tandem-axle weight limit of 34,000 pounds.
 - Where tandem axles must be spaced more than 40 inches and not more than 96 inches apart.
- GVW of 80,000 pounds unless the Bridge Formula dictates a lower weight limit.

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Federal Bridge Formula

The Federal Bridge Formula, also known as Bridge Formula B, was implemented by congress with the Federal-Aid Highway Amendments Act of 1974. The Federal Bridge Formula limits the axle group weight based on the number of axles and the axle spacing across any group of consecutive axles on the vehicle. While these limits are often presented as a chart, the formula is shown below:

$$W = 500 \left[\frac{LN}{(N - 1)} + 12N + 36 \right]$$

Where:

W = The maximum weight in pounds that can be carried by consecutive combination of two or more axles to the nearest 500 pounds

L = Spacing in feet between the outer axles of any combination of two or more axles

N = The number of axles being considered

Federal law includes an exception to the Bridge Formula allowing for a five-axle vehicle with two consecutive sets of tandem axles to carry a gross load of 34,000 pounds for each tandem if the first and last axles of the consecutive sets of tandem axles are at least 36 feet apart.

The Fixing America’s Surface Transportation (FAST) Act passed in December 2015 exempts emergency vehicles from meeting the nationwide interstate truck weight limits, while authorizing additional weight limits for these vehicles on the interstate system and within reasonable access to the interstate system. Reasonable access is defined as being at least 1 road-mile from access to and from the national network of highways. The FAST Act allows the following additional limitations for emergency vehicles:

- Single-axle weight limit of 24,000 pounds.
- Tandem-axle weight limit of 62,000 pounds.
- GVW of 86,000 pounds.

The FAST Act also amended interstate weight limits for various vehicle types, including covered heavy-duty tow and recovery vehicles and natural gas vehicles. A “covered heavy-duty tow and recovery vehicle” is a vehicle that is transporting a disabled vehicle to the nearest appropriate repair facility and has a GVW that exceeds the GVW of the disabled vehicle being transported. Covered heavy-duty tow and recovery vehicles are exempt from federal interstate weight limits.

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If a vehicle is operated by an engine fueled primarily by natural gas, it may exceed any vehicle weight limit, up to a maximum GVW of 82,000 pounds, by an amount that is equal to the difference between 1) the weight of the vehicle attributable to the natural gas tank and fueling system carried by that vehicle, and 2) the weight of a comparable diesel tank and fueling system. A vehicle or combination of vehicles may exceed the axle loading and the weight load maximum by a total of not more than 2,000 pounds for all axles of the truck, truck tractor or power unit.

Vehicles or combinations of vehicles powered wholly or partially by electric batteries (the Consolidated Appropriations Act 2019 (P.L. 116-6)) and with a gross weight of 82,000 pounds or less, may exceed the axle loading and the weight load maximum by a total of not more than 2,000 pounds for all axles of the truck, truck tractor or power unit.

4.01.01 AASHTO Design and Legal Loads

Design Load Rating Vehicles

The FHWA requires that the AASHTO HL-93/HS-20 truck (LRFR/LFR), tandem (LRFR) and lane loads (LRFR/LFR) be used for load rating according to LRFR or LFR, respectively. Figure 3.01.01 illustrates these load configurations. Rating methodologies are discussed in Section 7.01.

Legal Load Rating Vehicles

AASHTO legal load models were created with the implementation of the Federal Bridge Formula to represent the load effects of truck traffic on short, medium and long spans. They are designated as AASHTO Type 3, AASHTO Type 3S2 and AASHTO Type 3-3 (see Figure 3.01.02). These vehicles were previously referred to as Trucks 26-28 of the Michigan legal vehicles.

Specialized Hauling Vehicles

Per the MBE, specialized hauling vehicles (SHVs) are closely-spaced multi-axle single-unit trucks introduced by the trucking industry that utilize short wheelbases to maximize load. They include dump trucks, solid waste trucks, construction vehicles and other hauling trucks. SHVs cause load effects that exceed those of the AASHTO routine traffic commercial vehicles and, therefore, must be considered for

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load rating and posting analysis. SHV load models, shown in Figure 3.01.03, represent SHVs that meet the requirements of the Federal Bridge Formula and the Federal-Aid Highway Amendments Act of 1974. AASHTO SHV models include four single-unit loading configurations (AASHTO SU4, SU5, SU6, SU7) and a Notional Rating Load (NRL). The NRL is intended to be used as a screening load as it envelops the load effects of AASHTO SU4 - SU7. SHVs must be considered for load rating and posting analysis as it has been found that shorter span lengths are more susceptible to SHV axle weights and configurations.

Emergency Vehicles

The FHWA established two configurations (FHWA Type EV2 and FHWA Type EV3) that produce load effects that encompass those of typical emergency vehicles. Figure 3.01.04 illustrates these configurations.

Emergency vehicles must be considered for load rating and posting analysis as it has been found that shorter span lengths are more susceptible to emergency vehicle axle weights and configurations.

Table 4.1: Summary of the AASHTO Vehicles Required for Consideration in Load Ratings

Design Vehicles	Legal Vehicles	Special Haul Vehicles	Emergency Vehicles
HL-93 (LRFR) HS-20-44 (LFR)	Type 3	SU4	EV2
Tandem (LRFR)	Type 3S2	SU5	EV3
Lane Load	Type 3-3	SU6	
		SU7	

4.02 Michigan Legal Loads

The extension of grandfather rights has allowed states to continue the operation of vehicles on state and interstate highways beyond the limits mandated by federal regulations. These rights allow individual states control of size and weight limits. The limits were influenced by three different grandfather rights provisions. The first, enacted in 1956, addressed axle weights, gross weights and permits. The second, adopted in 1975, applied to the bridge formula and axle spacings. The third, enacted in 1991, ratified state practices regarding longer combination vehicles (LCVs).

The current legal load limitations in the state of Michigan are controlled in one of two ways, either directly by axle load limits or indirectly by a combination of vehicle length, axle spacing, axle loads and number of axles allowed by law.

Figure 3.02.01 illustrates common legal vehicle configurations found on Michigan roads (S-MI-01 through S-MI-25). In all loading cases, the axle loads are limited by the width of the tire. Per the Michigan Vehicle Code (MVC), the maximum allowable load for any wheel is 700 pounds per inch of tire width, or 850 pounds per inch of tire width for construction equipment during construction activities. Front axle loads are shown as 15.4 kips, as the trend in the trucking industry is moving toward 11-inch tire widths.

Michigan legal loads are commonly categorized as being one-unit, two-unit, or three-unit vehicles. A 1-unit vehicle consists of a single-frame truck-tractor. A 2-unit vehicle consists of a truck-tractor and a semitrailer or trailer and a 3-unit vehicle consists of a truck-tractor and two semitrailers or a truck-tractor, semitrailer and trailer combination.

Table 4.2: Summary of the Legal Vehicles Required for Consideration in Load Ratings

One-Unit Trucks	Two-Unit Trucks	Two-Unit Trucks	Three-Unit Trucks
S-MI-01 (NL DL SD)	S-MI-06 (NL DL)	S-MI-13 (NL DL)	S-MI-19 (NL DL)
S-MI-02 (NL DL SD)	S-MI-07 (NL DL)	S-MI-14 (NL DL)	S-MI-20 (NL DL)
S-MI-03 (NL DL)	S-MI-08 (NL DL)	S-MI-15 (NL DL)	S-MI-21 (NL DL)
S-MI-04 (NL DL)	S-MI-09 (NL DL SD)	S-MI-16 (NL DL)	S-MI-22 (NL DL)
S-MI-05 (NL DL)	S-MI-10 (NL DL SD)	S-MI-17 (NL DL)	S-MI-23 (NL DL)
	S-MI-11 (NL DL SD)	S-MI-18 (NL DL)	S-MI-24 (NL DL)
	S-MI-12 (NL DL)		S-MI-25 (NL DL)

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Michigan has three levels of legal loads: Normal, Designated and Special Designated.

4.02.01 Normal Loading

Normal loading defines the lowest set of maximum loadings that apply to all Michigan roads. Roadways owned by local authorities or the state may be designated to allow heavier than normal loads (3.02.02 and 3.02.03). Because trucks may cross between agencies with designated and normal loading, it is not recommended that normal loading be used in load rating analysis.

Section 257.722.1 of the MVC (Act 300 of 1949) defines normal loading as meeting the following set of rules:

- If the axle spacing is 9 feet or more between axles, the maximum axle load shall not exceed 18,000 pounds;
- If the axle spacing is less than 9 feet between two axles but more than (or equal to) 3 1/2 feet, the maximum axle load shall not exceed 13,000 pounds per axle; and
- If the axles are spaced less than 3 1/2 feet apart, the maximum axle load shall not exceed 9,000 pounds per axle.

This loading criteria sets limitations on individual axles. There is no direct maximum for the total GVW for normal loading. However, there is an indirect limit resulting from a combination of the maximum legal length of a vehicle, maximum legal axle loads, axle spacing and the total number of axles allowed. The MVC allows a maximum of 11 axles for legal vehicles.

According to the MVC, the length limitations are summarized as follows:

- Single vehicle: 40 feet.
- Truck tractor and semi-trailer combinations: No overall length limit but the semitrailer is not to exceed 50 feet.
- Truck and semitrailer or trailer combinations or a truck tractor, semitrailer and trailer: 65 feet, with an exception for saw logs, pulpwood and tree length poles, where the maximum overall length shall not exceed 70 feet.

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- Truck tractor and two semitrailers; truck tractor, semitrailer and trailer combinations: no overall length limit if the length of each semitrailer or trailer does not exceed 28 1/2 feet, or the overall length of the trailers in combination does not exceed 58 feet, measured from the front of the first trailer to the rear of the second trailer.

These and additional length requirements can be found in MVC (Act 300 of 1949) Section 257.719.

4.02.02 Designated Loading

Roadways owned by local authorities or by the state may be designated to allow heavier-than-normal loads. This designation is a variation to the normal loading described previously described, as follows:

- One tandem axle shall be allowed to carry 16,000 pounds per axle if no other axle is within 9 feet of any axle in the tandem and if no other tandem axle in the combination of axles exceeds a gross weight of 13,000 pounds per axle
- For truck tractors with semi-trailers that have five axles or less, two consecutive tandem axles shall be allowed to carry 16,000 pounds per axle if no other axle is within 9 feet of any axle on the tandem

As with normal loading, designated loading has no direct maximum for the total GVW. The GVW is indirectly controlled by the maximum legal length of the vehicle, axle spacing, legal axle weights and the maximum number of axles.

Per MDOT research, it was determined that designated loading produces controlling load effects over normal loading and is therefore recommended for load rating analyses, unless special designated loading is in effect.

4.02.03 Special Designated Loading

Special designated loading applies to interstate highways, though the state department of transportation or a local authority may adopt this loading for routes under their jurisdiction. Special designated loading may be applied to vehicles with a GVW less than 80,000 pounds. The loading constraints are as follows:

- No axle can carry a load greater than 20,000 pounds.

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- No tandem axle can carry a load greater than 34,000 pounds (17,000 pounds per axle of the tandem).
- Must meet requirements of the Federal Bridge Formula.

These routes are highlighted in green on MDOT's Truck Operators' Map, available at MDOT Transportation Service Centers, Michigan weigh stations and www.Michigan.gov/Truckers.

4.03 History of Michigan Design Live Loads

Design live loads are used during the design of a new bridge, and in reconstruction or rehabilitation designs. Design live loads are not legal loads. Generally speaking, design axle loads are more severe than legal axle loads and help to provide reasonable factors of safety for slab designs.

MDOT has gradually adopted HL-93 Mod as the standard design live load, which is 20 percent heavier than HL-93. The HL-93 load definition consists of the design vehicle or design tandem load in combination with the design lane load. For the HL-93 Mod, the design tandem load is replaced with a single 60-kip axle load before application of the 1.2 factor. Some local agencies have also adopted HL-93 Mod as their design standard.

Table 4.1 presents, as a historical reference, the history of design live loads in the Michigan Bridge Specifications, according to the 1983 Michigan BAG.

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Table 4.3: History of Design Live Loads in Michigan Bridge Specifications

Year	Loading (Floor System)	Long Span Girders, Trusses	Axle Loads
Law 1907*	10 T Traction Engine		
1907, 1909	12 T Steam Road Roller or 10 T	100 psf	(8 T)
1911	15 T Road Roller	100 psf	(10 T)
1914, 15, 16	18 T Road Roller	100 psf (80)**	(12 T) 10 feet (6 T)
1920, 22	18 T Truck of 10 T	100 psf (80)**	
1923	24 T Truck (Wayne County)	100 psf	(16 T) 12 feet (8 T)
1926	H-15 Truck (H-20, H-12.5, H-10)	Equivalent Lane Load	
1936	H-15 or H-20	Truck Train***	(12 T) 14 feet (3T)
1946	H-15, H-20, H-20-S16 (Adopted by Wayne County, 1941)	Equivalent Lane Load	
1958	H-15, H-20 or H-20-S16 + Alternative Military Load	Equivalent Lane Load	
1972	H-20 or HS-20 + Alternative Military Load	Equivalent Lane Load	(16 T) 14 feet (4 T)
1973	H-25 or HS-25 + Alternative Military Load	Equivalent Lane Load	(20 T) 14 feet (5 T)

* The 10-ton Traction Engine is not a specification but was used as a legal design load in many localities when purchasing bridges as late as 1912 per L.C. Smith. He also states that, "Modern bridge engineers are designing bridge floors for a 15-ton road rollers."

** For spans between 100 feet and 200 feet, the 100 psf load is reduced by 1 psf for every 5 additional feet. Therefore, for a 200-foot span, 80 psf would be used. The 80 psf would also control spans longer than 200 feet.

*** H15 Train is a series of H15 trucks separated by 30 feet. An H20 Train is an H15 Train with one H20 truck inserted.

4.04 Legal Loads in Other States and Provinces

All states and provinces have weight and dimensional restrictions for vehicles traveling on their roads. If these limitations are exceeded, a permit must be obtained from the governing transportation agency. The following summarizes the general load rating procedures of nearby states and provinces, including the rating vehicles and the analysis methods used. General size and weight limitations are also discussed. Because state policies, processes and procedures constantly evolve, it is advised that users check for updates and reference the latest versions of policy manuals from other states.

For bridges that lie on the border of Michigan and a neighboring state, the bridge rating analyst is directed to rate the structures with Michigan legal loads, but to do so in alignment with the limits of the neighboring state.

Wisconsin

The Wisconsin Department of Transportation (WisDOT) uses the AASHTO HL-93 or HS-20-44, EVs, AASHTO SHVs, AASHTO routine commercial legal vehicles (Type 3, 3S2, and 3-3), WisDOT's specialized annual permit vehicles, as well as a 190,000-pound standard permit vehicle (Wis-SPV) for load rating. WisDOT uses LRFR for load rating analyses of bridges designed using LRFD. Bridges designed using LFD or ASD methodology are to be rated using LFR though LRFR analysis may also be used with approval from the WisDOT Bureau of Structures Rating Unit. Existing timber or concrete masonry superstructures designed using ASD may be rated using ASR.

More information may be found in the WisDOT Bridge Manual (July 2024), Chapter 45 - Bridge Rating.

Michigan shares 23 border bridges with Wisconsin. WisDOT is the designated lead state to ensure NBIS compliance for local agency structures on the border while MDOT is the designated lead state for trunkline border structures. The designated lead state is responsible for ensuring load ratings are performed by, or under the direct supervision of, a registered professional engineer in accordance with 23 CFR 650.309.

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Ontario

The Ontario Ministry of Transportation (MTO) has a standard set of controlled vehicle loads called the Ontario Highway Bridge Evaluation Loads (OHBEL). These loads are designated as Level 1, Level 2 and Level 3. Each level includes truck and lane loadings.

More information may be found in the Ontario Structure Inspection Manual (OSIM) (2008).

Illinois

The Illinois Department of Transportation (IDOT) uses the AASHTO HL-93 or HS-20 vehicle for load rating. IDOT load ratings are analyzed in accordance with the AASHTO specifications used to design the bridge initially. Legal load ratings are based on the Illinois legal vehicles, which are represented as notional loads, not actual vehicles. Twelve legal load configurations and four routine permit load configurations together with emergency vehicles EV2 and EV3 are used and represent single and combination-unit vehicles that are allowed to operate in Illinois.

Additional information is available in the IDOT Structural Services Manual (November 2024), Section 4 - Load Rating.

Indiana

The Indiana Department of Transportation (INDOT) lists the following vehicles as legal vehicles used for load rating evaluation: H-20, HS-20, alternative military, and AASHTO legal vehicles (including SHVs and EVs). They additionally identify five routine permit vehicles and five special permit vehicles. LRFR is used for bridges designed using LRFD. For state-owned or maintained bridges, LRFR is the preferred analysis method regardless of original design criteria, but other methods may be considered.

More information may be found in the INDOT Bridge Inspection Manual (April 2022) - Part 3: Load Rating.

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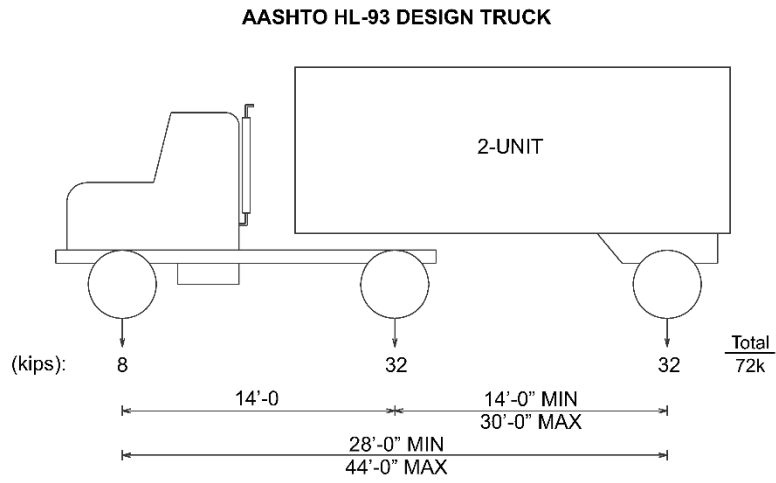
Ohio

The Ohio Department of Transportation (ODOT) has a standard set of rating vehicles called “Ohio legal loads” that are used to rate all bridges within the Ohio inventory. These vehicles include the AASHTO HL-93 design vehicle, commercial legal loads designated as 2F1, 3F1 and 5C1, AASHTO routine commercial legal vehicles, SHVs and EVs, as well as permit loads PL 60T and PL 65T. ODOT requires LRFR analysis for structures designed after 2010 and has established LRFR as the default load rating method for existing bridges. LFR may be used with the approval of the bridge owner. Existing timber bridges may be rated using ASR.

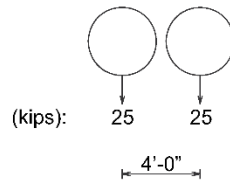
Additional information is available in the ODOT Bridge Design Manual (July 2024):
Section 900 - Bridge Load Rating.

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Figure 4.01.01 - AASHTO Design Loading Configurations



AASHTO HL-93 DESIGN TANDEM



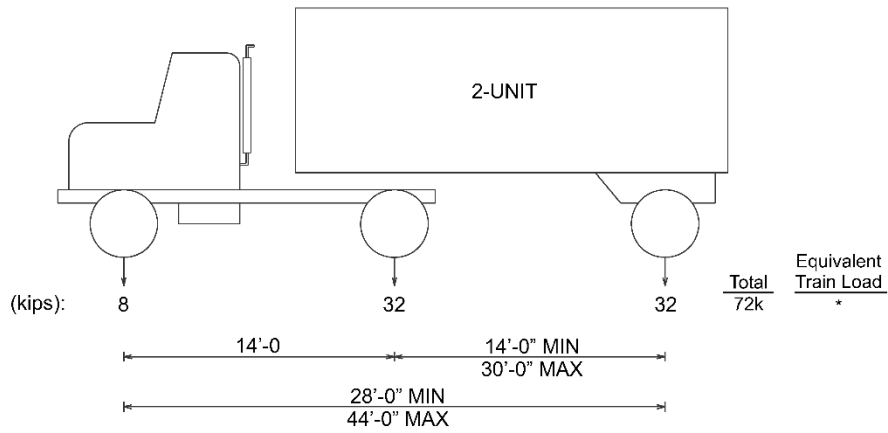
AASHTO HL-93 DESIGN LANE



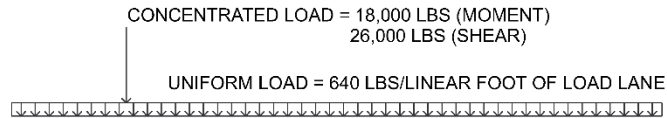
Refer to AASHTO LRFD Section 3.6.1.2 and 3.6.1.3 for more information.

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AASHTO HS-20 DESIGN TRUCK



AASHTO HS-20 LANE LOAD



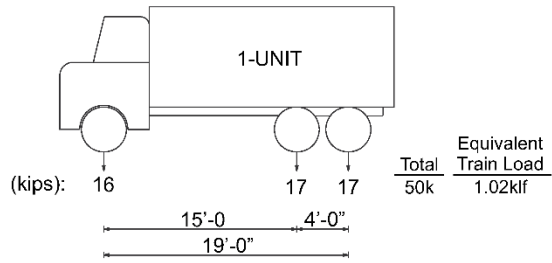
* See Figure 3.7.6B in the AASHTO Standard Specifications for Highway Bridges

Refer to AASHTO Standard Specifications Section 3.11.3 for information on additional concentrated load for negative moment in continuous spans.

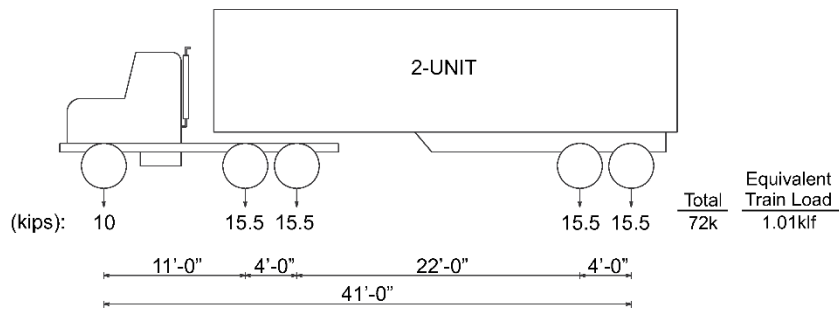
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Figure 4.01.02 - AASHTO Routine Commercial Legal Loading Configurations

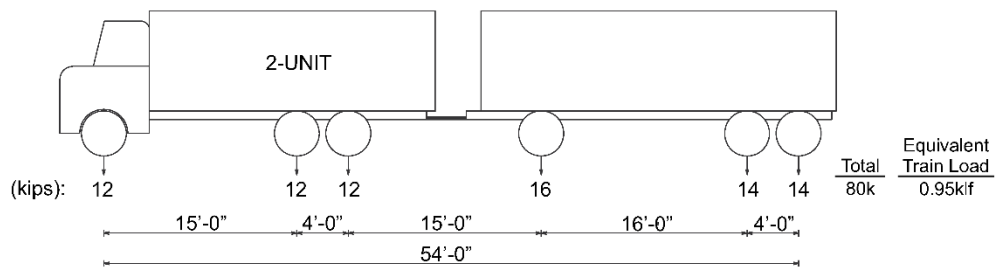
AASHTO TYPE 3



AASHTO TYPE 3S2

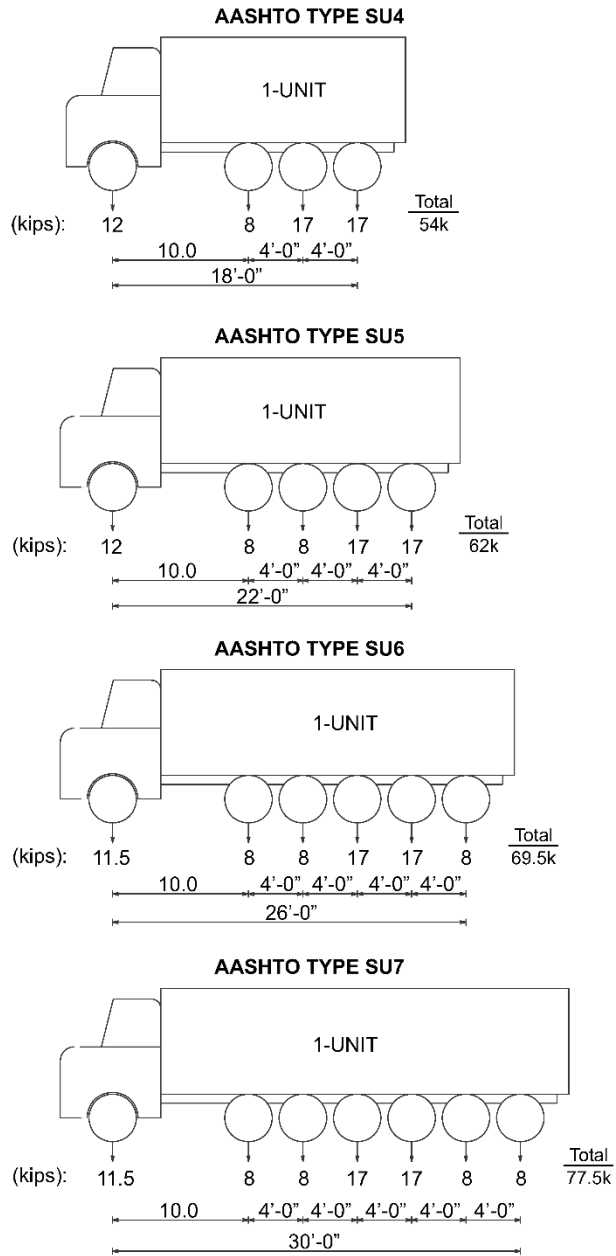


AASHTO TYPE 3-3



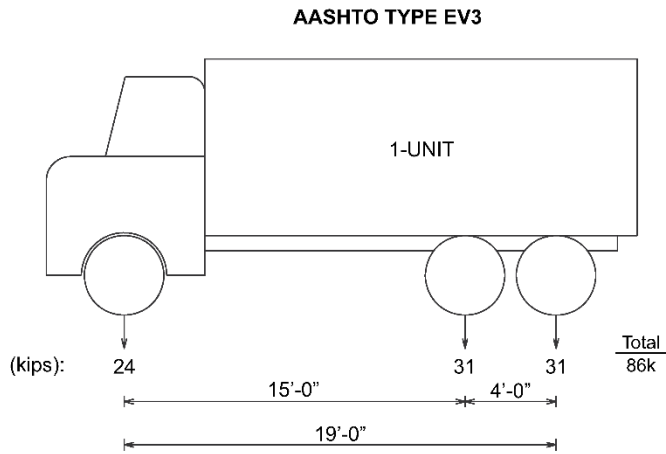
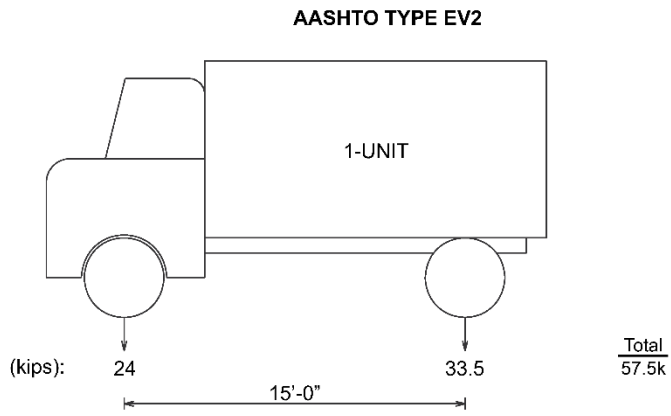
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Figure 4.01.03 - AASHTO Specialized Hauling Vehicle (SHV) Loading Configurations



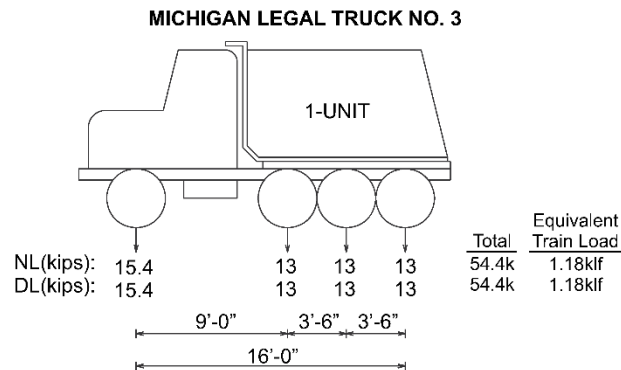
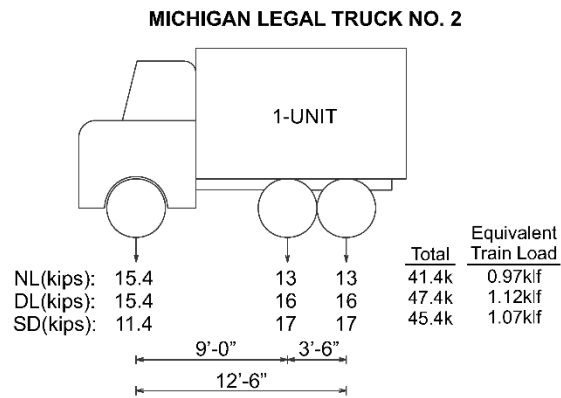
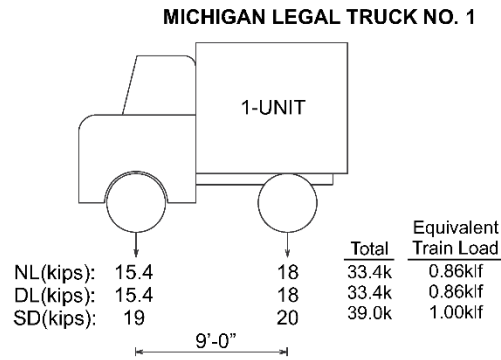
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Figure 4.01.04 - Emergency Vehicle (EV) Loading Configurations



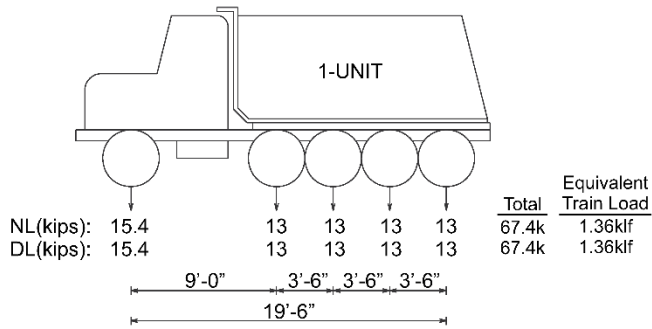
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Figure 4.02.01 - Michigan Legal Loading Configurations

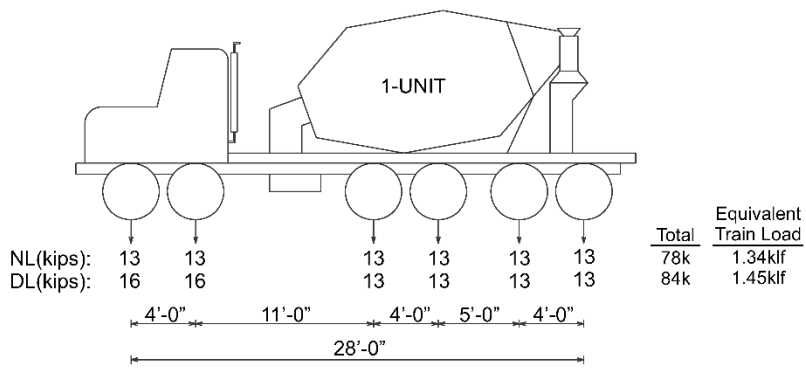


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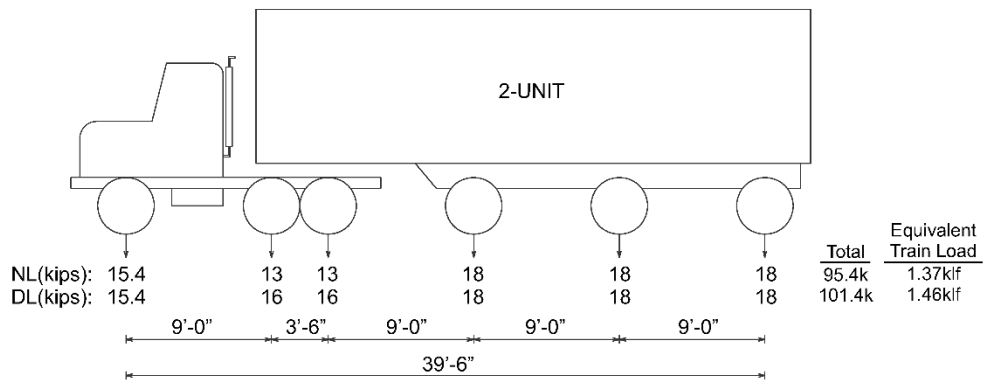
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MICHIGAN LEGAL TRUCK NO. 5

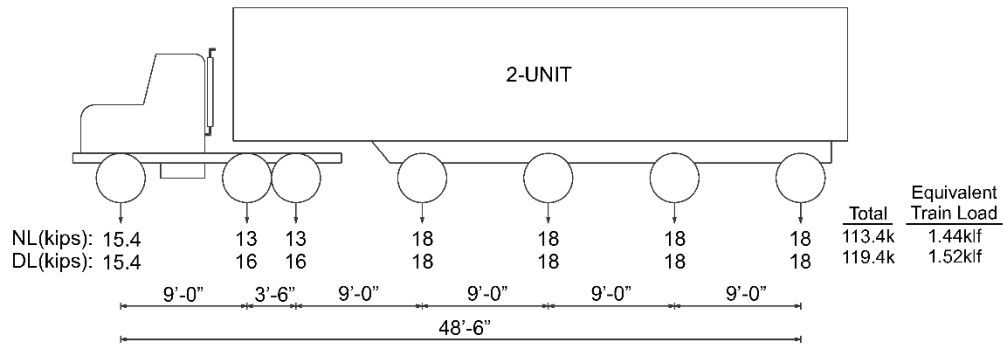


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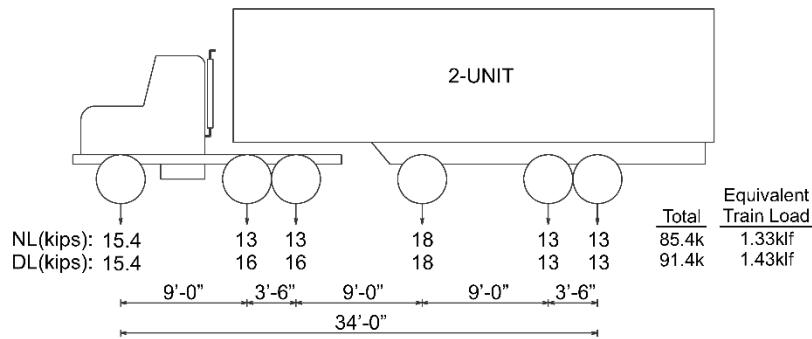


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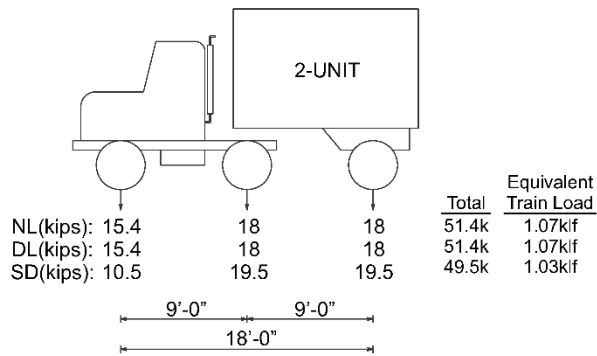
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MICHIGAN LEGAL TRUCK NO. 8

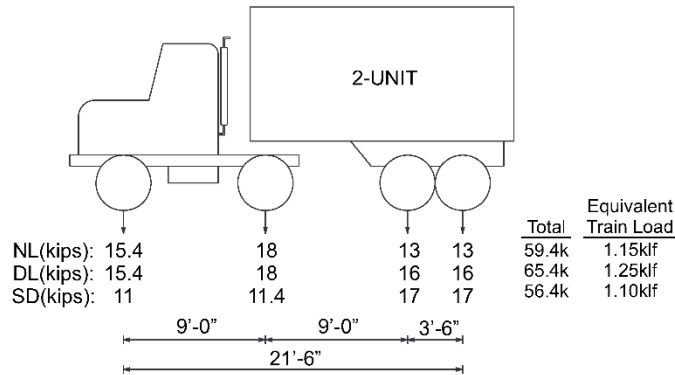


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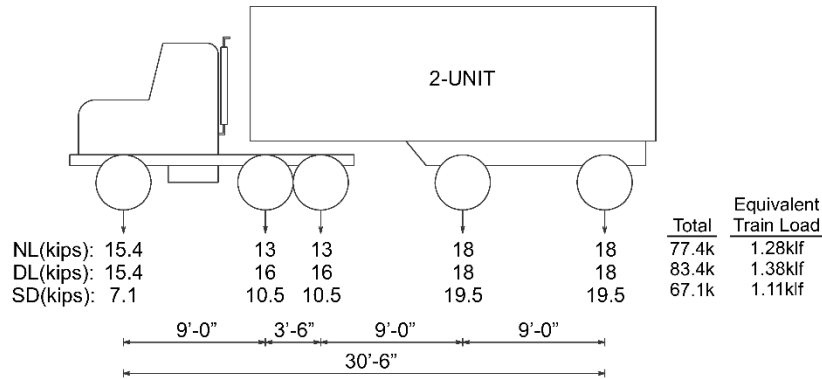


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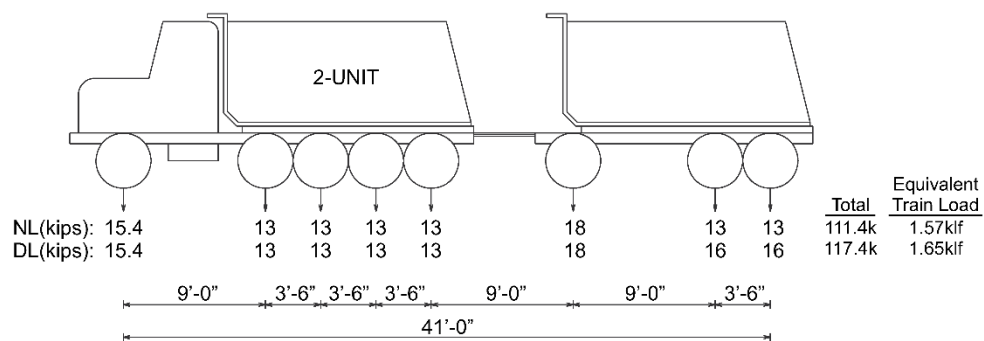
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MICHIGAN LEGAL TRUCK NO. 11

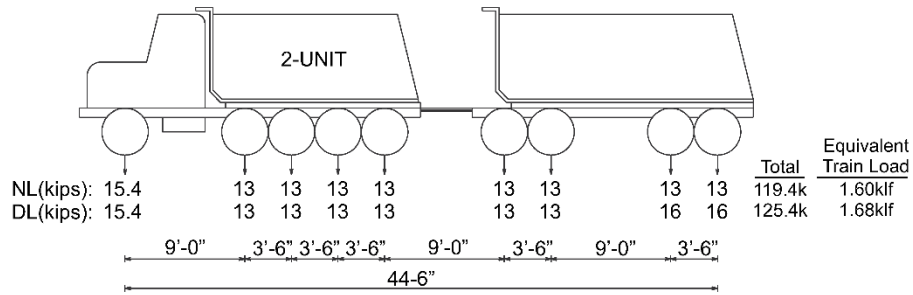


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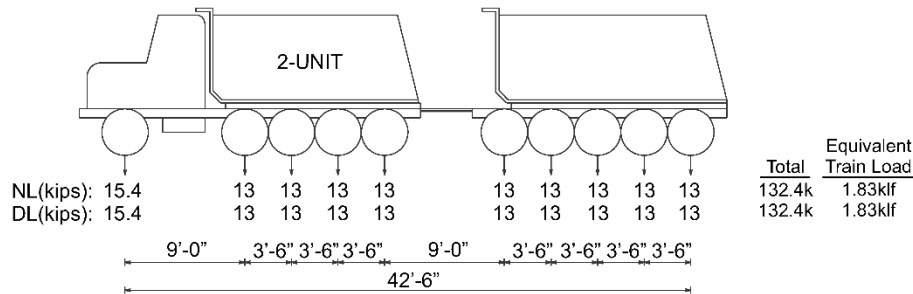


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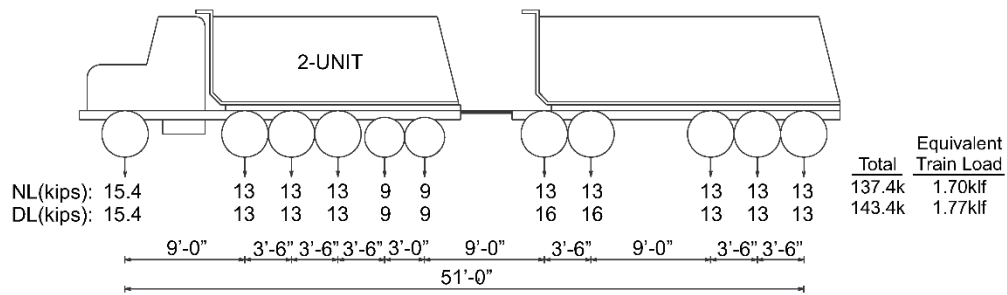
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MICHIGAN LEGAL TRUCK NO. 14

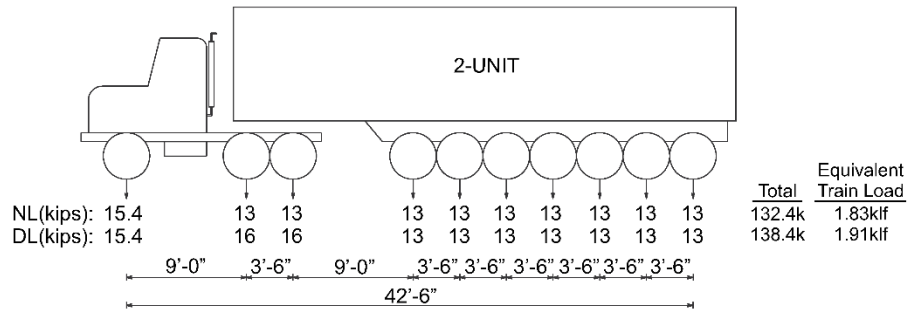


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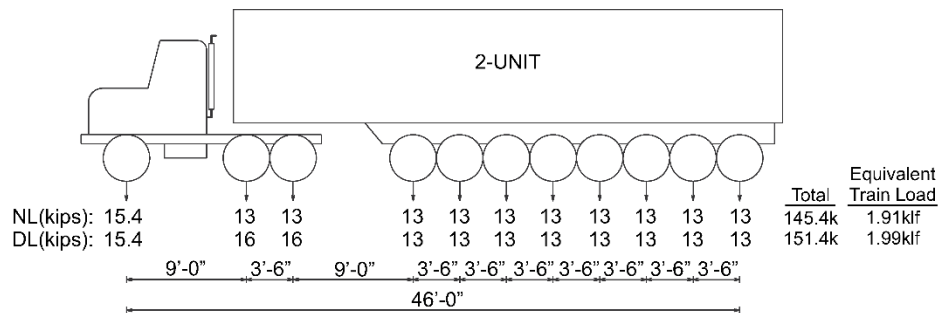


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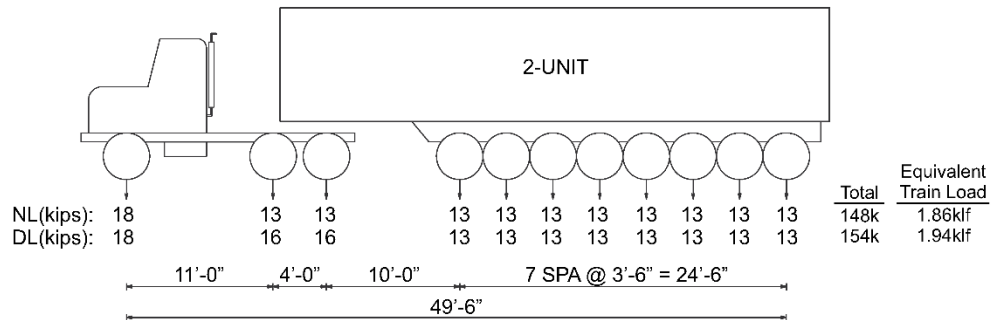
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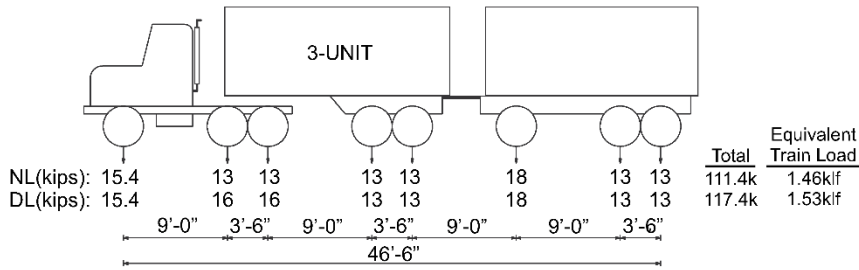


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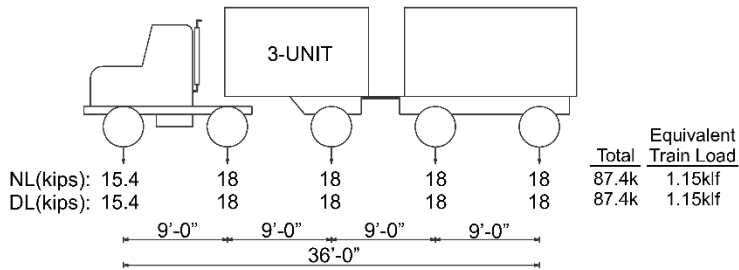


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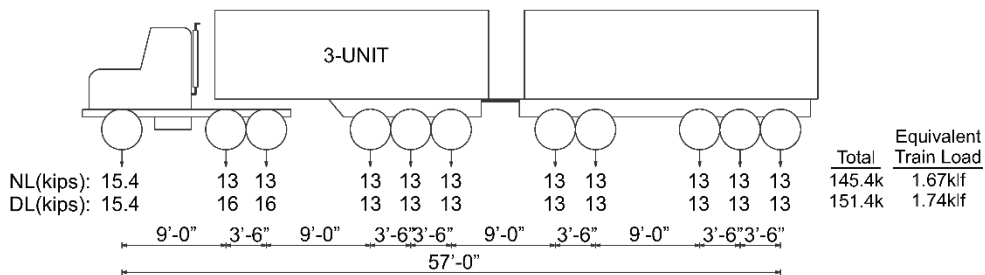
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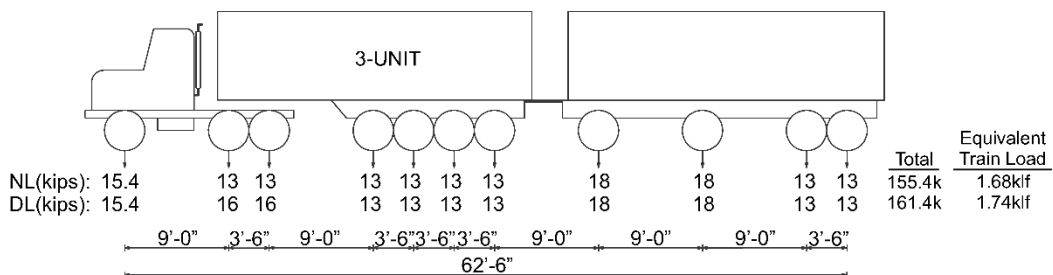
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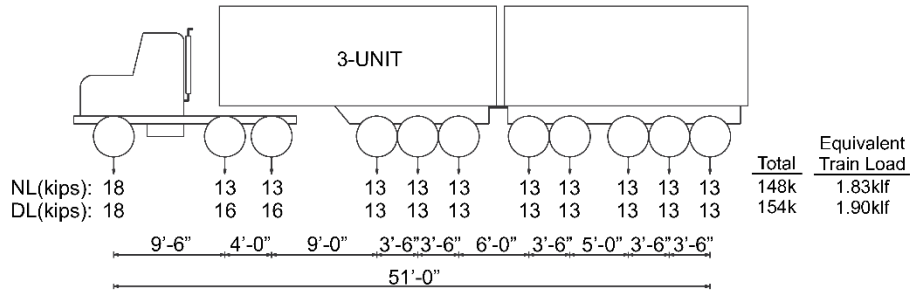


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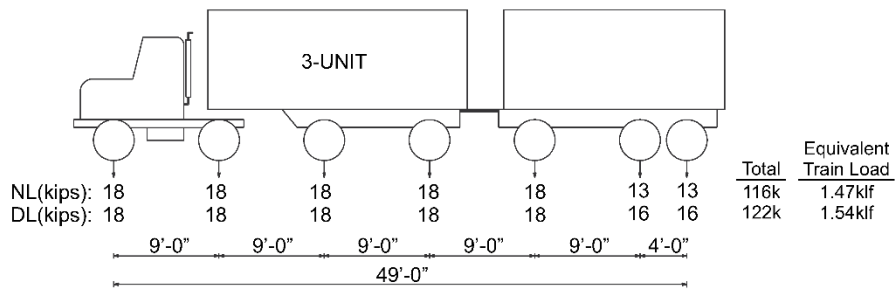


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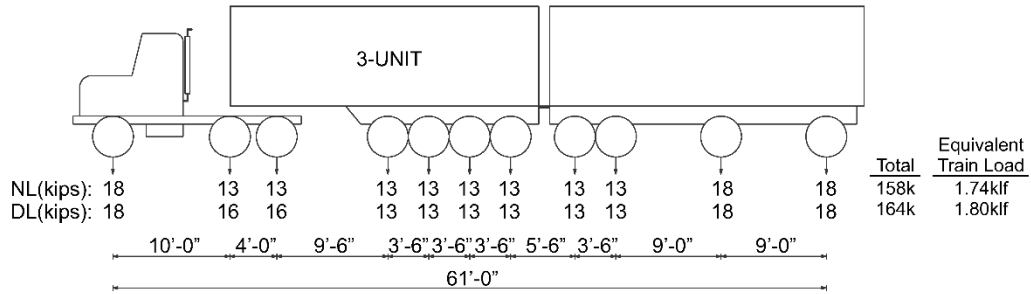
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Chapter 5

LIVE LOAD DISTRIBUTION

5.01 General

The intent of this chapter is to provide the user with guidance in the selection and application of LLDF for the purpose of determining live load shears and moments in stringers and beams providing support for bridge deck systems. This chapter has been developed on the premise that the user has an understanding of the AASHTO bridge specifications and that these references are readily available.

The AASHTO LRFD Bridge Design Specifications 4.6.2 - Approximate Methods of Analysis contains equations for LLDF for a variety of typical cross sections. In the AASHTO Standard Specifications, Sections 3.23 - 3.28 pertain to LLDF.

The analyst may be confronted with situations where LLDF derived in accordance with Section 4.6.2 of the AASHTO LRFD Specifications or Sections 3.23 - 3.28 of the AASHTO Standard Specifications will lead to an analysis that shows that the supporting members cannot safely carry all legal loads at the operating level (rating factor less than 1.0). In that case, the analyst and/or agency may choose to implement one or a combination of other more refined methods to obtain load distribution factors that more accurately reflect the true behavior of the structure per the AASTHO MBE 6A.3.3. These alternate methods are listed and described in Section 5.04.

Pedestrian live load should be distributed only to those beams whose tributary width includes a sidewalk. The load on each beam carrying the sidewalk shall be based on tributary width.

Impact shall be added to the live load used for rating in accordance with the current AASHTO LRFD, MBE or Standard Specifications. Impact may be reduced when conditions of alignment, enforced speed posting and similar situations require a vehicle to substantially reduce speed in crossing the structure. The condition of the approach roadway and deck joints also influences the selection of an appropriate impact factor. See AASHTO MBE C6A.4.4.3 for guidelines on applying and adapting the impact factor for pavement surface conditions.

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Note any changes to the standard distribution factors and dynamic allowance/impact factor on the analysis assumptions form under “Unique factors that affect capacity.” A new load rating is required if there are any changes to the live load distribution mechanism (e.g., evidence of transverse post-tensioning becoming less effective) or if a worsening roadway condition is observed when a reduced impact factor is used.

Applicability

Empirical live load distribution equations as specified in AASHTO are provided with an intended range of applicability that is stated in the specifications. Use of live load distribution equations outside of the applicability range is generally prohibited. Therefore, it is important that the analysis includes a check on the applicability of the bridge type, geometry and condition (i.e., deterioration) to select an appropriate method in determining the live load distribution factor.

Application of the information and methods in this chapter is limited to structures for which load distribution takes place mainly through flexure and torsion in the longitudinal and transverse directions, with deflections due to shear being negligible. Bridge types that satisfy these criteria are defined as *shallow superstructure* bridges, and include the solid slab, voided slab and slab-on-girder bridges. In contrast, multicell box girder bridges exhibit significant shear deformation, which is accompanied by bending of the top and bottom flanges about their own centerlines. For this reason, if similar orthotropic plate theory is to be implemented in determining structural behavior, a provision must be included to account for shear deformation.

The simplified method of applying a factor to determine the transverse distribution of live load, known as the D-Type Method, was developed by idealizing bridges as orthotropic plates. To represent a bridge as an orthotropic plate, it must reasonably satisfy the following conditions:

1. Width is constant.
2. Line support conditions exist.
3. Skew angle does not exceed 20 degrees.
4. Curvature is negligible; $L^2/bR < 1.0$

where: L = Bridge Length

R = radius of curvature measured to the bridge centerline, and

b = $(1/2)$ (Deck Width).

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5. A solid or voided slab bridge is of uniform depth across the section.
6. Slab-on-girder bridges are made up of at least four parallel prismatic beams of similar stiffness.
7. Deck overhang for slab-on-girder bridges does not exceed 60 percent of the spacing between the girders.

For more information on this topic, see Guide Specifications for Distribution of Loads for Highway Bridges (AASHTO 1994).

Limitations/Exclusions

The AASHTO LRFD and Standard Specifications prescribed methods used to determine the transverse distribution of wheel loads are empirically derived and have been developed to *conservatively* encompass a broad range of basic superstructure types and geometry within a certain range of applicability. Analysis of structurally and/or geometrically complex bridges (MBE 6.1.6) is beyond the scope of this document. These structures must be evaluated on a case-by-case basis using advanced modeling techniques or other owner-approved methods. As noted above, should it become necessary to predict structural capacity with greater precision to evaluate marginal structures, those with a rating factor slightly less than 1.0, the AASHTO LRFD Bridge Design Specifications provide a more refined approach and may be used in conjunction with LFR procedures with caution and justification to accomplish this objective with owner's approval and proper documentation. Other, still more highly refined methods, which include 3-D modeling or field testing may be utilized to more accurately determine the load effects and capacity for structures deemed marginal.

5.02 Distribution of Loads - Load and Resistance Factor Design

The empirical procedure for determining the distribution of live loads is described in AASHTO LRFD Bridge Design Specifications Section 4.6.2. The Manual for Bridge Evaluation contains sample calculations for computing the LLDF in Appendix A.

Applicability ranges, such as beam spacing, shall be checked to ensure compliance with the ranges specified in AASHTO LRFD 4.6.2. Note that the range of beam spacings for structures considered in the University of Michigan studies falls within the range of applicability as specified in this section (MDOT SPR-1362, MDOT SPR-1378, MDOT SPR-1393 and MDOT SPR-1429). The multiple presence factors, defined in Table 3.6.1.1.2-1, have been included in the approximate equations for distribution factors in Sections 4.6.2.2 and 4.6.2.3 for both single and multiple lanes loaded; these factors do not need to be applied to distribution factors determined in accordance with the provisions of these sections. Where the lever rule is specified, the engineer must determine the number of vehicles and lanes and, therefore, must include the multiple presence (see AASHTO LRFD Commentary C3.6.1.1.2).

Note that the AASHTO LRFD Specifications express the distribution factors as a fraction of full lanes, whereas the AASHTO Standard Specifications express them as a fraction of wheel lines.

5.03 Distribution of Loads - Load Factor Design

The fraction of vehicle load effect transferred to a single member using the Standard Specifications can be found in Section 3.23 for multi-girder bridges and Sections 3.24 - 3.28 for other bridge types.

The option exists to substitute field measured values, analytically calculated values or those determined from advanced structural analysis methods. During the implementation of any one of these methods, the position of loading shall be investigated to provide the condition causing the maximum response in the component, section and load effect being evaluated.

The user is cautioned to refer to AASHTO Standard Specification Sections 3.11 and 3.12 for guidelines defining the application of live load and reductions in load intensity. Regarding

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the latter, Section 3.12.2 states that reductions in load intensity shall not be applied when the distribution factors from AASHTO Table 3.23.1 are used to determine moments in longitudinal beams, which means the lower probability of multi-lanes loaded simultaneously is already built in the equations.

The AASHTO Standard Specifications Section 3.23 produces distribution factors as a fraction of wheel loads so LLDF values produced using the standard specifications should be divided by two if used to determine a fraction of a full lane.

5.04 Alternate Methods for Determining Live Load Distribution

5.04.01 LRFD Live Load Distribution Factors

MDOT has sponsored load testing of several bridges on the trunkline system, with one objective being to obtain LLDF that more accurately reflect how loads are distributed in the transverse direction. These projects, conducted by the University of Michigan are:

- Development of a Guide for Evaluation of Existing Bridges; MDOT SPR-1362 (1998).
- Development of a Guide for Evaluation of Existing Bridges, Phase 2; MDOT SPR-1378 (2000).
- Verification of Girder Distribution Factors for Steel Girder Bridges; MDOT SPR-1393 (2001).
- Verification of Girder Distribution Factors for Continuous Steel Girder Bridges; MDOT SPR-1429 (2003).

The individual reports may be found by searching the [MDOT Research Administration Repository](#) website by report number. The website contains many MDOT Research-related documents.

The structures examined were all composite slab-on-steel beam bridges with skew angles not exceeding 30 degrees. Beam spacing for these bridges ranged from 4 feet, 4 inches to 9 feet, 4 inches, and span lengths ranged from 32 feet to 140 feet.

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One of the conclusions and recommendations provided by this series of reports is that AASHTO LRFD live load distribution methods may be used in conjunction with LFD analytical techniques for rating those bridges that are similar in structure type and fall within the skew, span length and beam spacing limits considered in the studies. MDOT supports and has adopted this live load distribution recommendation.

5.04.02 Refined Analytical Methods

Other analytical methods may be implemented to obtain results that more accurately reflect the true bridge behavior. The Manual for Bridge Evaluation, Section 6A.3.3 - Refined Methods of Analysis, describes appropriate use cases and refers to the AASHTO LRFD Bridge Design Specifications, Section 4.6.3 - Refined Methods of Analysis, for a description of appropriate methods

Great care must be exercised when creating refined models to ensure that the boundary conditions and model geometry are correct and that loads are placed at positions that produce the maximum response for the load effect at a given section/location being investigated. Guidelines for detailed analysis of bridge decks and sample problems to illustrate their application are given in Appendix H of NCHRP Project 12-26/2 final report; Distribution of Wheel Loads on Highway Bridges, Phase III and in the FHWA Manual for Refined Analysis in Bridge Design and Evaluation (FHWA-HIF-18-046).

5.04.03 Load Testing

In some cases, it may prove to be more economical to load test a particular bridge (or group of bridges) rather than to post the bridge(s) for restricted loads or to rebuild the bridge(s) in question. The analyst should confer with the owning agency to determine if load testing is economically appropriate. See Section 3.02.03 - Load Testing for more information.

5.05 Unique Structure Types

Concrete jack arch or encased beams (with or without tie rods) are unique in Michigan and distribution factors are not included in the AASHTO LRFD or Standard Specifications. The following table may be used to estimate the LLDF for these structure types.

Table 5.1: Distribution of Lane Loads in Interior Longitudinal Beams for LFR Analysis

Deck Type	Beam Type	Clear Deck Width Less Than 18 Feet	Clear Deck Width 18 Feet and Greater
Concrete jack arch or encased beams with or without tie rods	Steel stringer	S/10	S/8

Note: The distribution factors are presented as a fraction of full lanes to maintain consistency with previous versions of the BAG, whereas the AASHTO Standard Specifications express them as a fraction of wheel lines; therefore, these values need to be multiplied by two for distribution of wheel lines (S/5 and S/4) for LFR analysis where S is the beam spacing in feet.

Chapter 6

GENERAL ANALYSIS PROCEDURE

Rating of the structure for its safe load carrying capacity must start with a thorough field investigation. All physical features of the bridge that have an effect on its structural integrity shall be examined. Any damaged or deteriorated sections shall be noted along with adequate data so that their effect can be appropriately evaluated.

The process to complete a bridge load rating analysis is comprised of many steps. The most significant include gathering data relevant to the bridge, following an appropriate method of analysis (Chapter 3), selecting the appropriate load designation for analysis (Chapter 4), determining the live load distribution factor, if applicable to the model used (Chapter 5), and calculating the load rating factors.

6.01 Analytical Methods

Basic information may be available from a variety of sources. Specific details regarding span length, beam spacing, beam size, material properties and other miscellaneous items are generally available in the original design plans and/or as-constructed plans. If these sources are unavailable, an inspection of the bridge by an NBIS-qualified team leader to measure pertinent details may be sufficient for an approximate rating. If a more exact rating is required, load tests may be necessary to determine the safe load capacity. Material sampling is discussed below and historical material properties may be found in the appendix or the MBE section 6A.5.2 (concrete), 6A.6.2 (steel) and 6A.7.2 (wood).

Gathering Plans

The original design, as-built, and reconstruction or repair plans all contain vital information for conducting a load rating. Shop drawings may also provide valuable insight into the applied loads and structural capacity of the bridge.

The design plans contain information on the overall bridge geometry, connection details, placement of reinforcement and the material assumptions used for design.

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As-built plans indicate any modifications made to the original design during fabrication or construction. These plans should be used along with the original design plans to reflect changes in loads, bridge and section geometry, and material properties of the completed bridge.

Shop drawings and fabrication plans may contain additional information not found in the design plans and reflect the members and materials used in fabrication of bridge components prior to erection.

For various reasons, plans may not exist for a structure. When this is the case, it may be necessary to conduct detailed field measurements to determine the bridge and section geometry, connection details and other relevant information. For reinforced and prestressed concrete structures where reinforcement details cannot be determined, it may be necessary to complete a judgment rating. See Section 3.02.01 and MBE 6.1.4 for more information.

Field Inspection

The condition of all structural components and extent of deterioration must be considered in the calculation of a load rating. This information may be available in a recent thorough field inspection. Inspections are to be performed as described in the Michigan Structure Inspection Manual (MiSIM), Section 4 of the AASHTO MBE, and the FHWA Bridge Inspector's Reference Manual (BIRM). The effective area of members used in a capacity analysis must be the original gross area minus the area that can no longer carry load due to deterioration or corrosion. Consideration of deterioration shall also be taken in structural analysis to compute the dead and live load effects. Deterioration may result in new critical sections or failure modes, especially when discrete, localized defects exist. These shall be considered in load rating analysis.

The existence, extent and thickness of any overlay on a bridge deck is of great significance when performing load rating calculations. Deck overlays are very common and they can have a significant effect on the capacity of a structure that remains available for carrying live load. It is the responsibility of the load rating engineer to be aware of the details of any overlay that may exist on a structure to be load rated.

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Sampling

Material sampling may be used for strength determination in conjunction with analytical methods. Field samples may be taken and tests conducted to determine the actual “as-built” strength of the structural components. Testing may also be helpful to establish the effect of material degradation on material properties. Per Section 5.3 of the MBE, a minimum of three samples are required to provide results representative of the entire structure being evaluated. MBE Sections 5.4 and 5.5 contain more information on laboratory tests and interpretation and evaluation of test results, respectively. Standard ASTM and AASHTO test methods are identified in these sections for both concrete and steel.

For structural steel strength measurement, MDOT’s practice is to take three samples from three different beams, usually from the bottom flange near an end support or other location where loss of material will not negatively impact the capacity. Tensile testing should be done in accordance with ASTM A-370. Built-up members or plate girders that may contain different grades of steel should be carefully evaluated with regard to sampling size and location.

Deck concrete may be cored and tested for compressive strength in accordance with ASTM C-39. A minimum of three cores should be tested.

If the results of the material sampling test indicate that greater-than-anticipated strength is present, that greater strength can be used for analysis and rating of the bridge. However, if lower-than-anticipated strength is found, that result cannot be ignored and must be used in the rating process.

Actual steel and concrete strength results may be used with any approved analytical technique.

6.02 Analysis Vehicle Selection

The extension of grandfather rights has allowed states to continue operation of vehicles on state and interstate highways in excess of the limits mandated by federal regulations. These rights allowed individual states continued control of size and weight limits for certain routes on the interstate or national highway systems otherwise regulated by federal truck size and weight law. As a result, each state has a different weight limit “package” consisting of different mixes of these combinations.

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As discussed in Chapter 4, there are a variety of legal vehicles that use the roads and bridges in Michigan. Michigan law categorizes loads as either normal, designated or special designated (Section 4.2). The analyst must determine the legal loads allowed by the jurisdiction for the bridge being investigated. Bridges owned and maintained by MDOT (interstate highways or M-routes, for example) must use designated or special designated loads. MDOT publishes the Michigan Truck Operators Map that indicates state routes that are special designated. Local agencies that allow normal loading on their system should use designated loading when performing a load rating analysis on a structure because truckers will not be aware when going from a designated loading agency to a normal loading agency since no traffic signs exist to differentiate between the two. The following discussion is limited to designated loading.

The intent of this chapter is to aid in vehicle selection and placement to generate maximum live load effects (e.g., moment and shear). In general, individual axle loads and spacings are critical for short-span bridges. As spans increase in length, the individual axles of a vehicle become less significant while the vehicle's gross weight becomes more significant in generating maximum effects. AASHTOWare BrR can be used to run all legal vehicles and will position those vehicles incrementally across the bridge to produce the maximum load effects.

The LRFR specifications for load rating bridges and LRFD specifications for designing bridges are based on factors calibrated from structural load and resistance statistics to achieve a more uniform level of reliability for all bridges. The live load factors in the LRFR specifications are based on load data representative of heavy truck traffic nationwide. However, the specifications allow for recalibrating live load factors for a jurisdiction using weigh-in-motion data. MDOT has implemented customized live load factors based on the analysis described in MDOT Research Report R-1511. The live load factors for Michigan legal trucks are shown in Tables 6.1 - 6.3 for normal, designated and special designated loading. Similar tables for Michigan overload trucks, class A, B and C, are provided in Tables 8.1 - 8.3. See Chapter 8 for more information on the overload truck classifications and the applicability to MDOT and local agencies.

The appendix contains moment and shear tables to aid in determining which of the trucks is the "controlling" vehicle. The tables list the moment and shear for every legal vehicle for simply supported span lengths between 5 feet and 300 feet. The vehicle that produces the greatest moment or shear for a given span is the vehicle that will control the load rating for moment or shear capacity. It is important to note that this may not be the vehicle that will

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control a posting limit. The vehicle that will control the posting limit is the vehicle with the largest value for load effect divided by weight. Load effects and the corresponding vehicle weight are available in the appendix for span lengths between 5 feet and 300 feet, among all vehicles under consideration for posting (those with a rating factor less than 1.0).

Permit Load Rating

A permit load rating must be performed when a hauler requests to transport a load that does not conform with state statutes for legally configured vehicles. See Chapter 8 for more information on conducting a permit load rating.

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Table 6.1: Michigan Legal Vehicle Load Factors for Strength Limit States, Greater Than 5,000 ADTT

Truck	Normal Loading:	Normal Loading:	Designated Loading:	Designated Loading:	Special Designated Loading:	Special Designated Loading:
	GVW (kips)	Load Factor γ_{LL}	GVW (kips)	Load Factor γ_{LL}	GVW (kips)	Load Factor γ_{LL}
1	33.4	1.80	33.4	1.80	39.0	1.80
2	41.4	1.80	47.4	1.80	45.4	1.80
3	54.4	1.80	54.4	1.80	54.4	1.80
4	67.4	1.80	67.4	1.80	67.4	1.80
5	78.0	1.80	84.0	1.75	84.0	1.75
6	95.4	1.61	101.4	1.54	101.4	1.54
7	113.4	1.44	119.4	1.39	119.4	1.39
8	85.4	1.73	91.4	1.65	91.4	1.65
9	51.4	1.80	51.4	1.80	49.5	1.80
10	59.4	1.80	65.4	1.80	56.4	1.80
11	77.4	1.80	83.4	1.76	67.1	1.80
12	111.4	1.45	117.4	1.41	117.4	1.41
13	119.4	1.39	125.4	1.35	125.4	1.35
14	132.4	1.31	132.4	1.31	132.4	1.31
15	137.4	1.28	143.3	1.25	143.3	1.25
16	132.4	1.31	138.4	1.28	138.4	1.28
17	145.4	1.24	151.4	1.21	151.4	1.21
18	148.0	1.23	154.0	1.20	154.0	1.20
19	111.4	1.45	117.4	1.41	117.4	1.41
20	87.4	1.71	87.4	1.71	87.4	1.71
21	145.4	1.24	151.4	1.21	151.4	1.21
22	155.4	1.20	161.4	1.17	161.4	1.17
23	148.0	1.23	154.0	1.20	154.0	1.20
24	116.0	1.42	122.0	1.37	122.0	1.37
25	158.0	1.18	164.0	1.16	164.0	1.16
Type 3	50.0	1.80	50.0	1.80	50.0	1.80
Type 3S2	72.0	1.80	72.0	1.80	72.0	1.80
Type 3-3	80.0	1.80	80.0	1.80	80.0	1.80

* Load factors may be interpolated for a specific ADTT

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Table 6.2: Michigan Legal Vehicle Load Factors for Strength Limit States, 1,000 ADTT

Truck	Normal Loading:	Normal Loading:	Designated Loading:	Designated Loading:	Special Designated Loading:	Special Designated Loading:
	GVW (kips)	Load Factor γ_{LL}	GVW (kips)	Load Factor γ_{LL}	GVW (kips)	Load Factor γ_{LL}
1	33.4	1.65	33.4	1.65	39.0	1.65
2	41.4	1.65	47.4	1.65	45.4	1.65
3	54.4	1.65	54.4	1.65	54.4	1.65
4	67.4	1.65	67.4	1.65	67.4	1.65
5	78.0	1.65	84.0	1.65	84.0	1.65
6	95.4	1.57	101.4	1.51	101.4	1.51
7	113.4	1.40	119.4	1.36	119.4	1.36
8	85.4	1.65	91.4	1.61	91.4	1.61
9	51.4	1.65	51.4	1.65	49.5	1.65
10	59.4	1.65	65.4	1.65	56.4	1.65
11	77.4	1.65	83.4	1.65	67.1	1.65
12	111.4	1.42	117.4	1.37	117.4	1.37
13	119.4	1.36	125.4	1.32	125.4	1.32
14	132.4	1.28	132.4	1.28	132.4	1.28
15	137.4	1.25	143.3	1.22	143.3	1.22
16	132.4	1.28	138.4	1.25	138.4	1.25
17	145.4	1.21	151.4	1.19	151.4	1.19
18	148.0	1.20	154.0	1.18	154.0	1.18
19	111.4	1.42	117.4	1.37	117.4	1.37
20	87.4	1.65	87.4	1.65	87.4	1.65
21	145.4	1.21	151.4	1.19	151.4	1.19
22	155.4	1.17	161.4	1.15	161.4	1.15
23	148.0	1.20	154.0	1.18	154.0	1.18
24	116.0	1.38	122.0	1.34	122.0	1.34
25	158.0	1.16	164.0	1.14	164.0	1.14
Type 3	50.0	1.65	50.0	1.65	50.0	1.65
Type 3S2	72.0	1.65	72.0	1.65	72.0	1.65
Type 3-3	80.0	1.65	80.0	1.65	80.0	1.65

* Load factors may be interpolated for a specific ADTT

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Table 6.3: Michigan Legal Vehicle Load Factors for Strength Limit States, Less Than or Equal to 100 ADTT

Truck	Normal Loading:	Normal Loading:	Designated Loading:	Designated Loading:	Special Designated Loading:	Special Designated Loading:
	GVW (kips)	Load Factor γ_{LL}	GVW (kips)	Load Factor γ_{LL}	GVW (kips)	Load Factor γ_{LL}
1	33.4	1.40	33.4	1.40	39.0	1.40
2	41.4	1.40	47.4	1.40	45.4	1.40
3	54.4	1.40	54.4	1.40	54.4	1.40
4	67.4	1.40	67.4	1.40	67.4	1.40
5	78.0	1.40	84.0	1.40	84.0	1.40
6	95.4	1.40	101.4	1.40	101.4	1.40
7	113.4	1.35	119.4	1.31	119.4	1.31
8	85.4	1.40	91.4	1.40	91.4	1.40
9	51.4	1.40	51.4	1.40	49.5	1.40
10	59.4	1.40	65.4	1.40	56.4	1.40
11	77.4	1.40	83.4	1.40	67.1	1.40
12	111.4	1.36	117.4	1.32	117.4	1.32
13	119.4	1.31	125.4	1.27	125.4	1.27
14	132.4	1.23	132.4	1.23	132.4	1.23
15	137.4	1.21	143.3	1.18	143.3	1.18
16	132.4	1.23	138.4	1.20	138.4	1.20
17	145.4	1.17	151.4	1.14	151.4	1.14
18	148.0	1.16	154.0	1.13	154.0	1.13
19	111.4	1.36	117.4	1.32	117.4	1.32
20	87.4	1.40	87.4	1.40	87.4	1.40
21	145.4	1.17	151.4	1.14	151.4	1.14
22	155.4	1.13	161.4	1.11	161.4	1.11
23	148.0	1.16	154.0	1.13	154.0	1.13
24	116.0	1.33	122.0	1.29	122.0	1.29
25	158.0	1.12	164.0	1.10	164.0	1.10
Type 3	50.0	1.40	50.0	1.40	50.0	1.40
Type 3S2	72.0	1.40	72.0	1.40	72.0	1.40
Type 3-3	80.0	1.40	80.0	1.40	80.0	1.40

* Load factors may be interpolated for a specific ADTT

6.03 Live Load Distribution Factor

LLDF vary greatly depending on beam spacing, bridge deck type and beam or girder type. The LLDF approach presented in either the LRFD or the LFD specifications may be used depending on the method of load rating selected. For more information about LLDF, see Chapter 5.

6.04 Load Rating Analysis

6.04.01 Software

Software is a powerful tool that can be used to assist in load rating calculations. It is the responsibility of the load rating engineer to use the software with the knowledge and understanding of both the assumptions being made and the resulting outputs. Additional calculations may be required to support or supplement a software-driven analysis; for example, in situations where localized deterioration exists that must be investigated beyond the capabilities of the software. It is important to keep documentation of these additional calculations with the load rating documentation in the bridge file.

AASHTOWare Bridge Rating (BrR)

AASHTOWare BrR is the primary software application recommended by MDOT to assist in load rating analyses. AASHTOWare BrR is available to local agencies and their consultants free of charge for use on Michigan bridges, courtesy of MDOT. Load rating support is provided through MDOT's partnership with the Center for Technology and Training (CTT) at Michigan Technological University. CTT provides training and engineering support for AASHTOWare BrR as well as the overall load rating process.

AASHTOWare BrR uses a graphical user interface to assist in developing a computational model of a bridge. Ratings may be performed using LRFR, LFR or ASR methodologies, as applicable. Bridge models are saved in an integrated database making it easy to store, review and update existing bridge models and verify capacity for permit loads. Load ratings should be kept up to date by modifying the AASHTOWare BrR model to reflect the most recent bridge

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inspection (reflecting distress, deterioration or other changes to the structure) and running an analysis using the latest available version of the software.

AASHTOWare BrR contains libraries of standard and user-defined vehicles, loads, analysis templates, steel and prestressed concrete cross sections, load and resistance factors, materials, parapets and other bridge components. Vehicle analysis templates containing the 25 Michigan legal vehicles and the 20 overload vehicles are available on CTT's website. The analysis templates are set up to simplify the analysis procedure and to provide the Michigan-specific live load factors for the Michigan legal loads in LRFR analysis.

AASHTOWare BrR may be used for the following bridge types:

- Girder/floor beam/stringer systems
- Steel multi-stringer or multi-girder
- Concrete multi-stringer or multi-girder
- Reinforced concrete girders or slabs
- Prestressed concrete I-girders or box beams
- Cast in-place reinforced and post-tensioned concrete multi-cell box girders
- Culverts (concrete box and CMP)
- Simple trusses

Other Software

When AASHTOWare BrR is not applicable, other software options may be acceptable pending approval of the bridge owner. The most appropriate software package may vary based on structure type/project scope.

6.04.02 Hand Calculations

Spreadsheets

An engineer may create a spreadsheet to aid with load rating calculations. An advantage that a spreadsheet has over commercially available software is that it can be specifically tailored to individual needs and the formulas, or code, can

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be checked, verified and modified. Spreadsheet concepts and operating details should always be verified by someone other than the originator.

Spreadsheets are often used in conjunction with commercial software to aid in additional investigation of a particular topic in the analysis. In these cases, the spreadsheet may take advantage of input generated from other sources such as loading, load effects or member capacity. All assumptions used, including input generated from other sources, should be clearly documented in the spreadsheet.

The following spreadsheets are available on MDOT's Load Rating/Bridge Analysis Spreadsheets webpage:

- MDOT CMP LRFR Spreadsheet and Documentation
- MDOT CMP LFR Spreadsheet and Documentation
- Gusset Plate LRFR Analysis and Documentation
- Gusset Plate LFR Analysis and Documentation
- LFD Pin and Hanger Check Spreadsheet

These spreadsheets have been designed to aid a qualified engineer in completing the bridge load rating analysis. Sound engineering judgment and familiarity with the analysis are required to choose appropriate input values and to recognize situations that may deviate from the standard case on which these spreadsheets are based.

Superposition

The principle of superposition is often used in mechanics of materials and structural analysis. For example, in strength-of-materials studies, the total stress at a point in a material resulting from various applied forces can be obtained by summing the stresses due to each force considered individually.

The principle of superposition can be stated as follows:

Principle of Superposition: The total effect at a given location in a structure due to a number of loads applied simultaneously is equal to the sum of the effects for the loads applied individually.

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For the principle of superposition to be valid there must be a linear relationship among forces, stresses and deflections. There are two conditions for which superposition is not valid:

1. When the structural material does not behave according to Hooke's law; that is, when the stress is not proportional to the strain (material nonlinearity).
2. When the deflections of the structure are so large that computations cannot be based on the original geometry of the structure (geometric nonlinearity).

Unless otherwise stated, the principle of superposition is assumed to be valid in this BAG. In special situations, such as time-dependent effects and staged construction, the principle of superposition may apply but the final load effects should be determined based on the sequence of application of loads (stage analysis).

Beam Diagrams and Formulas

Many publications contain moment, shear and deflection diagrams for common beam loadings. These can be used to analyze a variety of bridge superstructure load scenarios. An example of two of the most common beam diagrams taken from the American Institute for Steel Construction are shown in Figures 6.1 and 6.2.

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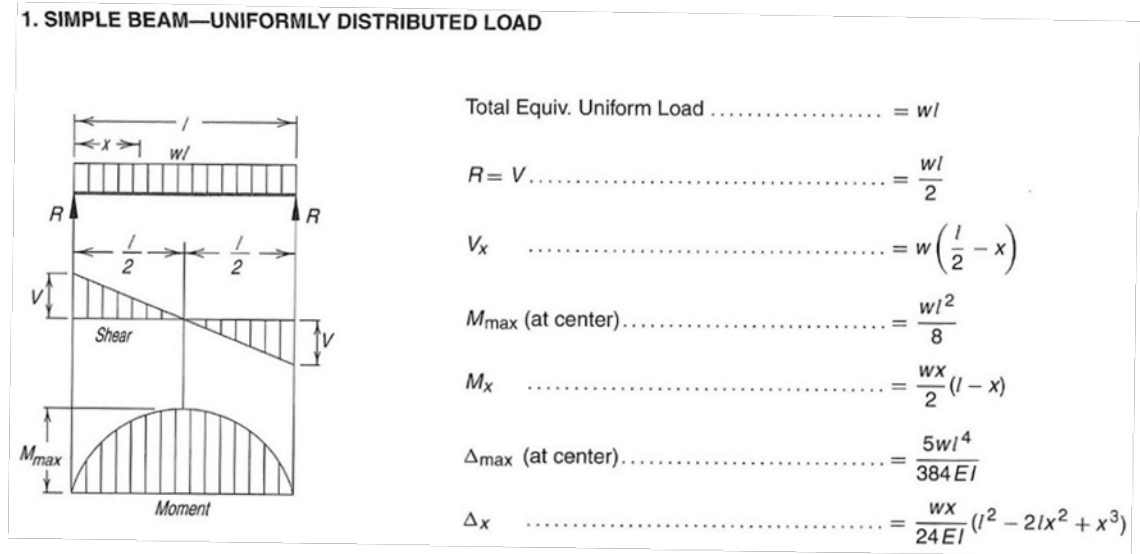


Figure 6.1: Moment, shear and deflection diagrams/equations for uniform distributed load

8. SIMPLE BEAM—CONCENTRATED LOAD AT ANY POINT

Total Equiv. Uniform Load = $\frac{8Pab}{l^2}$

$R_1 = V_1 (= V_{\max} \text{ when } a < b)$ = $\frac{Pb}{l}$

$R_2 = V_2 (= V_{\max} \text{ when } a > b)$ = $\frac{Pa}{l}$

M_{\max} (at point of load) = $\frac{Pab}{l}$

M_x (when $x < a$) = $\frac{Pbx}{l}$

Δ_{\max} (at $x = \sqrt{\frac{a(a+2b)}{3}}$ when $a > b$) ... = $\frac{Pab(a+2b)\sqrt{3a(a+2b)}}{27EI}$

Δ_a (at point of load) = $\frac{Pa^2b^2}{3EI}$

Δ_x (when $x < a$) = $\frac{Pbx}{6EI}(l^2 - b^2 - x^2)$

Figure 6.2: Moment, shear and deflection diagrams/equations for concentrated load

Using the principle of superposition, these beam diagrams can be added together in a variety of ways to reproduce dead and live loads for simple spans. An example of superposition is shown in Figure 6.3.

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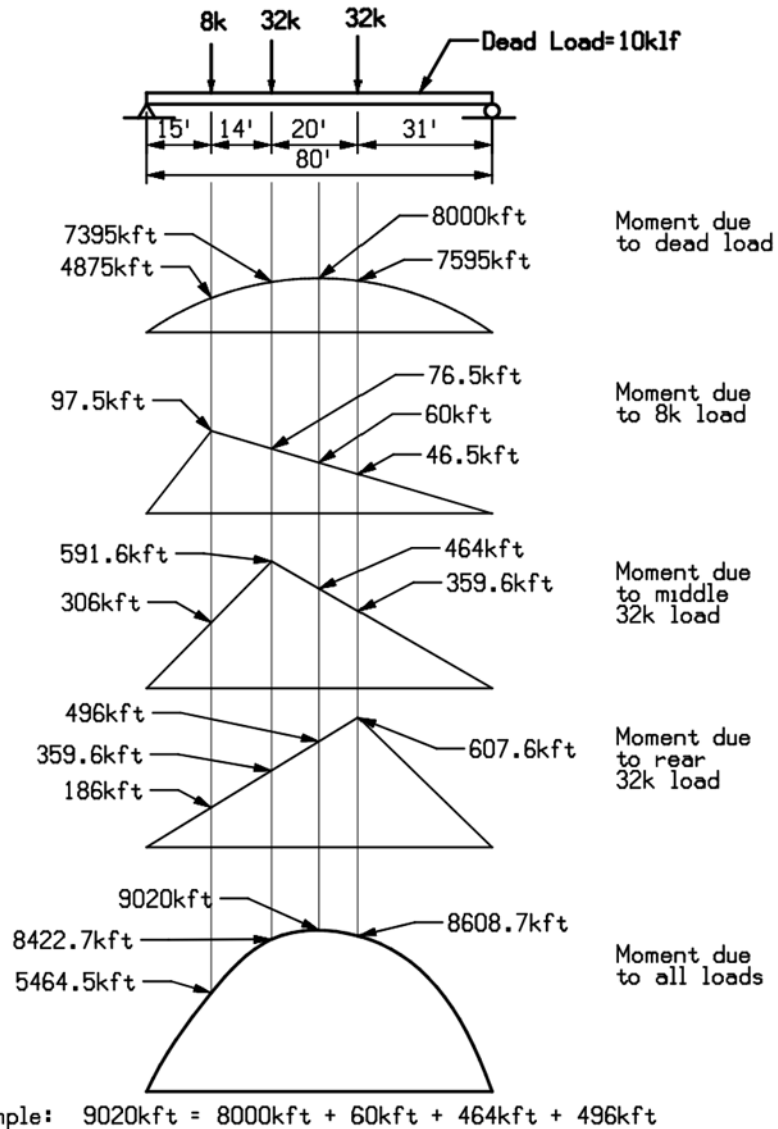


Figure 6.3: Example of superposition

The MBE appendices (e.g., Appendix G6B) contain resources for determining maximum moment and shear at any point on a span. Various beam diagrams also exist for fixed end moments and continuous spans. Using the same methodology as depicted in Figure 6.3, beam diagrams may be used for continuous superstructures. For continuous spans, the engineer should be aware of the degree of fixity at each support and whether a beam diagram is appropriate. If it is determined that the degree of fixity at each support is such that it cannot be modeled using the standard beam formulas, then a more detailed analysis is needed.

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The moment distribution method and differential equations are among other hand calculation methods available to the engineer; these are beyond the scope of this manual.

Influence Lines

Influence lines are another method used to calculate bending moments and shears. Influence lines can be defined as a function whose value at a point represents the value of some structural quantity due to a unit force placed at the point. Consider a three-span continuous model. An influence line for determining the negative moment at the left interior support would appear similar to that shown in Figure 6.4.

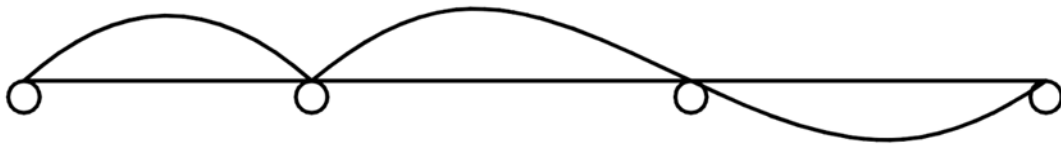


Figure 6.4: Negative moment of concern

Influence lines require careful forethought to understand which points are of significance and how to achieve the greatest effect on those points. One useful design aid is a publication called Moments, Shears and Reactions for Continuous Highway Bridges. This publication is produced by the American Institute of Steel Construction (AISC) and is useful for continuous structures. This publication gives influence coefficients that are derived from influence lines. Though this publication was originally published in 1959, it is still available on the AISC website (www.aisc.org). Influence lines can be used together with superposition to compute the load effect under evaluation due to either moving loads or stationary loads.

Critical Locations on Beams

For simple spans, maximum moments will occur at or near midspan and maximum shears will occur at the supports. Evaluations of capacity versus applied midspan moments and end shears are the most important examinations for load rating of simply supported bridges. However, for bridges with

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continuous spans or with pin and hangers, critical sections are not as obvious and require careful analysis.

On simply supported structures, other circumstances may require an investigation of capacity at a location other than at or near midspan and at the supports. If a structural section change, such as a cover plate end or flange transition, occurs on a beam or girder, it may be necessary to examine the capacity of the reduced section versus the applied moment at that change location. Also, if significant deterioration has occurred at a location other than at midspan (for moment) or beam end (for shear), it may be necessary to evaluate the capacity of the member at that compromised location. Even though these areas may not coincide with the location of maximum applied moment or shear, a reduced capacity may cause these locations to become the critical location for the load rating due to the load effect value and the capacity at the location. Maximum moment and/or shear (maximum produced by all considered limit states) at these locations or any other location on a simple beam can be calculated using the AISC diagrams (AISC Table 3-23). In addition, many currently available computer programs will generate the required information for any location on a beam.

Analysis software may be used to determine the maximum bending moments and shears where each applicable vehicle is “rolled” across the bridge. During this process, maximum values for bending moment and shear are recorded along a given span for each vehicle and for each placement. These tabulations of moments and shears for each vehicle are called “envelopes.” An example of moment and shear envelopes is shown in Figure 6.5. Once created, the envelopes for each vehicle can be compared to determine which vehicle produces the most severe loading effects for each span length. These maximums can be compiled into a chart for all applicable span lengths. A complete set of maximum charts is contained in the appendix.

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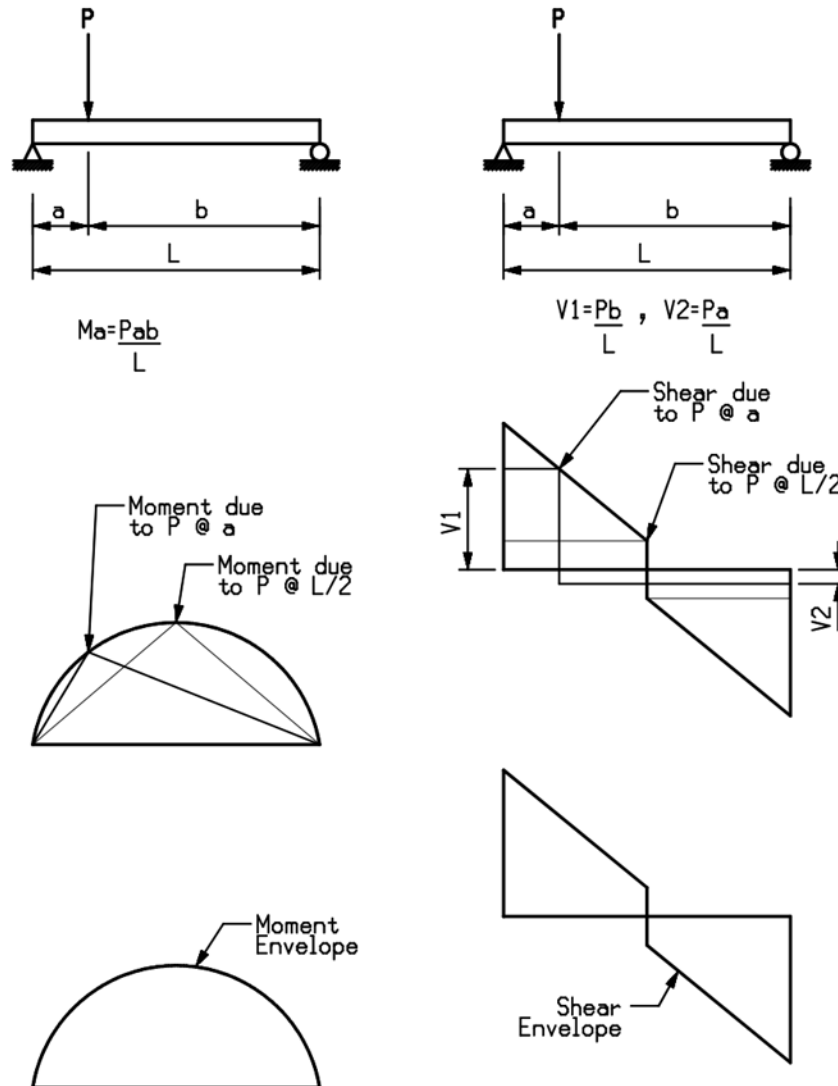


Figure 6.5: Moment and shear envelope example

6.05 Results

This general equation for load rating features the numerator representing the remaining capacity available to resist live load effects:

$$\text{Rating Factor} = \frac{\text{Capacity} - \text{Factored Dead Load Effects}}{\text{Factored Live Load Effects}}$$

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A typical bridge analysis examines every primary structural element in the bridge. For each of these elements, the load rating considers the load effect (generally moment and shear) for each of the required limit states (see MBE Table 6A.4.2.2-1). Given the number of legal live loads under consideration, this could result in the calculation of hundreds of rating factors for a typical bridge analysis. The controlling rating factor is the minimum of all factors. It is important to identify the controlling vehicle, value of the corresponding rating factor, the failure mode/load effect (moment, shear, etc), controlling member and the critical location within member for each legal and permit vehicle.

After determining the rating factors for the legal live loads, it may be found that many, or all, legal loads cannot be safely carried by that bridge (i.e., the rating factor is less than 1.0). When this is the case, it is necessary to post the structure to restrict vehicles that exceed the bridge capacity. Please see Chapter 7 for detailed information on completing the posting procedure.

All ratings should be reported as a rating factor, regardless of the rating method used. Report the rating factor using two decimal places, truncated to the hundredth place. For example, if a bridge has a calculated rating factor of 1.679, report 1.67. A maximum rating factor of up to 9.99 may be reported.

6.06 Load Rating Documentation

Documentation is important in load rating just as it is in most engineering calculations. Calculations create a written record of the basis for the load rating of a given bridge. It is required that a copy of all load rating calculations, along with any structure inspection information that formed a basis for the rating, be maintained in a file for each bridge. Load ratings must either be analyzed by or checked by a professional engineer registered in the state of Michigan. The same engineer cannot perform both duties. MDOT uses AASHTOWare BrM software to store all applicable documentation in each structure's bridge file. This allows others to refer to a previous load rating and see the assumptions that were used in that work. This information may also be helpful for future ratings.

Additional documentation needs are described in the following:

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Bridge Analysis Assumptions Form

All assumptions made during the load rating analysis should be clearly identified on the Bridge Analysis Assumptions form. Assumptions include but are not limited to approximations, material properties, vehicle selection live load factors, and live load distribution.

It is MDOT policy for proposed construction to indicate the job number and proposed work under “Work Performed.” For prestressed concrete, prestressing strand f_{pu} may be listed under beam F_y . For culverts, the clear roadway width should be calculated and entered on the analysis assumptions form. If there is a gap between roadways, such as a traffic separator, the clear roadway entry should be left blank and the individual clear roadway widths entered under “Unique factors that affect capacity.” “Unique factors that affect capacity” is also where fill depth calculations should be included.

When possible, assumptions should be accompanied by a brief statement that substantiates the assumption. The Bridge Analysis Assumptions form can be found on the MDOT Load Rating webpage.

Bridge Analysis Summary Form

A summary of results should be prepared at the conclusion of all rating calculations. The summary should contain at a minimum the inventory and operating capacities of the structure, the controlling member and a description of any posting that may be required. The Bridge Analysis Summary form can be found on the MDOT Load Rating webpage.

Documenting Software

When documenting software, record the name of the software, version and developer, at minimum.

The bridge file should contain documentation of the final input and output. When using AASHTOWare Bridge Rating, for example, submittal of the XML model file meets the documentation need for input. An output report should be generated to document the computed results for the software version used at the time of analysis. Important results should be highlighted on the output for easy review. Significant limitations that affect the results should be documented.

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It is important that input and output be checked to verify that the software is running correctly. The input should be checked to verify that all parameters are entered correctly. The output should be checked for “reasonableness.” Software should not be used blindly.

Documenting Judgment Ratings

All applicable items shall be documented and placed in the bridge file along with the judgment rating results:

- Statement of efforts to obtain design documents.
- Field evaluation notes.
- Description of load path, redundancy, traffic, evidence of damage.
- Justification of method used to determine load rating.
- Statement that “Load rating is based on field evaluation and documented engineering judgment.”
- Calculations as needed to support the judgment rating.

Documenting Calculations

Calculations should be performed by a competent engineer familiar with bridge design and/or load rating. It is important that calculations be neat and orderly, and contain references to books, manuals, inspection information and test data used to aid in the calculations. Assumptions should be noted to provide clarity. The engineer performing the analysis or the engineer reviewing the analysis must be a professional engineer licensed in the state of Michigan. A sample calculation is shown in Figure 6.6. When reviewing Figure 6.6, note that the right edge of the paper is reserved for references to manuals and codes. Also, note that results are clearly identified, equations are fully written out and units of measurement are labeled. This is especially important when working with spreadsheets or other engineering calculation software.

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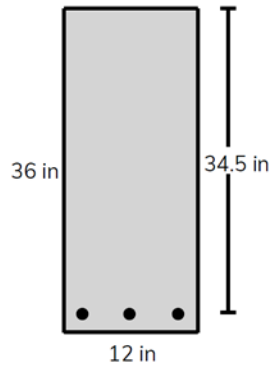
MAIN ST BRIDGE OVER BIG RIVER
LOAD RATING COMPUTATIONS

Computed by: Jane Smith Feb 19, 2025
Checked by: John Doe Feb 21, 2025

BEAM ANALYSIS

BEAM PROPERTIES

$\phi = 0.9$
 $\alpha_1 = 0.85$
 $\beta_1 = 0.85$
 $b = 12 \text{ in}$
 $d = 36 \text{ in}$
 $d_s = 34.5 \text{ in}$
Concrete
 $f'_c = 3.0 \text{ ksi}$
 $\epsilon_u = 0.003$
Steel
 $A_s = 3 \text{ in}^2$
 $f_y = 60 \text{ ksi}$
 $E_s = 29000 \text{ ksi}$



LRFD 5.5.4.2
LRFD 5.6.2.2
LRFD 5.6.2.2

MOMENT CAPACITY

Check $\epsilon_t > \epsilon_{tl}$ LRFD 5.6.2.1

$\epsilon_{tl} = 0.005$ LRFD 5.6.2.1

$\epsilon_t = \left(\frac{d - c}{c} \right) * \epsilon_u = 0.0126 > \epsilon_y \text{ OK!}$ Nawy 2003

$c = \frac{A_s * f_y}{\alpha_1 * f'_c * \beta_1 * b} = 6.920 \text{ in}$ LRFD (5.6.3.1.2-4)

$a = c * \beta_1 = 5.882 \text{ in}$ LRFD 5.6.3.2.2

$\phi M_n = \phi * A_s * f_y * \left(d_s - \frac{a}{2} \right) = 426.044 \text{ ft} * \text{kip}$ LRFD (5.6.3.2.2-1)

LRFD - AASHTO LRFD Bridge Design Specifications 10th Edition, 2024

Figure 6.6: Calculation example

Chapter 7

POSTING PROCEDURES

7.01 Load Posting Analysis

When the load carrying capacity of a bridge is insufficient for legal loads, the structure must be posted to restrict vehicles that are too heavy from crossing. Chapter 6 describes the process of selecting analysis vehicles. If the load rating analysis finds the legal load rating factor (B.EP.02) to be less than 1.0, a bridge must be posted. Load posting status (B.PS.01) and posting status change date (B.PS.02) must be coded appropriately; see the SNBI for coding options. When a bridge requires posting, the type of restriction (load, vehicle type, speed, number of lanes, other) is recorded using posting type (B.EP.03) and posting value (B.EP.04).

Coding Guide: *If the load rating analysis finds the Michigan operating rating factor (MDOT Item 64MB) to be less than 1.0, a bridge must be posted.*

For LRFR, because of the vehicle-specific live load factors, all 25 Michigan legal vehicles and the three AASHTO routine commercial legal vehicles (Type 3, Type 3S2, Type 3-3) must be run. For LFR analysis, where the live load factors are constant across all Michigan legal vehicles, MDOT has a practice to analyze using Michigan legal vehicles 5DL, 17DL, 18DL and 23DL. If the rating factor is less than 1.05 for any of the four vehicles, then all 25 Michigan legal loads and the AASHTO routine commercial legal vehicles Type 3, Type 3S2 and Type 3-3 must be run. This practice was validated by a study comparing the moment and shear values for the four vehicles against the maximum moment and shear tables for all vehicles shown in the appendix. Research Report TI-2131 - Investigation of Controlling Michigan Legal and Overload Truck Configurations in Load Rating describes the study.

Chapter 3 explains how specialized hauling vehicles (SHVs) and emergency vehicles (EVs) produce moment and shear load effects for typical bridge spans that are enveloped by the 25 state legal vehicles. Therefore, it is MDOT policy to not include these vehicles when completing load rating calculations. However, when a posting is required, any of the 25 Michigan legal vehicles, three AASHTO routine commercial legal vehicles (Type 3, Type

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3S2, Type 3-3), AASHTO specialized hauling vehicles (SU4, SU5, SU6 and SU7), and FHWA emergency vehicles (EV2 and EV3) with rating factors less than 1.0 are to be considered when determining a safe posting load. It is important to note that the lowest rating factor does not necessarily correspond to the lowest safe posting load and, therefore, the safe posting load/tonnage must be determined for all vehicles with rating factors less than 1.0.

For every span, there is one vehicle that will yield the lowest safe posting load either as a single tonnage or for each of the vehicle categories (one-unit, two-unit or three-unit) shown on posting signs (Section 7.03). It is important to identify and use this particular “controlling vehicle” to calculate the safe posting load. This is important since operators, in general, do not know which of the legal vehicles they are driving, nor should they be asked to stop and make this determination before crossing a posted bridge. It would also be impractical to prepare posting signs for all legal vehicles.

When all vehicles in a particular category (one-unit, two-unit or three-unit) produce a rating factor greater than 1.0, the bridge does not require load posting for any legal loads in that category. Posting of the bridge may be required if any vehicle in another category produces a rating factor less than 1.0. In this case, the weight limit associated with a vehicle category that did not require posting would be set at the maximum legal weight in that category. See Table 7.1 for an example of this situation and Figure 7.1 for the resulting posting sign.

Table 7.1: Load Posting Weight Limit Example

Vehicle Category	Max Legal Vehicle Weight in Category (tons)	Controlling Rating Factor	Posting required as a result of rating within this category?	Posting Sign Weight Limits
One-unit	42	1.041	No	42
Two-unit	77	0.795	Yes	54
Three-unit	82	0.850	Yes	64

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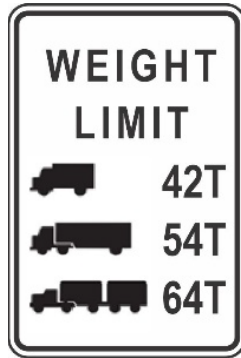


Figure 7.1: Sample posting sign from Table 7.1 example

The safe posting load (LRFR terminology in the MBE) or the bridge member rating (tons) (LFR terminology in the MBE) is determined using the following equations, respectively. Because each vehicle varies in weight, the vehicle entered in B.LR.07 - Controlling Legal Load Rating Factor will not necessarily be the vehicle that controls the posting calculations. Therefore, all vehicles within a category that produce a rating factor less than 1.0 must be considered. The following equations are computations of the posting load according to LRFR and LFR methods. The calculated tonnage, found using the following equation, should always be rounded down to the nearest whole number.

LRFR (MBE 6A.8.3-1):

$$\begin{aligned} & \text{Safe posting load (tons)} \\ &= \frac{\text{weight of rating vehicle (tons)}}{0.7} [\text{legal load rating factor} - 0.3] \end{aligned}$$

where RF is between 0.3 and 1.0

LFR (MBE 6B.4.1-2):

$$\text{Bridge member rating (tons)} = \text{rating factor} * \text{weight of nominal truck (tons)}$$

If the safe live load carrying capacity is found to be less than 3 tons, a bridge must be closed to traffic and the load posting status (B.PS.01) must be coded “C”. If the legal load rating factor indicates that the bridge can carry all legal loads (RF greater than 1.0), posting is not required. However, a bridge owner may elect to post a bridge for a lower weight limit than determined by calculations for such reasons as to extend the life of a bridge.

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Coding Guide: *If the safe live load carrying capacity is found to be less than 3 tons, a bridge must be closed to traffic and NBI Item 41, Structure Open, Posted, or Closed to Traffic, must be coded as “K”.*

7.02 Load Posting Process

The load posting process includes the following steps:

- Analysis discovers that posting is necessary, or owner decides to post.
 - MiBridge or BrM is updated with:
 - A load posting status (B.PS.01) coded as “Needs Action (A)” (open with load posting recommended, but no weight limit sign is in place).
-

Coding Guide: *Item 41 coded as “B” (open, posting recommended but not legally implemented).*

- The bridge owner coordinates erecting weight limits signs not more than 50 feet in advance of the structure, and additional weight limit signs with an advisory distance or directional legend shall be located in advance of the applicable section of highway or structure so that prohibited vehicles can detour or turn around prior to the limit zone. The posted weight must not exceed the calculated safe posting load.
 - Once the bridge is posted, MiBridge or BrM is updated with:
 - A load posting status (B.PS.01) coded appropriately, see SNBI for coding options.
-

Coding Guide: *Item 41 coded as “P” (posted for load).*

- The bridge owner or their representative uploads photos of the posted bridge to MiBridge or BrM. Photos must include the sign at each end of the structure and the advance warning signs.

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The process required by MDOT for posting a bridge includes properly coding the SNBI Section 5: Loads, Load Rating, and Posting items. B.PS.01 contains codes for load posting status of permanent (P), temporary (T) or supported (S) structures.

Table 7.2: Load Posting Status Code Definitions from SNBI Item B.PS.01

Load Posting Status Codes	Description
New (N)	Bridge is newly constructed and not yet open to traffic but is expected to be open within 12 months.
Open (O)	Bridge is open with no restrictions.
Needs Action (A)	Bridge that is open with load posting recommended but no weight limit signs in place or a weight limit sign that is not legally enforceable.
Weight (P)	Bridge is posted with a weight limit sign or signs.
Other (R)	A posting sign or other traffic control device(s) at the bridge that reduces loading by reducing speed (to reduce impact), limiting the number of lanes or vehicles, or restricting commercial vehicles in general.
Needs Reduction (D)	Bridge is posted, with posting reduction recommended but not implemented.
Missing (M)	Bridge has a legally enforceable load posting and was posted but one or more required signs are missing or illegible.
Closed (C)	Bridge is closed to all traffic.

The permanent/temporary/supported designation precedes the load posting status codes (for example, PP indicates a permanent bridge posted for weight). If a particular bridge is currently not posted and a load rating shows the capacity to be deficient for legal loads, B.PS.01 must have its coding changed from an “O” to an “A.” Only after the bridge is physically posted can the coding be changed from an “A” to a “P.”

It is imperative that corrective action be taken when the requirement for load posting is known. The FHWA requires that a structure be posted as soon as possible but not later

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than 30 days of identification of need. When a bridge requires posting, the bridge owner must coordinate sign installation. Signs may be placed temporarily while waiting for weather or MISSDIG to enable permanent installation.

Coding Guide: *Four of the nine possible codes for item 41 that are shown in the following are taken from the Michigan Structure Inventory and Appraisal Coding Guide.*

Table 7.3: Load Posting Status Code Definitions from MI SI&A Item 41

Code	Description
A	Open, no restriction.
B	Open, posting recommended but not legally implemented (all signs not in place or do not show the correct information or are not in the correct location).
P	Posted for load (may include other restrictions such as temporary bridges which are load posted).
K	Bridge closed.

If a particular bridge is currently not posted and a load rating shows the capacity to be deficient for legal loads, Item 41 should have its coding changed from an “A” to a “B.” Only after the bridge is posted, can the coding be changed from a “B” to a “P.”

It is imperative that corrective action be taken when the requirement for load posting is known. The FHWA requires that a structure be posted within 30 days of identification of need. When a bridge requires posting (Item 41 coded as “B”), the bridge owner must coordinate sign installation.

7.03 Weight Limit Signs

MVCSection 257.631 states that if an analysis finds that a structure cannot safely withstand legal loads, maximum load limitation signs shall be erected and maintained not more than 50 feet from each end of the structure and also at a suitable distance from each end of the bridge to enable vehicles to take a different route.

The *Michigan Manual on Uniform Traffic Control Devices* ([MMUTCD](#)) regulates the signs that can be used as well as the information shown on those signs, such as symbols and text. Bridges can be posted based on vehicle type, GVW, axle weight or a combination of gross vehicle weight and axle weight.

Sign type R12-5a (see Figure 7.2) is the most common bridge load limit sign. It is used to post weight limits based on vehicle type. The sign uses typical configurations to show easily recognizable vehicles since it is not possible for signs to represent every vehicle configuration. It is important to note that the number of axles shown on each silhouette is a representative example only. Actual number of axles and axle configuration may differ.

The first silhouette is a single-unit vehicle. The single-unit vehicle has a power unit and cargo area that share a single chassis. The power unit and cargo area are not designed to be detachable. The second silhouette is a two-unit vehicle. For this vehicle, the power unit or single-unit vehicle is detachable from the trailer. The third silhouette is a three-unit vehicle.

Michigan's R12-5a sign differs from the standard R12-5 due to the three-unit vehicle silhouette. For Michigan, this vehicle combination consists of three units that are detachable from one another, including any power unit with two trailers. When posting by vehicle type, the maximum one-unit vehicle is 42 tons, the maximum two-unit vehicle is 77 tons, and the maximum three-unit vehicle is 82 tons (see Chapter 4).

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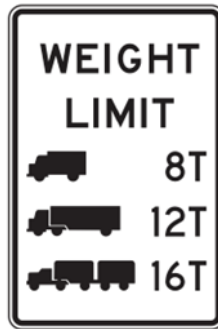


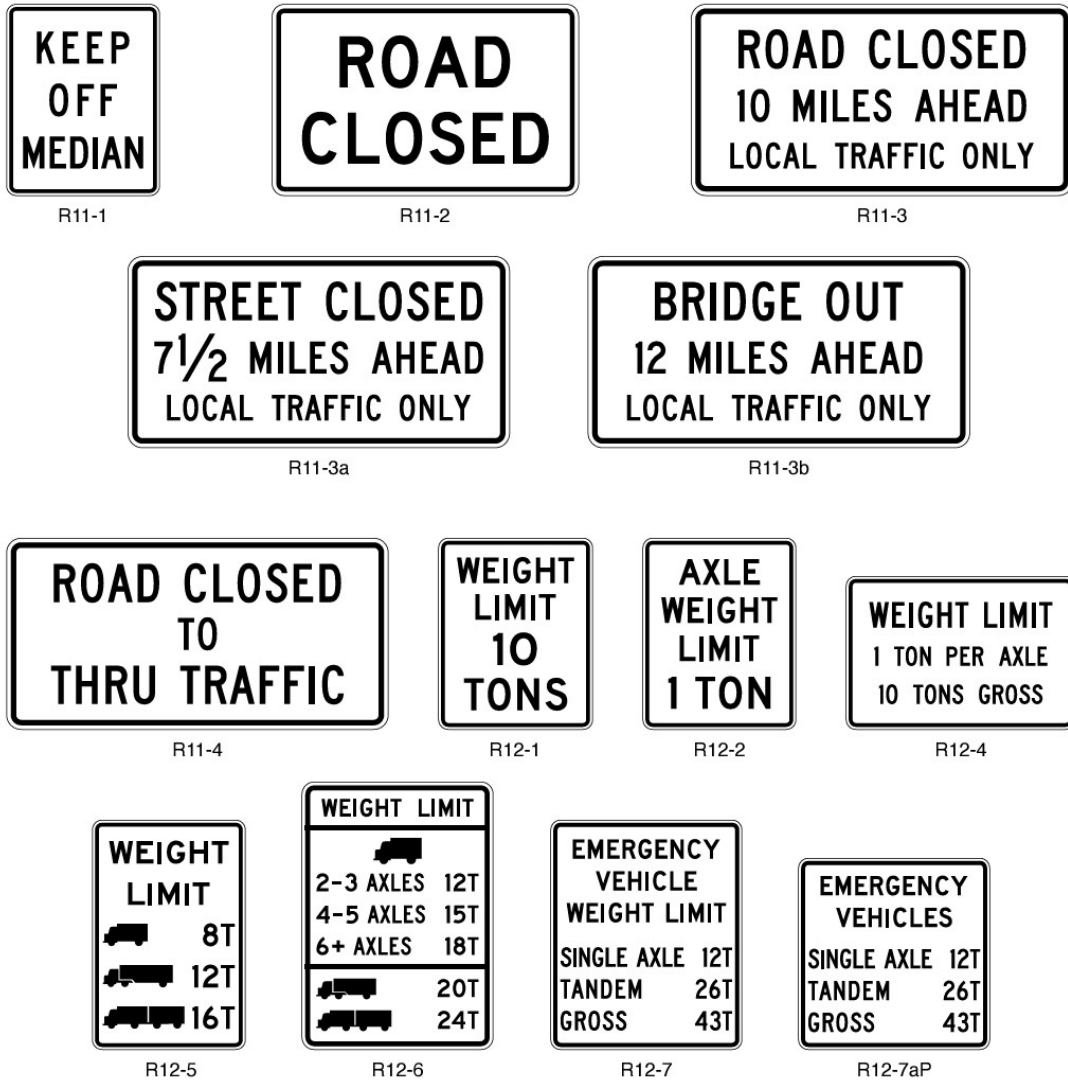
Figure 7.2: R12-5a load weight limit sign

The MMUTCD 2025 Edition, Part 2B Regulatory Signs, Barricades and Gates, gives examples of typical signs used for posting bridges (Figure 2B-30).

Figure 7.3 illustrates examples of various weight limit signs: Sign R12-5 and R12-5a are the most common bridge weight limit signs and should contain values less than or equal to 42, 77 and 82 tons for one, two, or three-unit vehicles, respectively (see Chapter 4). Signs R12-1 and R12-2 may be useful in situations where severe load restrictions apply to a bridge or to a bridge component. The maximum value for R12-1 is 42 tons and R12-2 is 12 tons. Sign R12-4 can be used to combine the information contained on R12-1 and R12-2. In any case, careful analysis of the structure will determine the types of loading that control and will, therefore, dictate the information required on the weight limit signs.

After a load rating has been completed and it is determined that the bridge cannot support all legal vehicles, the bridge owner must order the fabrication of weight limit signs and coordinate to have the signs erected.

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Figure 7.3: Road closed and weight limit signs

Chapter 8

PERMIT LOAD ANALYSIS PROCEDURES

The majority of vehicles that travel on Michigan roads and bridges are configured such that they are classified as legal, allowed to operate on roadways without restriction and conform to the MVC. Occasionally, transporters require the use of vehicles with wider, heavier or more closely spaced axles than allowed by law, a gross weight exceeding that allowed by law, or a combination of these. Vehicles having axle spacings and/or axle weights that exceed what is allowed per the MVC require a permit for legal travel on Michigan roadways.

8.01 Permitting Procedures

8.01.01 MDOT Procedures

MDOT utilizes two different types of permitting methods. Routine permits (also known as extended permits) and single-trip permits.

Extended permits are available for a variety of commodities, including construction equipment, agricultural equipment, mobile homes, raw forest products and others. Extended permits issued by MDOT are valid for movement on state highway rightsof way only and must be renewed annually. Extended permits are not valid on highways or structures that are posted for lighter-than-legal loading or are designated as Overload Class D. The list of structures designated Overload Class D is updated on a monthly basis and is located under trucker information/restrictions and conditions on the MDOT website: michigan.gov/en/mdot/Business/truckers.

Single-trip permit applications require information pertaining to axle weights, axle spacings, tire widths, transverse wheel spacing (if the vehicle width exceeds 8 feet), route start and route end location. Single-trip permits issued by MDOT are valid for one trip over a specified route for a five-day period. Single-trip permits are not valid on highways or structures that are posted for lighter-than-legal loading or are designated as Overload Class D.

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More information on MDOT's extended and single-trip permits can be found on the MDOT Oversize/overweight permits webpage. Form T-2, Information on the Movement of Oversize or Overweight Vehicles and Loads, provides information on conditions and limitations of permits. Permits are not issued for divisible loads that can be readily dismantled, reduced or otherwise arranged to conform to legal limits.

8.01.02 Local Agency Procedures

Like MDOT, local agencies throughout the state issue routine permits, also known as annual permits, and single-trip permits for travel on the roads and bridges within their jurisdiction and may have their own procedures for the issuance of overweight vehicle permits. Many use an online system available from each individual agency's website. The County Road Association of Michigan website (www.micountyroads.org) lists websites and contact information for all county road agencies in Michigan. Other local agencies may be contacted directly. The Michigan Municipal League website (<https://mml.org/resources-research/league-member-communities-a/>) lists member communities and, if available, links to agency websites.

8.02 Load Rating for Permit Loads

A permit load rating must be performed by the bridge owning agency when a hauler requests to transport a load that does not conform with state statutes for legally configured vehicles.

8.02.01 MDOT Extended (Routine) Permits

MDOT performed a weigh in motion (WIM) analysis with MDOT Research Report SPR-1640, Developing Representative Michigan Truck Configurations for Bridge Load Rating, and the findings were extended permit loads are encompassed by Michigan legal loads. Therefore, structures that meet Michigan legal load requirements have a load capacity that is adequate for all routine permit loads that fall within the criteria set forth in the T-2 document, Information on the Movement of Oversize or Overweight Vehicles and Loads.

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8.02.02 MDOT Single-Trip Permits

The MDOT Overload Classification System establishes a load rating procedure for single-trip permits. A vehicle-specific single-trip permit load rating is not performed if the load/configuration falls within the overload class assigned to the structure. If the vehicle is not enveloped by the MDOT Overload Classification System then a vehicle-specific load rating must be performed using the exact load configuration requested to be transported and must be placed to produce the maximum load effect.

Single-trip permit load ratings are performed considering multiple loaded lanes when performing an LRFR analysis. If the single-trip permit restrictions include no other trucks on the bridge, then single-lane loading can be used when performing an LRFR analysis. However, when performing an LFR analysis, loading may be applied as a single loaded lane. In both methods, the permit rating is performed at the operating level.

MDOT has established a list of 20 vehicle configurations, called overloads (see Figure 8.1), that are used as part of MDOT's permitting system for single-trip permit analysis. Each of the overload vehicle configurations can be further classified as Class A, Class B or Class C, based on maximum allowable axle loads. The vehicle configurations shown in Figure 8.1 depict overload class A, B and C analysis vehicles. Figure 8.1 is intended for out-to-out tire gauges of 8 feet; however, larger gauges can be evaluated using the adjustment method described in Figure 8.2.

The LRFR specifications for load rating bridges and LRFD specifications for designing bridges are based on factors calibrated from structural load and resistance statistics to achieve a uniform level of reliability for all bridges. The live load factors in the LRFR specifications are based on load data representative of heavy truck traffic nationwide. However, the specifications allow for recalibrating live load factors for a jurisdiction using weigh-in-motion data. MDOT has implemented customized live load factors based on the analysis described in MDOT Research Report R-1511. The live load factors for Michigan overload trucks, Class A, B and C, are provided in Tables 8.1 - 8.3 for bridges with an average daily truck traffic (ADTT) of 5,000, 1,000 and 100.

Michigan trunkline bridges are classified as overload class A, B, C or D as part of each load rating analysis. Each overload is broken down into three weight classes:

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A, B and C. Class A considers each vehicle at the maximum weight, while class B and C represent reduced axle weight configurations for each vehicle. Class B and C are further broken down for bridges designed with H15 loads (1962-1975) where the deck controls; see values marked with an asterisk in the Figure 8.1 table where the 60,000 axle load is replaced with the values controlling the deck. Bridges are to be evaluated for their ability to carry each of the 20 permit vehicles. Class A bridges can support all 20 loads at the maximum weight (load rating greater than 1.0). Bridges that cannot support all 20 loads at the maximum weight (load rating less than 1.0) are evaluated at a lower set of axle weights. Class B bridges pass all 20 loads at the class B level, and class C bridges pass all 20 loads at the class C level. If a bridge cannot pass all 20 loads at the class C level, it is coded as class D and no overweight permits (extended or single-trip) are issued to cross the structure. There are no analysis vehicle configurations for overload class D. It is MDOT policy to allow overload class ratings of 0.97 to 0.99 to remain designated as the overload class that produced the 0.97 to 0.99 rating; however, this raise in overload class is not applicable if the legal load analysis was based on refined analysis using 3D AASHTOWare engine or allowing plastic analysis or using AASHTO 1979 Interim Code to check shear.

MDOT's overload classification system is used as part of an efficient review in the MDOT permitting system, MiTrip, which is to be integrated with AASHTOWare BrM to check that the submitted load for a single-trip permit is enveloped by the overload vehicles. If a permit request vehicle is not enveloped by the overload classification system, it is then analyzed on a case-by-case basis within the MDOT load rating unit. Possible reasons for not being able to analyze the specific permit vehicle for a bridge could include lengthy analysis time for complex bridge types and bridge types not supported within the automated system.

Moment and shear tables for simply supported spans from 5 feet to 300 feet loaded with the MDOT classes A, B and C overload vehicles are located in the appendix.

8.02.03 MDOT MiTrip Software System

The future version of MiTrip, which is the MDOT permit load processing software, will integrate AASHTOWare BrR data by use of BIN files to perform load rating analysis for permit vehicles when a BrR file is available for a structure. Structures

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without BrR data and a BIN file will rely on the MDOT Overload Classification System for permit review.

8.02.04 Local Agency System

Local agencies are not required to use MDOT's overload classes and BrR data integration; however, it is encouraged to promote consistency throughout the state. Engineers performing permit load analysis for bridges owned by local agencies should contact the appropriate local authority for information regarding their permitting process.

Prior to issuing a permit for a vehicle that exceeds Michigan legal axle limits, the bridges along the route requested in the permit application must be analyzed to verify their safe load carrying capacity for the permit vehicle. This analysis determines the approval or denial of the permit application.

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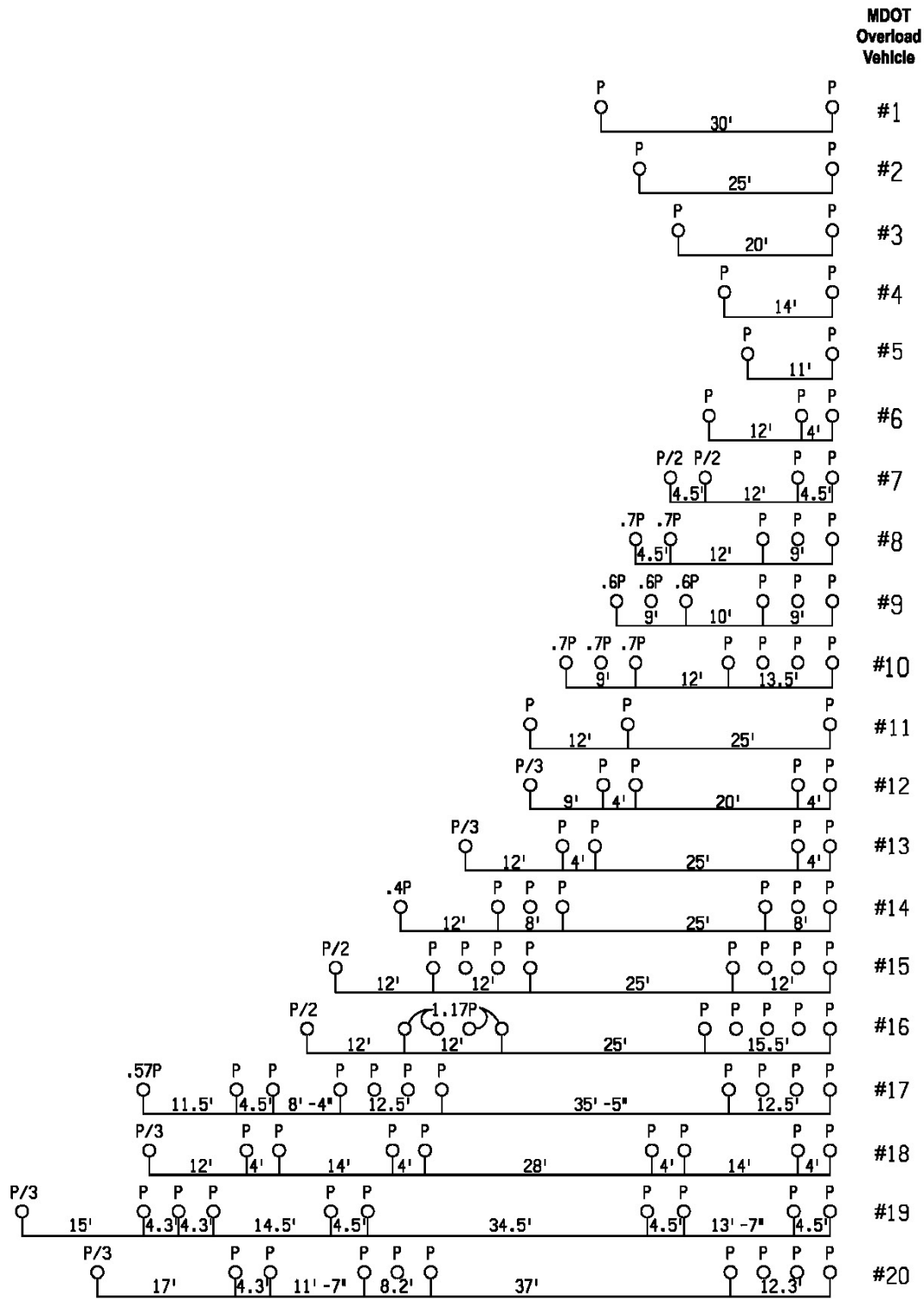


Figure 8.1: Permissible overload classes on state bridges

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Figure 8.1 (continued): Permissible Overload Classes on State Bridges

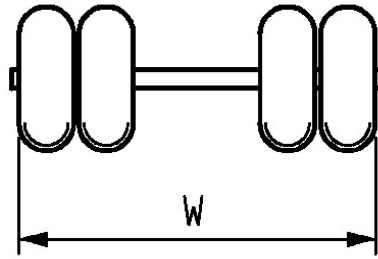
Overload Truck	Class A ++:	Class A ++:	Class B ++:	Class B ++:	Class C ++:	Class C ++:
	Axle (k) ‡	Gross (tons)	Axle (k) ‡	Gross (tons)	Axle (k) ‡	Gross (tons)
1	60	60	60	60	60	60
			38*	38*	38*	38*
2	60	60	60	60	60	60
			38*	38*	38*	38*
3	60	60	59	59	57	57
			38*	38*	38*	38*
4	60	60	54	54	49	49
			38*	38*	38*	38*
5	60	60	52	52	44	44
			38*	38*	38*	38*
6	42	63	36	54	30	45
7	46	69	38	57	31	46.5
8	34	74.8	29	63.8	24	52.8
9	33	79.2	27	64.8	22	52.8
10	29	88.5	24	73.2	20	61
11	60	90	53	79.5	46	69
			38*	57*	38*	57*
12	44	95.3	37	80.1	31	67.2
13	45	97.5	39	84.4	34	73.7
			38*	82.3*		
14	33	105.6	28	89.6	24	76.8
15	28	119	24	102	20	85
16	24	122.2	20	101.8	17	86.5
17	25.8	136.3	22	116.2	17.3	91.4
18	34	141.7	29	120.8	24	100
19	29.7	138.6	25.1	117.2	21.5	100.4
20	28.3	132	24.2	112.9	20.5	95.7

‡ Loads exceeding these values must be checked for individual bridges

++ For bridge class, refer to MDOT Item 193A - Michigan Overload Class

* For bridges designed for H15 between 1962 and 1975, the slab controls

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Where W is not 8 feet, adjust axle load by the factor $\frac{W+8}{16}$ providing the axle load does not exceed 60,000 and except for restricted bridges with “R” noted in Item 193C - Overload Status. This formula is only valid for multi-stringer bridges with stringer spacing not greater than 10 feet.

Figure 8.2: Overload width adjustment

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Table 8.1: Overload Class Vehicle Load Factors for Strength Limit States, Routine Permits, Greater or Equal to 5,000 ADTT

Truck	Class A:	Class A:	Class B:	Class B:	Class C:	Class C:
	GVW (kips)	Load Factor γ_{LL}	GVW (kips)	Load Factor γ_{LL}	GVW (kips)	Load Factor γ_{LL}
1	120.0	1.39	120.0	1.39	120.0	1.39
2	120.0	1.39	120.0	1.39	120.0	1.39
3	120.0	1.39	118.0	1.40	114.0	1.43
4	120.0	1.39	108.0	1.48	98.0	1.58
5	120.0	1.39	104.0	1.52	88.0	1.70
6	126.0	1.35	108.0	1.48	90.0	1.67
7	138.0	1.28	114.0	1.43	93.0	1.64
8	149.6	1.22	127.6	1.34	105.6	1.50
9	158.4	1.18	129.6	1.33	105.6	1.50
10	177.0	1.12	146.4	1.24	122.0	1.37
11	180.0	1.11	159.0	1.18	138.0	1.28
12	190.6	1.10	160.2	1.18	134.4	1.30
13	195.0	1.10	168.8	1.14	147.4	1.23
14	211.2	1.10	179.2	1.11	153.6	1.20
15	238.0	1.10	204.0	1.10	170.0	1.14
16	244.4	1.10	203.6	1.10	173.0	1.13
17	272.6	1.10	232.4	1.10	182.8	1.10
18	283.4	1.10	241.6	1.10	200.0	1.10
19	277.2	1.10	234.4	1.10	200.8	1.10
20	264.0	1.10	225.8	1.10	191.4	1.10

* Load factors may be interpolated for a specific ADTT

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Table 8.2: Overload Class Vehicle Load Factors for Strength Limit States, Routine Permits, 1,000 ADTT

Truck	Class A:	Class A:	Class B:	Class B:	Class C:	Class C:
	GVW (kips)	Load Factor Y _{LL}	GVW (kips)	Load Factor Y _{LL}	GVW (kips)	Load Factor Y _{LL}
1	120.0	1.36	120.0	1.36	120.0	1.36
2	120.0	1.36	120.0	1.36	120.0	1.36
3	120.0	1.36	118.0	1.37	114.0	1.40
4	120.0	1.36	108.0	1.45	98.0	1.54
5	120.0	1.36	104.0	1.48	88.0	1.65
6	126.0	1.32	108.0	1.45	90.0	1.63
7	138.0	1.25	114.0	1.40	93.0	1.59
8	149.6	1.19	127.6	1.31	105.6	1.47
9	158.4	1.16	129.6	1.30	105.6	1.47
10	177.0	1.10	146.4	1.21	122.0	1.34
11	180.0	1.10	159.0	1.16	138.0	1.25
12	190.6	1.10	160.2	1.15	134.4	1.27
13	195.0	1.10	168.8	1.12	147.4	1.20
14	211.2	1.10	179.2	1.10	153.6	1.18
15	238.0	1.10	204.0	1.10	170.0	1.12
16	244.4	1.10	203.6	1.10	173.0	1.11
17	272.6	1.10	232.4	1.10	182.8	1.10
18	283.4	1.10	241.6	1.10	200.0	1.10
19	277.2	1.10	234.4	1.10	200.8	1.10
20	264.0	1.10	225.8	1.10	191.4	1.10

* Load factors may be interpolated for a specific ADTT

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Table 8.3: Overload Class Vehicle Load Factors for Strength Limit States, Routine Permits, 100 ADTT

Truck	Class A:	Class A:	Class B:	Class B:	Class C:	Class C:
	GVW (kips)	Load Factor Y _{LL}	GVW (kips)	Load Factor Y _{LL}	GVW (kips)	Load Factor Y _{LL}
1	120.0	1.30	120.0	1.30	120.0	1.30
2	120.0	1.30	120.0	1.30	120.0	1.30
3	120.0	1.30	118.0	1.32	114.0	1.34
4	120.0	1.30	108.0	1.39	98.0	1.40
5	120.0	1.30	104.0	1.40	88.0	1.40
6	126.0	1.27	108.0	1.39	90.0	1.40
7	138.0	1.20	114.0	1.34	93.0	1.40
8	149.6	1.15	127.6	1.26	105.6	1.40
9	158.4	1.12	129.6	1.25	105.6	1.40
10	177.0	1.10	146.4	1.16	122.0	1.29
11	180.0	1.10	159.0	1.12	138.0	1.20
12	190.6	1.10	160.2	1.11	134.4	1.22
13	195.0	1.10	168.8	1.10	147.4	1.16
14	211.2	1.10	179.2	1.10	153.6	1.14
15	238.0	1.10	204.0	1.10	170.0	1.10
16	244.4	1.10	203.6	1.10	173.0	1.10
17	272.6	1.10	232.4	1.10	182.8	1.10
18	283.4	1.10	241.6	1.10	200.0	1.10
19	277.2	1.10	234.4	1.10	200.8	1.10
20	264.0	1.10	225.8	1.10	191.4	1.10

* Load factors may be interpolated for a specific ADTT

Accessibility

If you require assistance accessing this information or require it in an alternative format, contact the Michigan Department of Transportation’s (MDOT) Americans with Disabilities Act (ADA) coordinator at [Michigan.gov/MDOT-ADA](https://www.michigan.gov/MDOT-ADA).

Appendix A: Simple-Span Load Effect Tables (Without Impact) - Michigan and AASHTO Legal and Design Vehicles

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Accessibility

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Michigan and AASHTO Legal and Design Vehicles

ONE-UNIT

Truck 1
Truck 2
Truck 3
Truck 4
Truck 5
AASHTO Type 3

TWO-UNIT

Truck 6
Truck 7
Truck 8
Truck 9
Truck 10
Truck 11
Truck 12
Truck 13
Truck 14
Truck 15
Truck 16
Truck 17
Truck 18
AASHTO Type 3S2
AASHTO Type 3-3

THREE-UNIT

Truck 19
Truck 20
Truck 21
Truck 22
Truck 23
Truck 24
Truck 25

Design

HS-20/HL-93
HL-93 Lane

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Simple Span Load Effects Without Impact (spans 5-49 feet) - Designated Loading

Span (ft)	Trk 1 M (ft*k)	Trk 1 V (k)	Trk 2 M (ft*k)	Trk 2 V (k)	Trk 3 M (ft*k)	Trk 3 V (k)	Trk 4 M (ft*k)	Trk 4 V (k)	Trk 5 M (ft*k)	Trk 5 V (k)	Type 3 M (ft*k)	Type 3 V (k)
5	21.6	18	20	20.8	18.5	16.9	19.3	16.9	19.2	19.2	20.4	20.4
6	27	18	24	22.7	23.1	18.4	22.5	18.4	24	21.3	25.5	22.7
7	30.9	18	31.4	24	26.4	19.5	27	19.5	27.4	22.9	29.1	24.3
8	36	18	39	25	31.7	21.9	32.5	21.9	36	24	38.3	25.5
9	40	18	46.7	25.8	42.3	23.8	42.3	23.8	42.7	24.9	45.3	26.4
10	45	19.5	54.4	26.4	51	25.4	52	25.4	51.2	25.6	54.4	27.2
11	49.1	20.8	62.2	26.9	61.8	26.6	61.8	27.2	58.2	26.2	61.8	27.8
12	54	21.9	70	27.3	70.7	27.6	71.5	29.3	66.7	26.7	70.8	28.3
13	58.2	22.7	77.8	28.3	81.3	28.5	81.3	31	73.8	27.1	78.5	28.8
14	63	23.5	85.7	29.7	90.3	29.3	93.8	32.5	82.3	27.9	87.4	29.1
15	67.2	24.2	93.6	30.8	101	29.9	107	33.8	89.6	29.5	95.2	29.5
16	73.3	24.7	102	31.9	110	30.5	119	34.9	98	30.9	104	29.8
17	80.8	25.2	109	32.8	120	31.9	132	35.9	109	32.1	112	30
18	89	25.7	118	33.6	129	33.1	145	36.8	121	33.2	121	30.2
19	96.6	26.1	130	34.3	140	34.2	158	37.6	134	34.2	129	30.4
20	105	26.5	141	35	149	35.3	171	38.7	147	35.1	138	31.4
21	113	26.8	153	35.6	159	36.2	184	40.1	160	35.9	146	32.3
22	121	27.1	165	36.1	169	37	197	41.3	173	36.6	155	33.1
23	129	27.4	177	36.6	179	37.8	210	42.5	185	37.3	163	33.8
24	137	27.6	188	37	192	38.4	223	43.5	198	37.9	171	34.5
25	145	27.9	200	37.5	205	39.1	236	44.5	211	39.1	180	35.1
26	153	28.1	212	37.8	218	39.7	252	45.4	224	40.2	188	35.7
27	161	28.3	224	38.2	232	40.2	269	46.2	237	41.3	196	36.2
28	170	28.5	236	38.5	245	40.7	286	46.9	250	42.2	205	36.7
29	178	28.6	248	38.8	258	41.2	303	47.6	263	43.7	214	37.2
30	186	28.8	259	39.1	272	41.6	319	48.3	276	45	226	37.6
31	194	28.9	271	39.4	285	42	336	48.9	291	46.3	238	38
32	202	29.1	283	39.6	299	42.4	353	49.5	308	47.4	251	38.4
33	210	29.2	295	39.9	312	42.8	370	50	325	48.5	263	38.7
34	219	29.3	306	40.1	326	43.1	387	50.5	342	49.6	275	39.1
35	227	29.4	318	40.3	339	43.5	403	51	361	50.6	288	39.4
36	235	29.6	330	40.5	352	43.8	420	51.5	381	51.5	300	39.7
37	243	29.7	342	40.7	366	44.1	437	51.9	402	52.4	312	39.9
38	252	29.8	354	40.9	379	44.3	454	52.3	422	53.2	325	40.2
39	260	29.8	366	41	393	44.6	471	52.7	443	54	337	40.5
40	268	29.9	377	41.2	406	44.8	488	53.1	463	54.8	350	40.7
41	276	30	389	41.3	420	45.1	504	53.4	484	55.5	362	40.9
42	285	30.1	401	41.5	434	45.3	521	53.8	505	56.1	374	41.1
43	293	30.2	413	41.6	447	45.5	538	54.1	526	56.8	387	41.3
44	301	30.3	425	41.8	461	45.7	555	54.4	547	57.4	399	41.5
45	310	30.3	437	41.9	474	45.9	572	54.7	568	58	412	41.7
46	318	30.4	448	42	488	46.1	589	54.9	589	58.6	424	41.9
47	326	30.5	460	42.1	501	46.3	605	55.2	610	59.1	437	42.1
48	334	30.5	472	42.2	515	46.4	622	55.5	631	59.6	449	42.3
49	343	30.6	484	42.3	529	46.6	639	55.7	652	60.1	461	42.4

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Simple Span Load Effects Without Impact (spans 5-49 feet) - Designated Loading

Span (ft)	Trk 6	Trk 6	Trk 7	Trk 7	Trk 8	Trk 8	Trk 9	Trk 9	Trk 10	Trk 10	Trk 11	Trk 11
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
5	21.6	20.8	21.6	20.8	22.5	20.8	21.6	18	22.5	20.8	21.6	20.8
6	27	22.7	27	22.7	26.3	22.7	27	18	26.3	22.7	27	22.7
7	31.4	24	31.4	24	31.5	24	30.9	18	31.5	24	31.4	24
8	39	25	39	25	39	25	36	18	39	25	39	25
9	46.7	25.8	46.7	25.8	46.7	25.8	40	18	46.7	25.8	46.7	25.8
10	54.4	26.4	54.4	26.4	54.4	26.4	45	19.8	54.4	26.4	54.4	26.4
11	62.2	26.9	62.2	26.9	62.2	26.9	49.1	21.3	62.2	26.9	62.2	26.9
12	70	27.3	70	27.3	70	27.3	54	22.5	70	27.3	70	27.3
13	77.8	28.3	77.8	28.3	77.8	28.4	58.2	23.5	77.8	28.4	77.8	28.3
14	85.7	29.7	85.7	29.7	85.7	29.9	63	24.4	85.7	29.9	85.7	29.7
15	93.6	30.8	93.6	30.8	93.6	31.3	67.2	25.2	93.6	31.3	93.6	30.8
16	102	31.9	102	31.9	102	32.4	74.3	25.9	102	32.4	102	31.9
17	109	32.8	109	32.8	109	33.5	82.6	26.5	109	33.5	109	32.8
18	119	33.6	119	33.6	119	34.4	91	27	119	34.4	119	33.6
19	131	34.3	131	34.3	131	35.2	99.5	28.3	131	35.2	131	34.3
20	144	35	144	35	143	36	108	29.4	143	36	144	35
21	156	35.6	156	35.6	156	36.6	119	30.5	156	36.6	156	35.6
22	169	36.1	169	36.1	168	37.5	132	31.4	168	37.6	169	36.1
23	181	37.5	181	37.5	181	38.6	145	32.3	181	38.8	181	37.5
24	193	38.8	193	38.8	193	39.6	158	33.1	193	39.9	193	38.8
25	205	39.9	205	39.9	206	40.6	171	33.8	206	40.9	205	39.9
26	221	41	221	41	221	41.9	184	34.5	218	41.9	221	41
27	237	42	237	42	237	43.2	197	35.1	231	42.7	237	42
28	253	42.9	253	42.9	254	44.4	210	35.7	243	43.5	253	42.9
29	270	43.8	270	43.8	270	45.5	222	36.3	255	44.3	270	43.8
30	286	44.6	286	44.6	286	46.5	235	36.8	268	45	286	44.6
31	302	45.4	302	45.4	302	47.4	248	37.2	280	45.7	302	45.4
32	319	46.6	319	46.6	319	48.3	261	37.7	293	46.3	319	46.1
33	335	47.8	335	47.8	335	49.2	274	38.1	309	46.9	335	46.7
34	351	48.9	351	48.9	351	50	287	38.5	324	47.4	351	47.4
35	368	50	368	50	368	50.7	299	38.9	341	47.9	368	47.9
36	388	51	388	51	385	51.4	312	39.2	356	48.4	388	48.5
37	409	51.9	409	51.9	405	52.1	325	39.5	373	48.9	409	49.2
38	429	52.8	429	52.8	424	52.7	338	39.8	388	49.3	429	50.1
39	450	53.7	450	53.7	444	53.3	351	40.1	404	49.7	450	51
40	471	54.5	471	54.5	464	53.9	364	40.4	420	50.1	471	51.8
41	492	55.3	492	55.7	487	54.4	377	40.7	436	50.5	492	52.6
42	512	56	512	56.9	510	54.9	389	40.9	452	50.8	512	53.3
43	533	56.7	533	58	532	55.6	402	41.2	468	51.2	533	54
44	554	57.4	554	59	555	56.4	415	41.4	484	51.5	554	54.7
45	575	58	575	60	577	57.2	428	41.6	501	51.8	575	55.3
46	595	58.6	595	61	600	58	441	41.9	516	52.1	595	55.9
47	616	59.2	616	61.9	622	58.7	454	42.1	533	52.4	616	56.5
48	638	59.8	638	62.8	645	59.4	467	42.3	549	52.6	637	57.1
49	663	60.3	663	63.6	668	60	479	42.4	565	52.9	658	57.6

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Simple Span Load Effects Without Impact (spans 5-49 feet) - Designated Loading

Span (ft)	Trk 12	Trk 12	Trk 13	Trk 13	Trk 14	Trk 14	Trk 15	Trk 15	Trk 16	Trk 16	Trk 17	Trk 17
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
5	22.5	20.8	20	20.8	19.3	16.9	20	20.8	20	20.8	20	20.8
6	26.3	22.7	24	22.7	22.5	18.4	24	22.7	24	22.7	24	22.7
7	31.5	24	31.4	24	27	19.5	31.4	24	31.4	24	31.4	24
8	39	25	39	25	32.5	21.9	39	25	39	25	39	25
9	46.7	25.8	46.7	25.8	42.3	23.8	46.7	25.8	46.7	25.8	46.7	25.8
10	54.4	26.4	54.4	26.4	52	25.4	54.4	26.4	54.4	26.4	54.4	26.4
11	62.2	27.2	62.2	27.2	61.8	27.2	62.2	27	62.2	27.2	62.2	27.2
12	71.5	29.3	71.5	29.3	71.5	29.3	70.7	28.8	71.5	29.3	71.5	29.3
13	81.3	31	81.3	31	81.3	31	81.3	30.2	81.3	31	81.3	31
14	93.8	32.5	93.8	32.5	93.8	32.5	92.4	31.8	93.8	32.5	93.8	32.5
15	107	33.8	107	33.8	107	34.7	104	33.5	107	34.7	107	34.7
16	119	34.9	119	34.9	124	36.6	116	35	124	36.6	124	36.6
17	132	35.9	132	35.9	139	38.2	130	36.3	140	38.2	140	38.2
18	145	36.8	145	36.8	156	39.7	143	37.4	156	40.1	156	40.1
19	158	37.6	158	37.6	171	41.1	158	38.4	172	42.1	172	42.1
20	171	38.8	171	38.7	189	42.3	172	39.4	189	43.9	189	43.9
21	184	40.3	184	40.1	204	43.3	186	40.2	208	45.5	208	45.5
22	197	41.6	197	41.3	221	44.3	200	41	227	47.6	228	47.6
23	210	42.9	210	42.5	237	45.2	215	42	250	49.5	250	49.5
24	223	44	223	43.5	254	46.6	229	43.3	272	51.2	273	51.2
25	236	45	236	44.5	269	47.8	243	44.5	296	52.8	296	53
26	254	46	252	45.4	286	49	257	45.6	318	54.3	319	55
27	271	46.9	269	46.2	302	50.3	272	47.2	341	55.6	341	56.8
28	289	47.7	286	47.1	319	51.8	289	48.7	363	56.9	367	58.5
29	306	48.8	303	48.2	334	53.1	307	50.1	387	58.1	393	60.1
30	324	50	319	49.2	351	54.4	325	51.4	409	59.2	419	61.5
31	341	51.2	336	50.1	368	56	343	52.6	432	60.7	445	62.9
32	359	52.3	355	51	388	57.5	361	53.7	454	62.1	470	64.2
33	379	53.8	375	52	408	58.9	379	54.8	478	63.5	496	65.4
34	400	55.2	394	53.3	430	60.4	397	55.8	500	65	522	66.8
35	422	56.5	418	54.4	453	62	415	56.8	523	66.7	548	68.3
36	443	57.8	441	55.5	476	63.6	435	58	545	68.2	574	69.7
37	464	59	465	57	501	65	457	59.2	569	69.7	600	71.1
38	485	60.1	488	58.4	526	66.4	483	60.3	593	71.1	626	72.8
39	507	61.2	511	59.7	552	67.7	509	61.6	622	72.4	652	74.4
40	528	62.2	534	61	578	68.9	535	62.9	653	73.7	680	76
41	550	63.2	558	62.2	605	70.1	561	64.2	683	74.9	711	77.4
42	571	64.1	581	63.3	635	71.2	587	65.4	715	76.1	740	78.8
43	594	65	605	64.4	664	72.4	613	66.8	745	77.3	771	80.1
44	620	65.8	628	65.4	693	73.8	639	68.2	776	78.7	802	81.4
45	645	66.6	651	66.4	722	75.1	665	69.6	806	80	837	82.6
46	670	67.4	675	67.4	751	76.3	692	70.8	838	81.3	870	83.8
47	699	68.4	698	68.3	780	77.5	718	72	868	82.5	905	85.2
48	728	69.4	722	69.5	810	78.7	744	73.2	899	83.7	938	86.6
49	757	70.4	749	70.6	839	79.8	770	74.3	929	84.8	973	87.9

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Simple Span Load Effects Without Impact (spans 5-49 feet) - Designated Loading

Span (ft)	Trk 18	Trk 18	3S2	3S2	3-3	3-3	Trk 19	Trk 19	Trk 20	Trk 20	Trk 21	Trk 21
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
5	22.5	16.9	18.6	18.6	19.2	16.8	22.5	20.8	21.6	18	20	20.8
6	26.3	18.7	23.3	20.7	24	18.7	26.3	22.7	27	18	24	22.7
7	31.5	20.6	26.6	22.1	27.4	20	31.5	24	30.9	18	31.4	24
8	35.4	22	34.9	23.3	32	21	39	25	36	18	39	25
9	43.6	23.8	41.3	24.1	37.3	21.8	46.7	25.8	40	18	46.7	25.8
10	52	25.4	49.6	24.8	44.8	22.4	54.4	26.4	45	19.8	54.4	26.4
11	61.8	27.2	56.4	25.4	50.9	22.9	62.2	26.9	49.1	21.3	62.2	26.9
12	71.5	29.3	64.6	25.8	58.3	23.3	70	27.3	54	22.5	71.5	27.6
13	81.3	31	71.5	26.2	64.6	23.7	77.8	28.3	58.2	23.5	81.3	28.5
14	93.8	32.5	79.7	26.6	72	24	85.7	29.7	63	24.4	91	29.4
15	107	34.7	86.8	26.9	78.4	24.3	93.6	30.8	67.2	25.2	101	30.4
16	124	36.6	94.9	27.8	85.8	24.5	102	31.9	74.3	25.9	111	31.3
17	140	38.2	102	28.5	92.2	24.7	109	32.8	82.6	26.5	120	32.9
18	156	40.1	110	29.2	99.6	24.9	118	33.6	91	27	130	34.3
19	172	42.1	117	29.8	106	25.1	130	34.3	99.5	28.4	140	35.6
20	189	43.9	126	30.4	113	25.2	141	35.2	108	29.7	150	37
21	208	45.5	133	30.9	120	26.1	153	36.3	121	30.9	159	38.6
22	228	47.6	141	31.4	127	26.9	165	37.3	135	31.9	169	40.1
23	250	49.5	150	31.8	134	27.7	177	38.2	148	32.9	179	41.4
24	273	51.2	160	32.2	141	28.3	189	39	162	33.8	192	42.7
25	296	53	171	32.5	148	29	203	39.8	175	34.6	209	43.8
26	319	55	181	32.8	155	29.5	218	40.8	189	35.3	227	44.8
27	341	56.8	191	33.1	162	30.1	231	42.1	202	36	244	45.8
28	367	58.5	201	33.4	169	30.6	250	43.3	216	37.3	262	46.7
29	393	60.1	212	33.7	176	31	268	44.5	229	38.5	279	47.8
30	419	61.5	222	33.9	183	31.5	287	45.5	243	39.6	297	49
31	445	62.9	232	34.2	192	31.9	305	46.5	256	40.6	314	50.1
32	470	64.2	242	34.4	203	32.3	323	47.4	270	41.6	332	51.2
33	496	65.4	253	34.6	214	32.6	341	48.3	283	42.5	350	52.6
34	522	66.5	263	34.8	225	32.9	360	49.1	299	43.4	371	53.9
35	548	67.8	273	35.4	235	33.3	378	50.1	316	44.2	392	55.1
36	574	69.3	283	36.2	246	33.9	397	51.1	334	45	414	56.3
37	600	70.6	294	36.9	257	34.5	415	52.2	352	46.1	439	57.4
38	626	71.9	304	37.5	268	35.1	433	53.1	369	47.2	463	58.4
39	652	73.4	314	38.2	279	35.6	452	54.4	390	48.3	487	59.4
40	678	75	324	38.8	290	36.4	470	55.6	411	49.2	511	60.3
41	704	76.4	335	39.3	300	37.2	491	56.7	433	50.2	536	61.2
42	733	77.9	345	40.1	311	37.9	513	57.8	455	51.1	560	62.4
43	763	79.2	355	40.8	322	38.6	536	58.8	477	51.9	584	63.5
44	793	80.5	365	41.5	333	39.3	559	59.8	499	52.7	608	64.6
45	823	81.7	376	42.2	344	39.9	581	60.7	521	53.5	633	65.7
46	853	82.9	386	42.9	355	40.5	604	61.6	543	54.2	657	67
47	885	84	396	43.5	366	41.1	627	62.5	564	54.9	684	68.1
48	919	85.1	406	44.1	377	41.7	649	63.3	586	55.6	712	69.3
49	953	86.2	424	44.7	388	42.2	672	64.1	608	56.2	740	70.7

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Simple Span Load Effects Without Impact (spans 5-49 feet) - Designated Loading

Span (ft)	Trk 22	Trk 22	Trk 23	Trk 23	Trk 24	Trk 24	Trk 25	Trk 25	HL-93	HL-93	HL-93	HL-93
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	Trk M (ft*k)	Trk V (k)	Lane M (ft*k)	Lane V (k)
5	22.5	20.8	21.6	18	21.6	19.2	21.6	19.2	40	32	2.0	1.6
6	26.3	22.7	27	18.7	27	21.3	27	21.3	48	32	2.9	1.9
7	31.5	24	30.9	20.6	30.9	22.9	30.9	22.9	56	32	3.9	2.2
8	39	25	36	22	36	24	36	24	64	32	5.1	2.6
9	46.7	25.8	43.6	23.8	42.7	24.9	42.7	24.9	72	32	6.5	2.9
10	54.4	26.4	52	25.4	51.2	25.6	52	25.6	80	32	8.0	3.2
11	62.2	27.2	61.8	26.6	58.2	26.2	61.8	27.2	88	32	9.7	3.5
12	71.5	29.3	71.5	27.6	66.7	26.7	71.5	29.3	96	32	11.5	3.8
13	81.3	31	81.3	29.5	73.8	27.1	81.3	31	104	32	13.5	4.2
14	93.8	32.5	91	31.1	82.3	28.7	93.8	32.5	112	32	15.7	4.5
15	107	33.8	101	32.5	89.6	30.1	107	33.8	120	34.1	18.0	4.8
16	119	34.9	111	34.1	98	31.4	119	34.9	128	36	20.5	5.1
17	132	35.9	124	35.9	105	32.5	132	35.9	136	37.6	23.1	5.4
18	145	36.8	137	37.6	115	33.4	145	36.8	144	39.1	25.9	5.8
19	158	37.6	153	39	126	34.3	159	38.3	152	40.4	28.9	6.1
20	171	38.8	169	40.3	139	35.1	175	39.7	160	41.6	32.0	6.4
21	184	40.3	185	41.5	151	35.8	192	41.2	168	42.7	35.3	6.7
22	197	41.6	202	42.8	164	36.5	208	42.8	176	43.6	38.7	7.0
23	210	42.9	218	44.4	176	37.8	224	44.4	184	44.5	42.3	7.4
24	223	44	234	45.8	189	39.1	242	45.8	193	45.3	46.1	7.7
25	236	45	250	47.1	201	40.2	261	47.1	207	46.1	50.0	8.0
26	254	46	267	48.8	214	41.3	280	48.3	222	46.8	54.1	8.3
27	271	47.1	283	50.3	226	42.3	300	49.4	237	47.4	58.3	8.6
28	289	48.5	302	51.8	239	43.2	319	50.4	252	48	62.7	9.0
29	306	49.7	324	53.3	251	44.1	339	51.3	267	48.8	67.3	9.3
30	324	50.8	348	55	264	44.9	358	52.8	282	49.6	72.0	9.6
31	345	51.9	370	56.6	276	45.6	377	54.2	297	50.3	76.9	9.9
32	365	52.9	394	58.1	291	46.9	397	55.5	313	51	81.9	10.2
33	386	54.1	419	59.5	308	48.1	416	56.7	328	51.6	87.1	10.6
34	406	55.4	445	60.8	325	49.2	437	57.9	343	52.2	92.5	10.9
35	430	56.7	471	62	342	50.2	460	59.2	361	52.8	98.0	11.2
36	455	57.9	497	63.2	358	51.2	484	60.6	379	53.3	104	11.5
37	481	59	523	64.3	378	52.2	507	61.9	397	53.8	110	11.8
38	506	60	549	65.6	399	53.1	531	63.2	414	54.3	116	12.2
39	532	61.1	575	66.9	421	53.9	556	64.4	432	54.8	122	12.5
40	557	62	601	68.3	442	54.7	584	65.5	450	55.2	128	12.8
41	583	62.9	626	69.5	464	55.9	611	66.6	468	55.6	134	13.1
42	608	64	653	70.9	485	57	639	67.7	485	56	141	13.4
43	634	65.3	678	72.4	507	58.1	666	68.6	503	56.4	148	13.8
44	659	66.5	705	73.9	528	59.2	694	70	521	56.7	155	14.1
45	685	67.7	734	75.3	550	60.2	721	71.3	539	57.1	162	14.4
46	710	68.8	764	76.6	571	61.1	751	72.5	556	57.4	169	14.7
47	736	69.9	794	77.9	592	62	784	73.7	574	57.7	177	15.0
48	762	71	825	79.1	614	62.9	815	74.8	592	58	184	15.4
49	792	72	859	80.2	635	63.8	848	75.9	610	58.3	192	15.7

MICHIGAN DEPARTMENT OF TRANSPORTATION
BRIDGE ANALYSIS GUIDE

Simple Span Load Effects Without Impact (spans 5-49 feet) - Special Designated Loading

Span (ft)	Trk 1 M (ft*k)	Trk 1 V (k)	Trk 2 M (ft*k)	Trk 2 V (k)	Trk 9 M (ft*k)	Trk 9 V (k)	Trk 10 M (ft*k)	Trk 10 V (k)	Trk 11 M (ft*k)	Trk 11 V (k)
5	24	20	21.3	22.1	23.4	19.5	21.3	22.1	23.4	19.5
6	30	20	25.5	24.1	29.3	19.5	25.5	24.1	29.3	19.5
7	34.3	20	33.4	25.5	33.4	19.5	33.4	25.5	33.4	19.5
8	40	20	41.4	26.6	39	19.5	41.4	26.6	39	19.5
9	44.4	20	49.6	27.4	43.3	19.5	49.6	27.4	43.3	19.5
10	50	21.9	57.8	28.1	48.8	21.5	57.8	28.1	48.8	21.5
11	54.5	23.5	66.1	28.6	53.2	23	66.1	28.6	53.2	23
12	60	24.8	74.4	29	58.5	24.4	74.4	29	58.5	24.4
13	64.6	25.8	82.7	29.9	63	25.5	82.7	29.9	63	25.5
14	70	26.8	91.1	31	68.3	26.5	91.1	31	68.3	26.5
15	74.7	27.6	99.5	31.9	72.8	27.3	99.5	31.9	72.8	27.3
16	82.1	28.3	108	32.8	80.4	28	108	32.8	80.4	28
17	91.1	28.9	116	33.5	89.5	28.7	116	33.5	89.5	28.7
18	100	29.5	125	34.2	98.6	29.3	125	34.2	98.6	29.3
19	109	30	135	34.8	108	30.3	135	34.8	108	30.3
20	119	30.5	146	35.3	117	31.3	146	35.3	117	31.3
21	128	30.9	157	35.8	126	32.1	157	35.8	126	32.1
22	137	31.2	169	36.2	139	32.9	169	36.5	139	33.2
23	147	31.6	180	36.6	151	33.7	180	37.3	151	34.3
24	156	31.9	192	37	163	34.3	192	38.1	163	35.4
25	166	32.2	203	37.3	176	34.9	203	38.9	176	36.4
26	175	32.4	214	37.6	188	35.5	214	39.5	189	37.3
27	185	32.7	225	37.9	200	36	225	40.2	205	38.1
28	194	32.9	237	38.2	213	36.5	237	40.7	219	38.9
29	204	33.1	248	38.4	225	36.9	248	41.3	235	39.6
30	213	33.3	260	38.7	237	37.4	260	41.8	249	40.3
31	223	33.5	271	38.9	250	37.7	271	42.3	265	41.1
32	232	33.7	282	39.1	262	38.1	282	42.7	279	41.9
33	242	33.8	294	39.3	274	38.5	294	43.1	295	42.7
34	251	34	305	39.5	287	38.8	307	43.5	309	43.4
35	261	34.1	316	39.6	299	39.1	321	43.9	325	44
36	271	34.3	328	39.8	311	39.4	335	44.2	339	44.7
37	280	34.4	339	39.9	324	39.6	349	44.5	355	45.3
38	290	34.5	351	40.1	336	39.9	362	44.9	369	45.9
39	299	34.6	362	40.2	348	40.2	376	45.2	385	46.4
40	309	34.7	373	40.4	361	40.4	390	45.4	399	46.9
41	319	34.8	384	40.5	373	40.6	404	45.7	415	47.4
42	328	34.9	396	40.6	386	40.8	418	46	431	47.9
43	338	35	407	40.7	398	41	432	46.2	448	48.3
44	348	35.1	419	40.8	410	41.2	446	46.4	464	48.8
45	357	35.2	430	40.9	423	41.4	460	46.7	481	49.2
46	367	35.3	441	41	435	41.6	474	46.9	498	49.6
47	377	35.4	452	41.1	447	41.7	488	47.1	515	49.9
48	386	35.4	464	41.2	460	41.9	502	47.3	531	50.3
49	396	35.5	475	41.3	472	42.1	516	47.5	548	50.6

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Simple Span Load Effects Without Impact (spans 50-94 feet) - Designated Loading

Span (ft)	Trk 1 M (ft*k)	Trk 1 V (k)	Trk 2 M (ft*k)	Trk 2 V (k)	Trk 3 M (ft*k)	Trk 3 V (k)	Trk 4 M (ft*k)	Trk 4 V (k)	Trk 5 M (ft*k)	Trk 5 V (k)	Type 3 M (ft*k)	Type 3 V (k)
50	351	30.6	496	42.4	542	46.7	656	55.9	673	60.6	474	42.6
51	359	30.7	508	42.5	556	46.9	673	56.2	694	61.1	486	42.7
52	368	30.7	519	42.6	570	47	690	56.4	715	61.5	499	42.8
53	376	30.8	531	42.7	583	47.2	706	56.6	736	61.9	511	43
54	384	30.8	543	42.8	597	47.3	723	56.8	757	62.3	524	43.1
55	392	30.9	555	42.9	610	47.4	740	57	778	62.7	536	43.2
56	401	30.9	567	43	624	47.6	757	57.2	799	63.1	549	43.4
57	409	31	579	43	637	47.7	774	57.3	820	63.5	561	43.5
58	417	31	591	43.1	651	47.8	791	57.5	841	63.8	573	43.6
59	426	31.1	602	43.2	665	47.9	807	57.7	862	64.2	586	43.7
60	434	31.1	614	43.3	678	48	824	57.8	883	64.5	598	43.8
61	442	31.1	626	43.3	692	48.1	841	58	904	64.8	611	43.9
62	451	31.2	638	43.4	706	48.2	858	58.2	925	65.1	623	44
63	459	31.2	650	43.5	719	48.3	875	58.3	946	65.4	636	44.1
64	467	31.2	662	43.5	733	48.4	892	58.4	967	65.7	648	44.2
65	476	31.3	673	43.6	746	48.5	909	58.6	988	66	661	44.3
66	484	31.3	685	43.6	760	48.6	925	58.7	1,010	66.3	673	44.4
67	492	31.3	697	43.7	773	48.7	942	58.8	1,030	66.5	686	44.4
68	501	31.4	709	43.7	787	48.8	959	59	1,050	66.8	698	44.5
69	509	31.4	721	43.8	801	48.9	976	59.1	1,070	67	711	44.6
70	517	31.4	733	43.9	814	48.9	993	59.2	1,090	67.3	723	44.7
71	525	31.4	745	43.9	828	49	1,010	59.3	1,110	67.5	736	44.8
72	534	31.5	756	43.9	842	49.1	1,030	59.4	1,140	67.8	748	44.8
73	542	31.5	768	44	855	49.2	1,040	59.5	1,160	68	760	44.9
74	551	31.5	780	44	869	49.2	1,060	59.7	1,180	68.2	773	45
75	559	31.6	792	44.1	882	49.3	1,080	59.8	1,200	68.4	785	45
76	567	31.6	804	44.1	896	49.4	1,090	59.9	1,220	68.6	798	45.1
77	575	31.6	816	44.2	909	49.4	1,110	60	1,240	68.8	810	45.2
78	584	31.6	827	44.2	923	49.5	1,130	60.1	1,260	69	823	45.2
79	592	31.6	839	44.3	937	49.6	1,140	60.1	1,280	69.2	835	45.3
80	600	31.7	851	44.3	950	49.6	1,160	60.2	1,300	69.4	848	45.4
81	609	31.7	863	44.3	964	49.7	1,180	60.3	1,320	69.6	860	45.4
82	617	31.7	875	44.4	978	49.7	1,190	60.4	1,350	69.7	873	45.5
83	625	31.7	887	44.4	991	49.8	1,210	60.5	1,370	69.9	885	45.5
84	634	31.8	898	44.4	1,000	49.8	1,230	60.6	1,390	70.1	898	45.6
85	642	31.8	910	44.5	1,020	49.9	1,250	60.7	1,410	70.2	910	45.6
86	650	31.8	922	44.5	1,030	49.9	1,260	60.7	1,430	70.4	923	45.7
87	659	31.8	934	44.5	1,050	50	1,280	60.8	1,450	70.6	935	45.7
88	667	31.8	946	44.6	1,060	50	1,300	60.9	1,470	70.7	948	45.8
89	675	31.8	958	44.6	1,070	50.1	1,310	61	1,490	70.9	960	45.8
90	684	31.9	970	44.6	1,090	50.1	1,330	61	1,510	71	973	45.9
91	692	31.9	981	44.7	1,100	50.2	1,350	61.1	1,530	71.1	985	45.9
92	700	31.9	993	44.7	1,110	50.2	1,360	61.2	1,560	71.3	998	46
93	709	31.9	1010	44.7	1,130	50.3	1,380	61.2	1,580	71.4	1,010	46
94	717	31.9	1020	44.8	1,140	50.3	1,400	61.3	1,600	71.6	1,020	46

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Simple Span Load Effects Without Impact (spans 50-94 feet) - Designated Loading

Span (ft)	Trk 6		Trk 7		Trk 8		Trk 9		Trk 10		Trk 11	
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
50	689	61.1	689	64.4	690	60.6	492	42.6	581	53.2	678	58.1
51	714	61.9	714	65.2	713	61.2	505	42.8	597	53.4	699	58.6
52	739	62.7	739	65.9	736	61.8	518	43	613	53.6	720	59.1
53	764	63.4	764	66.6	758	62.4	531	43.1	630	53.9	741	59.6
54	790	64.1	792	67.3	781	62.9	544	43.3	645	54.1	762	60
55	815	64.8	821	68	804	63.4	556	43.4	662	54.3	783	60.4
56	841	65.4	851	68.6	826	63.9	569	43.6	678	54.5	803	60.8
57	866	66.1	881	69.3	849	64.4	582	43.7	694	54.7	824	61.2
58	891	66.7	911	69.9	872	64.9	595	43.8	710	54.8	845	61.6
59	916	67.3	941	70.4	894	65.3	608	44	727	55	866	62
60	942	67.8	970	71	917	65.8	621	44.1	743	55.2	886	62.3
61	967	68.4	1,000	71.5	940	66.2	634	44.2	759	55.4	907	62.7
62	993	68.9	1,030	72.2	963	66.6	646	44.3	775	55.5	928	63
63	1,020	69.4	1,060	73	985	67	659	44.4	791	55.7	949	63.3
64	1,040	69.9	1,090	73.7	1,010	67.4	672	44.5	808	55.8	970	63.7
65	1,070	70.4	1,120	74.4	1,030	67.7	685	44.6	824	56	991	64
66	1,090	70.9	1,150	75.1	1,050	68.1	698	44.7	840	56.1	1,010	64.3
67	1,120	71.3	1,180	75.8	1,080	68.4	711	44.8	856	56.3	1,030	64.5
68	1,140	71.8	1,210	76.4	1,100	68.8	724	44.9	873	56.4	1,050	64.8
69	1,170	72.2	1,240	77	1,120	69.1	736	45	889	56.5	1,070	65.1
70	1,200	72.6	1,270	77.6	1,140	69.4	749	45.1	905	56.7	1,090	65.3
71	1,220	73	1,300	78.2	1,170	69.7	762	45.2	922	56.8	1,120	65.6
72	1,250	73.4	1,330	78.8	1,190	70	775	45.3	938	56.9	1,140	65.8
73	1,270	73.8	1,360	79.3	1,210	70.3	788	45.4	954	57	1,160	66.1
74	1,300	74.2	1,390	79.9	1,240	70.6	801	45.5	971	57.1	1,180	66.3
75	1,320	74.5	1,420	80.4	1,260	70.9	813	45.5	987	57.2	1,200	66.6
76	1,350	74.9	1,450	80.9	1,280	71.2	826	45.6	1,000	57.3	1,220	66.8
77	1,370	75.2	1,480	81.4	1,300	71.4	839	45.7	1,020	57.5	1,240	67
78	1,400	75.6	1,510	81.9	1,330	71.7	852	45.8	1,040	57.6	1,260	67.2
79	1,420	75.9	1,540	82.4	1,350	71.9	865	45.8	1,050	57.7	1,280	67.4
80	1,450	76.2	1,570	82.9	1,370	72.2	878	45.9	1,070	57.7	1,300	67.6
81	1,470	76.5	1,600	83.3	1,390	72.4	891	46	1,080	57.8	1,320	67.8
82	1,500	76.8	1,630	83.7	1,420	72.6	903	46	1,100	57.9	1,340	68
83	1,520	77.1	1,660	84.2	1,440	72.9	916	46.1	1,120	58	1,370	68.2
84	1,550	77.4	1,690	84.6	1,460	73.1	929	46.2	1,130	58.1	1,390	68.4
85	1,580	77.7	1,720	85	1,490	73.3	942	46.2	1,150	58.2	1,410	68.5
86	1,600	78	1,750	85.4	1,510	73.5	955	46.3	1,170	58.3	1,430	68.7
87	1,630	78.2	1,780	85.8	1,530	73.7	968	46.4	1,180	58.4	1,450	68.9
88	1,650	78.5	1,810	86.2	1,550	73.9	981	46.4	1,200	58.4	1,470	69
89	1,680	78.8	1,840	86.5	1,580	74.1	993	46.5	1,220	58.5	1,490	69.2
90	1,700	79	1,860	86.9	1,600	74.3	1,010	46.5	1,230	58.6	1,510	69.4
91	1,730	79.3	1,890	87.3	1,620	74.5	1,020	46.6	1,250	58.7	1,530	69.5
92	1,750	79.5	1,920	87.6	1,650	74.7	1,030	46.6	1,260	58.7	1,550	69.7
93	1,780	79.7	1,950	88	1,670	74.9	1,040	46.7	1,280	58.8	1,570	69.8
94	1,800	80	1,980	88.3	1,690	75	1,060	46.7	1,300	58.9	1,590	70

MICHIGAN DEPARTMENT OF TRANSPORTATION
BRIDGE ANALYSIS GUIDE

Simple Span Load Effects Without Impact (spans 50-94 feet) - Designated Loading

Span (ft)	Trk 12	Trk 12	Trk 13	Trk 13	Trk 14	Trk 14	Trk 15	Trk 15	Trk 16	Trk 16	Trk 17	Trk 17
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
50	786	71.3	777	71.7	868	80.8	797	75.4	960	85.9	1,010	89.2
51	815	72.2	808	72.8	897	81.8	829	76.4	990	86.9	1,040	90.4
52	844	73.1	839	73.8	926	82.8	861	77.4	1,020	87.9	1,070	91.6
53	874	73.9	871	74.7	955	83.7	893	78.4	1,050	88.9	1,110	92.7
54	903	74.7	902	75.7	988	84.7	925	79.3	1,090	89.8	1,140	93.8
55	932	75.5	933	76.6	1,020	85.5	957	80.2	1,120	90.7	1,180	94.8
56	961	76.3	964	77.5	1,050	86.4	989	81	1,150	91.5	1,210	95.9
57	991	77	995	78.3	1,090	87.2	1,020	81.9	1,190	92.3	1,250	96.8
58	1,020	77.7	1,030	79.1	1,120	87.9	1,050	82.7	1,220	93.1	1,290	97.8
59	1,050	78.4	1,060	79.9	1,150	88.7	1,090	83.5	1,260	93.9	1,330	98.7
60	1,080	79	1,090	80.7	1,190	89.4	1,120	84.5	1,290	94.6	1,360	99.6
61	1,110	79.6	1,120	81.4	1,220	90.1	1,150	85.5	1,330	95.4	1,400	100
62	1,140	80.2	1,150	82.1	1,250	90.8	1,190	86.4	1,360	96	1,440	101
63	1,170	80.8	1,180	82.8	1,290	91.5	1,230	87.3	1,400	96.7	1,480	102
64	1,200	81.4	1,210	83.5	1,320	92.1	1,260	88.2	1,430	97.4	1,510	103
65	1,230	82	1,250	84.1	1,350	92.7	1,300	89.1	1,470	98	1,550	104
66	1,250	82.5	1,280	84.7	1,380	93.3	1,330	89.9	1,500	98.6	1,590	104
67	1,280	83	1,310	85.3	1,420	93.9	1,370	90.7	1,530	99.2	1,630	105
68	1,310	83.5	1,340	85.9	1,450	94.5	1,400	91.5	1,570	99.8	1,670	106
69	1,340	84	1,370	86.5	1,480	95	1,440	92.2	1,600	100	1,700	106
70	1,370	84.5	1,400	87	1,520	95.6	1,480	93	1,640	101	1,740	107
71	1,400	85	1,430	87.6	1,550	96.1	1,510	93.7	1,670	101	1,780	108
72	1,430	85.4	1,460	88.1	1,580	96.6	1,550	94.4	1,710	102	1,820	108
73	1,460	85.8	1,500	88.6	1,620	97.1	1,580	95	1,740	102	1,850	109
74	1,490	86.3	1,530	89.1	1,650	97.6	1,620	95.7	1,780	103	1,890	109
75	1,520	86.7	1,560	89.6	1,680	98	1,650	96.3	1,810	103	1,930	110
76	1,550	87.1	1,590	90.1	1,710	98.5	1,690	96.9	1,850	104	1,970	110
77	1,580	87.5	1,620	90.5	1,750	98.9	1,730	97.5	1,880	104	2,010	111
78	1,610	87.9	1,650	91	1,780	99.3	1,760	98.1	1,920	105	2,040	112
79	1,640	88.2	1,680	91.4	1,810	99.8	1,800	98.7	1,950	105	2,080	112
80	1,670	88.6	1,710	91.8	1,850	100	1,830	99.3	1,980	106	2,120	113
81	1,690	89	1,750	92.3	1,880	101	1,870	99.8	2,020	106	2,160	113
82	1,720	89.3	1,780	92.7	1,910	101	1,900	100	2,050	106	2,200	113
83	1,750	89.6	1,810	93.1	1,950	101	1,940	101	2,090	107	2,230	114
84	1,780	90	1,840	93.4	1,980	102	1,980	101	2,120	107	2,270	114
85	1,810	90.3	1,870	93.8	2,010	102	2,010	102	2,160	108	2,310	115
86	1,840	90.6	1,900	94.2	2,040	102	2,050	102	2,190	108	2,350	115
87	1,870	90.9	1,930	94.5	2,080	103	2,080	103	2,230	108	2,380	116
88	1,900	91.2	1,960	94.9	2,110	103	2,120	103	2,260	109	2,420	116
89	1,930	91.5	2,000	95.2	2,140	103	2,160	104	2,300	109	2,460	116
90	1,960	91.8	2,030	95.6	2,180	104	2,190	104	2,330	109	2,500	117
91	1,990	92.1	2,060	95.9	2,210	104	2,230	105	2,360	110	2,530	117
92	2,020	92.4	2,090	96.2	2,240	104	2,260	105	2,400	110	2,570	118
93	2,050	92.6	2,120	96.5	2,280	105	2,300	105	2,430	110	2,610	118
94	2,080	92.9	2,150	96.8	2,310	105	2,330	106	2,470	110	2,650	118

MICHIGAN DEPARTMENT OF TRANSPORTATION
BRIDGE ANALYSIS GUIDE

Simple Span Load Effects Without Impact (spans 50-94 feet) - Designated Loading

Span (ft)	Trk 18		3S2		3-3		Trk 19		Trk 20		Trk 21	
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
50	987	87.3	442	45.2	398	42.7	694	64.9	630	56.9	769	72
51	1,020	88.6	459	45.7	412	43.2	723	65.6	652	57.5	797	73.2
52	1,050	89.9	477	46.2	429	43.7	753	66.3	674	58	825	74.4
53	1,090	91.1	494	46.7	446	44.2	782	67	695	58.6	853	75.6
54	1,120	92.3	512	47.2	463	44.6	811	67.6	717	59.1	881	76.7
55	1,160	93.4	530	47.6	480	45.2	840	68.2	739	59.6	911	77.8
56	1,190	94.5	547	48.1	497	45.9	870	68.8	761	60.1	942	78.8
57	1,220	95.5	565	48.5	514	46.5	899	69.4	783	60.6	975	79.8
58	1,260	96.5	583	48.9	530	47	929	70.2	805	61.1	1,010	80.8
59	1,290	97.5	601	49.3	548	47.6	958	71	827	61.5	1,040	81.7
60	1,330	98.5	618	49.7	564	48.1	987	71.8	848	62	1,080	82.6
61	1,360	99.4	636	50	582	48.7	1,020	72.6	870	62.4	1,110	83.5
62	1,400	100	654	50.4	598	49.2	1,050	73.3	892	62.8	1,150	84.4
63	1,430	101	672	50.7	615	49.7	1,080	74	914	63.2	1,190	85.2
64	1,470	102	689	51.1	632	50.1	1,100	74.7	936	63.6	1,230	86
65	1,510	103	707	51.4	649	50.6	1,130	75.3	958	63.9	1,260	86.7
66	1,550	104	725	51.7	666	51	1,160	76	980	64.3	1,300	87.7
67	1,590	104	743	52	684	51.5	1,190	76.6	1,000	64.6	1,340	88.7
68	1,630	105	760	52.3	704	51.9	1,220	77.2	1,020	65	1,380	89.6
69	1,660	106	778	52.6	724	52.3	1,250	77.8	1,050	65.3	1,410	90.5
70	1,700	106	796	52.9	744	52.7	1,280	78.3	1,070	65.6	1,450	91.3
71	1,740	107	814	53.1	764	53.1	1,310	78.9	1,090	65.9	1,490	92.2
72	1,780	108	832	53.4	784	53.4	1,340	79.4	1,110	66.2	1,530	93
73	1,820	108	849	53.6	804	53.8	1,370	79.9	1,130	66.5	1,570	93.8
74	1,860	109	867	53.9	824	54.2	1,400	80.4	1,150	66.8	1,600	94.6
75	1,890	110	885	54.1	844	54.5	1,430	80.9	1,180	67	1,640	95.3
76	1,930	110	903	54.4	864	54.8	1,460	81.4	1,200	67.3	1,680	96.1
77	1,970	111	921	54.6	884	55.2	1,490	81.9	1,220	67.6	1,720	96.8
78	2,010	111	939	54.8	904	55.5	1,520	82.3	1,240	67.8	1,750	97.5
79	2,050	112	956	55	924	55.8	1,540	82.8	1,260	68.1	1,790	98.2
80	2,090	112	974	55.3	944	56.1	1,570	83.2	1,290	68.3	1,830	98.9
81	2,130	113	992	55.5	964	56.4	1,600	83.6	1,310	68.6	1,870	99.5
82	2,160	113	1,010	55.7	984	56.7	1,630	84	1,330	68.8	1,900	100
83	2,200	114	1,030	55.9	1,000	57	1,660	84.4	1,350	69	1,940	101
84	2,240	114	1,050	56	1,020	57.2	1,690	84.8	1,370	69.2	1,980	101
85	2,280	115	1,060	56.2	1,040	57.5	1,720	85.2	1,390	69.4	2,020	102
86	2,320	115	1,080	56.4	1,060	57.8	1,750	85.6	1,420	69.7	2,060	103
87	2,360	116	1,100	56.6	1,080	58	1,780	86	1,440	69.9	2,090	103
88	2,390	116	1,120	56.8	1,100	58.3	1,810	86.3	1,460	70.1	2,130	104
89	2,430	117	1,140	56.9	1,120	58.5	1,840	86.7	1,480	70.2	2,170	104
90	2,470	117	1,150	57.1	1,140	58.8	1,870	87	1,500	70.4	2,210	105
91	2,510	117	1,170	57.3	1,160	59	1,900	87.3	1,530	70.6	2,250	105
92	2,550	118	1,190	57.4	1,180	59.2	1,930	87.7	1,550	70.8	2,280	106
93	2,590	118	1,210	57.6	1,200	59.4	1,960	88	1,570	71	2,320	106
94	2,620	119	1,220	57.7	1,220	59.7	1,980	88.3	1,590	71.2	2,360	107

MICHIGAN DEPARTMENT OF TRANSPORTATION
BRIDGE ANALYSIS GUIDE

Simple Span Load Effects Without Impact (spans 50-94 feet) - Designated Loading

Span (ft)	Trk 22	Trk 22	Trk 23	Trk 23	Trk 24	Trk 24	Trk 25	Trk 25	HL-93	HL-93	HL-93	HL-93
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	Trk M (ft*k)	Trk V (k)	Lane M (ft*k)	Lane V (k)
50	821	72.9	893	81.3	660	64.9	879	77	628	58.6	200	16.0
51	850	74	927	82.4	687	66	912	78	646	58.6	208	16.3
52	879	75.1	961	83.8	712	67.1	943	78.9	664	59.1	216	16.6
53	914	76.2	995	85.1	739	68.2	976	79.8	681	59.3	225	17.0
54	947	77.3	1,030	86.4	764	69.1	1,010	80.7	699	59.6	233	17.3
55	981	78.5	1,060	87.6	791	70.1	1,040	81.9	717	59.8	242	17.6
56	1,010	79.7	1,100	88.8	822	71	1,070	83	735	60	251	17.9
57	1,050	80.9	1,130	89.9	852	71.9	1,100	84.1	753	60.2	260	18.2
58	1,080	82	1,170	91.1	883	72.8	1,140	85.2	771	60.4	269	18.6
59	1,120	83.1	1,200	92.1	913	73.6	1,170	86.2	789	60.6	278	18.9
60	1,150	84.1	1,240	93.2	944	74.4	1,210	87.2	807	60.8	288	19.2
61	1,180	85.2	1,280	94.1	974	75.2	1,240	88.2	824	61	298	19.5
62	1,220	86.1	1,320	95.1	1,000	76	1,280	89.1	842	61.2	308	19.8
63	1,250	87.1	1,350	96	1,040	76.7	1,320	90	860	61.3	318	20.2
64	1,290	88	1,390	97	1,070	77.4	1,350	90.9	878	51.5	328	20.5
65	1,320	88.9	1,430	97.8	1,100	78.1	1,400	91.8	896	61.7	338	20.8
66	1,350	89.8	1,470	98.7	1,130	78.8	1,440	92.6	914	61.8	348	21.1
67	1,390	90.6	1,510	99.5	1,160	79.4	1,480	93.4	932	62	359	21.4
68	1,430	91.4	1,550	100	1,190	80	1,520	94.2	950	62.1	370	21.8
69	1,470	92.2	1,590	101	1,220	80.6	1,560	94.9	968	62.3	381	22.1
70	1,510	93	1,620	102	1,250	81.2	1,600	95.6	986	62.4	392	22.4
71	1,550	93.7	1,660	103	1,280	81.8	1,640	96.3	1,000	62.5	403	22.7
72	1,590	94.5	1,700	103	1,310	82.4	1,680	97	1,020	62.7	415	23.0
73	1,630	95.2	1,740	104	1,340	82.9	1,720	97.7	1,040	62.8	426	23.4
74	1,670	95.8	1,780	105	1,370	83.4	1,760	98.4	1,060	62.9	438	23.7
75	1,710	96.5	1,820	105	1,400	83.9	1,810	99	1,080	63	450	24.0
76	1,750	97.2	1,850	106	1,430	84.4	1,850	99.6	1,090	63.2	462	24.3
77	1,790	97.8	1,890	107	1,460	84.9	1,890	100	1,110	63.3	474	24.6
78	1,830	98.4	1,930	107	1,490	85.4	1,930	101	1,130	63.4	487	25.0
79	1,870	99	1,970	108	1,520	85.9	1,970	101	1,150	63.5	499	25.3
80	1,910	99.6	2,010	108	1,550	86.3	2,010	102	1,160	63.6	512	25.6
81	1,950	100	2,050	109	1,580	86.8	2,050	102	1,180	63.7	525	25.9
82	1,990	101	2,090	109	1,610	87.2	2,090	103	1,200	63.8	538	26.2
83	2,030	101	2,120	110	1,650	87.6	2,130	104	1,220	63.9	551	26.6
84	2,070	102	2,160	111	1,680	88	2,170	105	1,240	64	564	26.9
85	2,110	102	2,200	111	1,710	88.4	2,220	105	1,250	64.1	578	27.2
86	2,150	103	2,240	112	1,740	88.8	2,260	106	1,270	64.2	592	27.5
87	2,190	104	2,280	112	1,770	89.2	2,300	107	1,290	64.3	606	27.8
88	2,230	104	2,320	113	1,800	89.6	2,340	107	1,310	64.4	620	28.2
89	2,270	105	2,360	113	1,830	89.9	2,380	108	1,330	64.4	634	28.5
90	2,310	105	2,390	113	1,860	90.3	2,420	109	1,340	64.5	648	28.8
91	2,350	106	2,430	114	1,890	90.6	2,460	109	1,360	64.6	662	29.1
92	2,390	107	2,470	114	1,920	91	2,500	110	1,380	64.7	677	29.4
93	2,430	107	2,510	115	1,950	91.3	2,540	110	1,400	64.8	692	29.8
94	2,480	108	2,550	115	1,980	91.6	2,580	111	1,420	64.9	707	30.1

MICHIGAN DEPARTMENT OF TRANSPORTATION
BRIDGE ANALYSIS GUIDE

Simple Span Load Effects Without Impact (spans 50-94 feet) - Special Designated Loading

Span (ft)	Trk 1 M (ft*k)	Trk 1 V (k)	Trk 2 M (ft*k)	Trk 2 V (k)	Trk 9 M (ft*k)	Trk 9 V (k)	Trk 10 M (ft*k)	Trk 10 V (k)	Trk 11 M (ft*k)	Trk 11 V (k)
50	406	35.6	487	41.4	484	42.2	530	47.6	565	51
51	415	35.6	498	41.4	497	42.4	544	47.8	582	51.3
52	425	35.7	509	41.5	509	42.5	558	48	598	51.6
53	435	35.8	521	41.6	521	42.6	572	48.1	615	51.9
54	444	35.8	532	41.7	534	42.8	586	48.3	631	52.2
55	454	35.9	543	41.7	546	42.9	600	48.4	648	52.4
56	464	35.9	555	41.8	559	43	614	48.6	665	52.7
57	473	36	566	41.9	571	43.1	628	48.7	682	52.9
58	483	36.1	577	41.9	583	43.2	642	48.8	698	53.2
59	493	36.1	589	42	596	43.3	656	49	715	53.4
60	503	36.2	600	42	608	43.4	670	49.1	732	53.7
61	512	36.2	611	42.1	620	43.5	684	49.2	749	53.9
62	522	36.2	623	42.1	633	43.6	698	49.3	765	54.1
63	532	36.3	634	42.2	645	43.7	712	49.4	782	54.3
64	541	36.3	646	42.2	657	43.8	726	49.5	799	54.5
65	551	36.4	657	42.3	670	43.9	740	49.7	816	54.7
66	561	36.4	668	42.3	682	44	754	49.8	832	54.9
67	570	36.4	679	42.4	695	44.1	768	49.9	849	55.1
68	580	36.5	691	42.4	707	44.1	782	50	866	55.2
69	590	36.5	702	42.5	719	44.2	797	50	883	55.4
70	600	36.6	714	42.5	732	44.3	811	50.1	899	55.6
71	609	36.6	725	42.6	744	44.4	825	50.2	916	55.7
72	619	36.6	736	42.6	756	44.4	839	50.3	933	55.9
73	629	36.7	748	42.6	769	44.5	853	50.4	950	56
74	639	36.7	759	42.7	781	44.6	867	50.5	966	56.2
75	648	36.7	770	42.7	794	44.6	881	50.6	983	56.3
76	658	36.8	782	42.7	806	44.7	895	50.6	1,000	56.5
77	668	36.8	793	42.8	818	44.8	909	50.7	1,020	56.6
78	677	36.8	804	42.8	831	44.8	923	50.8	1,030	56.8
79	687	36.8	816	42.8	843	44.9	937	50.8	1,050	56.9
80	697	36.9	827	42.9	855	44.9	951	50.9	1,070	57
81	707	36.9	838	42.9	868	45	965	51	1,080	57.1
82	716	36.9	850	42.9	880	45.1	979	51.1	1,100	57.3
83	726	36.9	861	43	892	45.1	993	51.1	1,120	57.4
84	736	37	872	43	905	45.2	1,010	51.2	1,130	57.5
85	745	37	884	43	917	45.2	1,020	51.2	1,150	57.6
86	755	37	895	43.1	930	45.3	1,040	51.3	1,170	57.7
87	765	37	906	43.1	942	45.3	1,050	51.4	1,180	57.8
88	775	37.1	918	43.1	954	45.4	1,060	51.4	1,200	57.9
89	784	37.1	929	43.1	967	45.4	1,080	51.5	1,220	58
90	794	37.1	941	43.2	979	45.5	1,090	51.5	1,230	58.1
91	804	37.1	952	43.2	991	45.5	1,110	51.6	1,250	58.2
92	814	37.1	963	43.2	1,000	45.5	1,120	51.6	1,270	58.3
93	823	37.2	975	43.2	1,020	45.6	1,130	51.7	1,280	58.4
94	833	37.2	986	43.3	1,030	45.6	1,150	51.7	1,300	58.5

MICHIGAN DEPARTMENT OF TRANSPORTATION
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Simple Span Load Effects Without Impact (spans 95-139 feet) - Designated Loading

Span (ft)	Trk 1 M (ft*k)	Trk 1 V (k)	Trk 2 M (ft*k)	Trk 2 V (k)	Trk 3 M (ft*k)	Trk 3 V (k)	Trk 4 M (ft*k)	Trk 4 V (k)	Trk 5 M (ft*k)	Trk 5 V (k)	Type 3 M (ft*k)	Type 3 V (k)
95	725	31.9	1,030	44.8	1,150	50.4	1,410	61.4	1,620	71.7	1,040	46.1
96	734	32	1,040	44.8	1,170	50.4	1,430	61.4	1,640	71.8	1,050	46.1
97	742	32	1,050	44.8	1,180	50.5	1,450	61.5	1,660	71.9	1,060	46.2
98	750	32	1,060	44.9	1,200	50.5	1,460	61.6	1,680	72.1	1,070	46.2
99	759	32	1,080	44.9	1,210	50.5	1,480	61.6	1,700	72.2	1,080	46.2
100	767	32	1,090	44.9	1,220	50.6	1,500	61.7	1,720	72.3	1,100	46.3
101	775	32	1,100	44.9	1,240	50.6	1,510	61.7	1,740	72.4	1,110	46.3
102	784	32	1,110	45	1,250	50.6	1,530	61.8	1,770	72.5	1,120	46.4
103	792	32.1	1,120	45	1,260	50.7	1,550	61.8	1,790	72.6	1,130	46.4
104	800	32.1	1,140	45	1,280	50.7	1,570	61.9	1,810	72.8	1,150	46.4
105	809	32.1	1,150	45	1,290	50.8	1,580	61.9	1,830	72.9	1,160	46.5
106	817	32.1	1,160	45.1	1,300	50.8	1,600	62	1,850	73	1,170	46.5
107	825	32.1	1,170	45.1	1,320	50.8	1,620	62	1,870	73.1	1,180	46.5
108	834	32.1	1,180	45.1	1,330	50.9	1,630	62.1	1,890	73.2	1,200	46.6
109	842	32.1	1,190	45.1	1,340	50.9	1,650	62.1	1,910	73.3	1,210	46.6
110	851	32.1	1,210	45.1	1,360	50.9	1,670	62.2	1,930	73.4	1,220	46.6
111	859	32.2	1,220	45.2	1,370	51	1,680	62.2	1,950	73.5	1,230	46.6
112	867	32.2	1,230	45.2	1,390	51	1,700	62.3	1,980	73.6	1,250	46.7
113	875	32.2	1,240	45.2	1,400	51	1,720	62.3	2,000	73.6	1,260	46.7
114	884	32.2	1,250	45.2	1,410	51	1,730	62.4	2,020	73.7	1,270	46.7
115	892	32.2	1,270	45.2	1,430	51.1	1,750	62.4	2,040	73.8	1,280	46.8
116	901	32.2	1,280	45.3	1,440	51.1	1,770	62.5	2,060	73.9	1,300	46.8
117	909	32.2	1,290	45.3	1,450	51.1	1,780	62.5	2,080	74	1,310	46.8
118	917	32.2	1,300	45.3	1,470	51.2	1,800	62.5	2,100	74.1	1,320	46.8
119	926	32.2	1,310	45.3	1,480	51.2	1,820	62.6	2,120	74.2	1,330	46.9
120	934	32.2	1,320	45.3	1,490	51.2	1,840	62.6	2,140	74.3	1,350	46.9
121	942	32.3	1,340	45.3	1,510	51.2	1,850	62.7	2,160	74.3	1,360	46.9
122	951	32.3	1,350	45.4	1,520	51.3	1,870	62.7	2,190	74.4	1,370	47
123	959	32.3	1,360	45.4	1,540	51.3	1,890	62.7	2,210	74.5	1,380	47
124	967	32.3	1,370	45.4	1,550	51.3	1,900	62.8	2,230	74.6	1,400	47
125	976	32.3	1,380	45.4	1,560	51.3	1,920	62.8	2,250	74.6	1,410	47
126	984	32.3	1,400	45.4	1,580	51.4	1,940	62.9	2,270	74.7	1,420	47
127	992	32.3	1,410	45.4	1,590	51.4	1,950	62.9	2,290	74.8	1,430	47.1
128	1,000	32.3	1,420	45.5	1,600	51.4	1,970	62.9	2,310	74.9	1,450	47.1
129	1,010	32.3	1,430	45.5	1,620	51.4	1,990	63	2,330	74.9	1,460	47.1
130	1,020	32.3	1,440	45.5	1,630	51.5	2,000	63	2,350	75	1,470	47.1
131	1,030	32.3	1,460	45.5	1,640	51.5	2,020	63	2,370	75.1	1,480	47.2
132	1,030	32.4	1,470	45.5	1,660	51.5	2,040	63.1	2,400	75.1	1,500	47.2
133	1,040	32.4	1,480	45.5	1,670	51.5	2,050	63.1	2,420	75.2	1,510	47.2
134	1,050	32.4	1,490	45.5	1,680	51.5	2,070	63.1	2,440	75.3	1,520	47.2
135	1,060	32.4	1,500	45.6	1,700	51.6	2,090	63.2	2,460	75.3	1,530	47.2
136	1,070	32.4	1,510	45.6	1,710	51.6	2,100	63.2	2,480	75.4	1,550	47.3
137	1,080	32.4	1,530	45.6	1,730	51.6	2,120	63.2	2,500	75.5	1,560	47.3
138	1,080	32.4	1,540	45.6	1,740	51.6	2,140	63.2	2,520	75.5	1,570	47.3
139	1,090	32.4	1,550	45.6	1,750	51.6	2,160	63.3	2,540	75.6	1,580	47.3

MICHIGAN DEPARTMENT OF TRANSPORTATION
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Simple Span Load Effects Without Impact (spans 95-139 feet) - Designated Loading

Span (ft)	Trk 6		Trk 7		Trk 8		Trk 9		Trk 10		Trk 11	
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
95	1,830	80.2	2,010	88.6	1,710	75.2	1,070	46.8	1,310	59	1,620	70.1
96	1,850	80.4	2,040	88.9	1,740	75.4	1,080	46.8	1,330	59	1,640	70.2
97	1,880	80.6	2,070	89.3	1,760	75.5	1,100	46.9	1,350	59.1	1,660	70.4
98	1,900	80.8	2,100	89.6	1,780	75.7	1,110	46.9	1,360	59.2	1,680	70.5
99	1,930	81.1	2,130	89.9	1,810	75.9	1,120	47	1,380	59.2	1,700	70.6
100	1,960	81.3	2,160	90.2	1,830	76	1,130	47	1,400	59.3	1,720	70.8
101	1,980	81.5	2,190	90.5	1,850	76.2	1,150	47.1	1,410	59.3	1,740	70.9
102	2,010	81.7	2,220	90.7	1,870	76.3	1,160	47.1	1,430	59.4	1,760	71
103	2,030	81.8	2,250	91	1,900	76.5	1,170	47.1	1,440	59.5	1,780	71.1
104	2,060	82	2,280	91.3	1,920	76.6	1,190	47.2	1,460	59.5	1,800	71.2
105	2,080	82.2	2,310	91.6	1,940	76.8	1,200	47.2	1,480	59.6	1,820	71.4
106	2,110	82.4	2,340	91.8	1,960	76.9	1,210	47.3	1,490	59.6	1,840	71.5
107	2,130	82.6	2,370	92.1	1,990	77	1,220	47.3	1,510	59.7	1,870	71.6
108	2,160	82.7	2,400	92.3	2,010	77.2	1,240	47.3	1,530	59.7	1,890	71.7
109	2,180	82.9	2,430	92.6	2,030	77.3	1,250	47.4	1,540	59.8	1,910	71.8
110	2,210	83.1	2,460	92.8	2,060	77.4	1,260	47.4	1,560	59.8	1,930	71.9
111	2,230	83.3	2,490	93.1	2,080	77.5	1,280	47.4	1,570	59.9	1,950	72
112	2,260	83.4	2,520	93.3	2,100	77.7	1,290	47.5	1,590	59.9	1,970	72.1
113	2,280	83.6	2,550	93.5	2,120	77.8	1,300	47.5	1,610	60	1,990	72.2
114	2,310	83.7	2,580	93.8	2,150	77.9	1,310	47.5	1,620	60	2,010	72.3
115	2,340	83.9	2,610	94	2,170	78	1,330	47.6	1,640	60.1	2,030	72.4
116	2,360	84	2,640	94.2	2,190	78.1	1,340	47.6	1,660	60.1	2,050	72.5
117	2,390	84.2	2,670	94.4	2,220	78.3	1,350	47.6	1,670	60.2	2,070	72.6
118	2,410	84.3	2,700	94.6	2,240	78.4	1,370	47.7	1,690	60.2	2,090	72.7
119	2,440	84.5	2,730	94.8	2,260	78.5	1,380	47.7	1,710	60.3	2,120	72.8
120	2,460	84.6	2,760	95	2,280	78.6	1,390	47.7	1,720	60.3	2,140	72.9
121	2,490	84.8	2,790	95.2	2,310	78.7	1,400	47.8	1,740	60.3	2,160	73
122	2,510	84.9	2,820	95.4	2,330	78.8	1,420	47.8	1,750	60.4	2,180	73
123	2,540	85	2,850	95.6	2,350	78.9	1,430	47.8	1,770	60.4	2,200	73.1
124	2,560	85.2	2,880	95.8	2,380	79	1,440	47.9	1,790	60.5	2,220	73.2
125	2,590	85.3	2,910	96	2,400	79.1	1,460	47.9	1,800	60.5	2,240	73.3
126	2,610	85.4	2,940	96.2	2,420	79.2	1,470	47.9	1,820	60.5	2,260	73.4
127	2,640	85.5	2,970	96.4	2,440	79.3	1,480	47.9	1,840	60.6	2,280	73.4
128	2,660	85.7	3,000	96.6	2,470	79.4	1,490	48	1,850	60.6	2,300	73.5
129	2,690	85.8	3,030	96.7	2,490	79.5	1,510	48	1,870	60.7	2,320	73.6
130	2,720	85.9	3,060	96.9	2,510	79.6	1,520	48	1,890	60.7	2,340	73.7
131	2,740	86	3,090	97.1	2,540	79.7	1,530	48	1,900	60.7	2,370	73.8
132	2,770	86.1	3,120	97.3	2,560	79.7	1,550	48.1	1,920	60.8	2,390	73.8
133	2,790	86.3	3,150	97.4	2,580	79.8	1,560	48.1	1,930	60.8	2,410	73.9
134	2,820	86.4	3,180	97.6	2,600	79.9	1,570	48.1	1,950	60.8	2,430	74
135	2,840	86.5	3,210	97.7	2,630	80	1,580	48.1	1,970	60.9	2,450	74
136	2,870	86.6	3,240	97.9	2,650	80.1	1,600	48.2	1,980	60.9	2,470	74.1
137	2,890	86.7	3,270	98.1	2,670	80.2	1,610	48.2	2,000	60.9	2,490	74.2
138	2,920	86.8	3,300	98.2	2,690	80.3	1,620	48.2	2,020	61	2,510	74.2
139	2,940	86.9	3,330	98.4	2,720	80.3	1,640	48.2	2,030	61	2,530	74.3

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Simple Span Load Effects Without Impact (spans 95-139 feet) - Designated Loading

Span (ft)	Trk 12	Trk 12	Trk 13	Trk 13	Trk 14	Trk 14	Trk 15	Trk 15	Trk 16	Trk 16	Trk 17	Trk 17
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
95	2,110	93.2	2,180	97.1	2,340	105	2,370	106	2,500	111	2,690	119
96	2,130	93.4	2,220	97.4	2,380	106	2,410	107	2,540	111	2,720	119
97	2,160	93.7	2,250	97.7	2,410	106	2,440	107	2,570	111	2,760	119
98	2,190	93.9	2,280	98	2,440	106	2,480	107	2,610	112	2,800	120
99	2,220	94.1	2,310	98.3	2,470	106	2,510	108	2,640	112	2,840	120
100	2,250	94.4	2,340	98.6	2,510	107	2,550	108	2,680	112	2,880	120
101	2,280	94.6	2,370	98.8	2,540	107	2,580	108	2,710	112	2,910	121
102	2,310	94.8	2,400	99.1	2,570	107	2,620	109	2,750	113	2,950	121
103	2,340	95	2,430	99.3	2,610	107	2,660	109	2,780	113	2,990	121
104	2,370	95.3	2,470	99.6	2,640	108	2,690	109	2,810	113	3,030	121
105	2,400	95.5	2,500	99.8	2,670	108	2,730	110	2,850	113	3,060	122
106	2,430	95.7	2,530	100	2,710	108	2,760	110	2,880	114	3,100	122
107	2,460	95.9	2,560	100	2,740	108	2,800	110	2,920	114	3,140	122
108	2,490	96.1	2,590	101	2,770	109	2,840	111	2,950	114	3,180	123
109	2,520	96.3	2,620	101	2,800	109	2,870	111	2,990	114	3,220	123
110	2,550	96.5	2,650	101	2,840	109	2,910	111	3,020	115	3,250	123
111	2,580	96.6	2,680	101	2,870	109	2,940	112	3,060	115	3,290	123
112	2,600	96.8	2,720	101	2,900	109	2,980	112	3,090	115	3,330	124
113	2,630	97	2,750	102	2,940	110	3,010	112	3,130	115	3,370	124
114	2,660	97.2	2,780	102	2,970	110	3,050	112	3,160	115	3,410	124
115	2,690	97.4	2,810	102	3,000	110	3,090	113	3,200	116	3,440	124
116	2,720	97.5	2,840	102	3,040	110	3,120	113	3,230	116	3,480	125
117	2,750	97.7	2,870	102	3,070	110	3,160	113	3,260	116	3,520	125
118	2,780	97.9	2,900	103	3,100	111	3,190	113	3,300	116	3,560	125
119	2,810	98	2,940	103	3,140	111	3,230	114	3,330	116	3,590	125
120	2,840	98.2	2,970	103	3,170	111	3,270	114	3,370	117	3,630	125
121	2,870	98.4	3,000	103	3,200	111	3,300	114	3,400	117	3,670	126
122	2,900	98.5	3,030	103	3,230	111	3,340	114	3,440	117	3,710	126
123	2,930	98.7	3,060	104	3,270	111	3,370	115	3,470	117	3,750	126
124	2,960	98.8	3,090	104	3,300	112	3,410	115	3,510	117	3,780	126
125	2,990	99	3,120	104	3,330	112	3,440	115	3,540	117	3,820	127
126	3,020	99.1	3,150	104	3,370	112	3,480	115	3,580	118	3,860	127
127	3,040	99.3	3,190	104	3,400	112	3,520	116	3,610	118	3,900	127
128	3,070	99.4	3,220	104	3,430	112	3,550	116	3,640	118	3,930	127
129	3,100	99.5	3,250	105	3,470	112	3,590	116	3,680	118	3,970	127
130	3,130	99.7	3,280	105	3,500	113	3,620	116	3,710	118	4,010	127
131	3,160	99.8	3,310	105	3,530	113	3,660	116	3,750	118	4,050	128
132	3,190	100	3,340	105	3,570	113	3,690	117	3,780	119	4,090	128
133	3,220	100	3,370	105	3,600	113	3,730	117	3,820	119	4,120	128
134	3,250	100	3,410	105	3,630	113	3,770	117	3,850	119	4,160	128
135	3,280	100	3,440	106	3,660	113	3,800	117	3,890	119	4,200	128
136	3,310	100	3,470	106	3,700	113	3,840	117	3,920	119	4,240	129
137	3,340	101	3,500	106	3,730	114	3,870	118	3,960	119	4,270	129
138	3,370	101	3,530	106	3,760	114	3,910	118	3,990	119	4,310	129
139	3,400	101	3,560	106	3,800	114	3,950	118	4,030	120	4,350	129

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Simple Span Load Effects Without Impact (spans 95-139 feet) - Designated Loading

Span (ft)	Trk 18	Trk 18	3S2	3S2	3-3	3-3	Trk 19	Trk 19	Trk 20	Trk 20	Trk 21	Trk 21
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
95	2,660	119	1,240	57.9	1,240	59.9	2,010	88.6	1,610	71.3	2,400	107
96	2,700	119	1,260	58	1,260	60.1	2,040	88.9	1,640	71.5	2,430	108
97	2,740	120	1,280	58.2	1,280	60.3	2,070	89.2	1,660	71.7	2,470	108
98	2,780	120	1,300	58.3	1,300	60.5	2,100	89.5	1,680	71.8	2,510	109
99	2,820	120	1,310	58.5	1,320	60.7	2,130	89.8	1,700	72	2,550	109
100	2,850	121	1,330	58.6	1,340	60.9	2,160	90	1,720	72.1	2,590	109
101	2,890	121	1,350	58.7	1,360	61.1	2,190	90.3	1,740	72.3	2,620	110
102	2,930	121	1,370	58.9	1,380	61.3	2,220	90.6	1,770	72.4	2,660	110
103	2,970	122	1,390	59	1,400	61.4	2,250	90.8	1,790	72.6	2,700	111
104	3,010	122	1,400	59.1	1,420	61.6	2,280	91.1	1,810	72.7	2,740	111
105	3,050	122	1,420	59.2	1,440	61.8	2,310	91.4	1,830	72.9	2,780	111
106	3,090	123	1,440	59.4	1,460	62	2,340	91.6	1,850	73	2,810	112
107	3,120	123	1,460	59.5	1,480	62.1	2,370	91.8	1,880	73.1	2,850	112
108	3,160	123	1,480	59.6	1,500	62.3	2,400	92.1	1,900	73.3	2,890	112
109	3,200	123	1,490	59.7	1,520	62.5	2,420	92.3	1,920	73.4	2,930	113
110	3,240	124	1,510	59.8	1,540	62.6	2,450	92.5	1,940	73.5	2,960	113
111	3,280	124	1,530	59.9	1,560	62.8	2,480	92.8	1,960	73.6	3,000	114
112	3,320	124	1,550	60	1,580	62.9	2,510	93	1,980	73.8	3,040	114
113	3,350	125	1,560	60.1	1,600	63.1	2,540	93.2	2,010	73.9	3,080	114
114	3,390	125	1,580	60.2	1,620	63.2	2,570	93.4	2,030	74	3,120	115
115	3,430	125	1,600	60.3	1,640	63.4	2,600	93.6	2,050	74.1	3,150	115
116	3,470	125	1,620	60.4	1,660	63.5	2,630	93.8	2,070	74.2	3,190	115
117	3,510	126	1,640	60.5	1,680	63.7	2,660	94	2,090	74.4	3,230	115
118	3,550	126	1,650	60.6	1,700	63.8	2,690	94.2	2,120	74.5	3,270	116
119	3,590	126	1,670	60.7	1,720	63.9	2,720	94.4	2,140	74.6	3,310	116
120	3,620	126	1,690	60.8	1,740	64.1	2,750	94.6	2,160	74.7	3,340	116
121	3,660	126	1,710	60.9	1,760	64.2	2,780	94.8	2,180	74.8	3,380	117
122	3,700	127	1,730	61	1,780	64.3	2,810	95	2,200	74.9	3,420	117
123	3,740	127	1,740	61.1	1,800	64.5	2,840	95.2	2,220	75	3,460	117
124	3,780	127	1,760	61.2	1,820	64.6	2,870	95.3	2,250	75.1	3,490	117
125	3,820	127	1,780	61.3	1,840	64.7	2,890	95.5	2,270	75.2	3,530	118
126	3,850	128	1,800	61.4	1,860	64.8	2,920	95.7	2,290	75.3	3,570	118
127	3,890	128	1,820	61.4	1,880	64.9	2,950	95.9	2,310	75.4	3,610	118
128	3,930	128	1,830	61.5	1,900	65.1	2,980	96	2,330	75.5	3,650	119
129	3,970	128	1,850	61.6	1,920	65.2	3,010	96.2	2,360	75.6	3,680	119
130	4,010	128	1,870	61.7	1,940	65.3	3,040	96.4	2,380	75.7	3,720	119
131	4,050	129	1,890	61.8	1,960	65.4	3,070	96.5	2,400	75.7	3,760	119
132	4,090	129	1,910	61.8	1,980	65.5	3,100	96.7	2,420	75.8	3,800	120
133	4,120	129	1,920	61.9	2,000	65.6	3,130	96.8	2,440	75.9	3,840	120
134	4,160	129	1,940	62	2,020	65.7	3,160	97	2,470	76	3,870	120
135	4,200	129	1,960	62.1	2,040	65.8	3,190	97.1	2,490	76.1	3,910	120
136	4,240	129	1,980	62.1	2,060	65.9	3,220	97.3	2,510	76.2	3,950	120
137	4,280	130	2,000	62.2	2,080	66	3,250	97.4	2,530	76.3	3,990	121
138	4,320	130	2,010	62.3	2,100	66.1	3,280	97.6	2,550	76.3	4,020	121
139	4,350	130	2,030	62.4	2,120	66.2	3,310	97.7	2,570	76.4	4,060	121

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Simple Span Load Effects Without Impact (spans 95-139 feet) - Designated Loading

Span (ft)	Trk 22	Trk 22	Trk 23	Trk 23	Trk 24	Trk 24	Trk 25	Trk 25	HL-93	HL-93	HL-93	HL-93
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	Trk M (ft*k)	Trk V (k)	Lane M (ft*k)	Lane V (k)
95	2,520	108	2,590	116	2,010	92	2,630	112	1,430	64.9	722	30.4
96	2,560	109	2,620	116	2,040	92.3	2,670	112	1,450	65	737	30.7
97	2,600	110	2,660	116	2,070	92.6	2,710	113	1,470	65.1	753	31.0
98	2,640	110	2,700	117	2,100	92.9	2,750	113	1,490	65.1	768	31.4
99	2,680	111	2,740	117	2,130	93.2	2,790	114	1,510	65.2	784	31.7
100	2,720	111	2,780	117	2,160	93.5	2,830	114	1,520	65.3	800	32.0
101	2,760	112	2,820	118	2,190	93.7	2,870	115	1,540	65.3	816	32.3
102	2,800	112	2,860	118	2,220	94	2,910	115	1,560	65.4	832	32.6
103	2,840	113	2,890	119	2,260	94.3	2,950	116	1,580	65.5	849	33.0
104	2,880	113	2,930	119	2,290	94.6	2,990	116	1,600	65.5	865	33.3
105	2,920	113	2,970	119	2,320	94.8	3,040	117	1,610	65.6	882	33.6
106	2,960	114	3,010	120	2,350	95.1	3,080	117	1,630	65.7	899	33.9
107	3,000	114	3,050	120	2,380	95.3	3,120	117	1,650	65.7	916	34.2
108	3,040	115	3,090	120	2,410	95.6	3,160	118	1,670	65.8	933	34.6
109	3,080	115	3,120	121	2,440	95.8	3,200	118	1,690	65.8	950	34.9
110	3,120	116	3,160	121	2,470	96.1	3,240	119	1,700	65.9	968	35.2
111	3,160	116	3,200	121	2,500	96.3	3,280	119	1,720	65.9	986	35.5
112	3,200	116	3,240	121	2,530	96.5	3,320	119	1,740	66	1,004	35.8
113	3,240	117	3,280	122	2,560	96.7	3,360	120	1,760	66.1	1,022	36.2
114	3,280	117	3,320	122	2,590	97	3,400	120	1,780	66.1	1,040	36.5
115	3,320	118	3,360	122	2,620	97.2	3,450	121	1,790	66.2	1,058	36.8
116	3,360	118	3,390	123	2,650	97.4	3,490	121	1,810	66.2	1,076	37.1
117	3,400	118	3,430	123	2,680	97.6	3,530	121	1,830	66.3	1,095	37.4
118	3,440	119	3,470	123	2,710	97.8	3,570	122	1,850	66.3	1,114	37.8
119	3,480	119	3,510	123	2,740	98	3,610	122	1,870	66.4	1,133	38.1
120	3,520	119	3,550	124	2,770	98.2	3,650	122	1,880	66.4	1,152	38.4
121	3,560	120	3,590	124	2,800	98.4	3,690	123	1,900	66.4	1,171	38.7
122	3,600	120	3,620	124	2,830	98.6	3,730	123	1,920	66.5	1,191	39.0
123	3,640	120	3,660	124	2,860	98.8	3,770	123	1,940	66.5	1,210	39.4
124	3,690	121	3,700	125	2,900	99	3,810	124	1,960	66.6	1,230	39.7
125	3,730	121	3,740	125	2,930	99.2	3,860	124	1,970	66.6	1,250	40.0
126	3,770	121	3,780	125	2,960	99.3	3,900	124	1,990	66.7	1,270	40.3
127	3,810	122	3,820	125	2,990	99.5	3,940	125	2,010	66.7	1,290	40.6
128	3,850	122	3,860	125	3,020	99.7	3,980	125	2,030	66.8*	1,311	41.0
129	3,890	122	3,890	126	3,050	99.9	4,020	125	2,050	66.8*	1,331	41.3
130	3,930	123	3,930	126	3,080	100	4,060	126	2,060	66.8*	1,352	41.6
131	3,970	123	3,970	126	3,110	100	4,100	126	2,080	66.9*	1,373	41.9
132	4,010	123	4,010	126	3,140	100	4,140	126	2,100	66.9*	1,394	42.2
133	4,050	124	4,050	127	3,170	101	4,180	127	2,120	67.0*	1,415	42.6
134	4,090	124	4,090	127	3,200	101	4,220	127	2,130	67.0*	1,436	42.9
135	4,130	124	4,130	127	3,230	101	4,270	127	2,150	67.0*	1,458	43.2
136	4,170	124	4,160	127	3,260	101	4,310	127	2,170	67.1*	1,480	43.5
137	4,210	125	4,200	127	3,290	101	4,350	128	2,190	67.1*	1,502	43.8
138	4,250	125	4,240	128	3,320	101	4,390	128	2,210	67.1*	1,524	44.2
139	4,290	125	4,280	128	3,350	101	4,430	128	2,220	67.2*	1,546	44.5

* HS-20 Lane Load Controls, See Page A-27

MICHIGAN DEPARTMENT OF TRANSPORTATION
BRIDGE ANALYSIS GUIDE

Simple Span Load Effects Without Impact (spans 95-139 feet) - Special Designated Loading

Span (ft)	Trk 1 M (ft*k)	Trk 1 V (k)	Trk 2 M (ft*k)	Trk 2 V (k)	Trk 9 M (ft*k)	Trk 9 V (k)	Trk 10 M (ft*k)	Trk 10 V (k)	Trk 11 M (ft*k)	Trk 11 V (k)
95	843	37.2	997	43.3	1,040	45.7	1,160	51.8	1,320	58.6
96	852	37.2	1,010	43.3	1,050	45.7	1,180	51.8	1,330	58.7
97	862	37.2	1,020	43.3	1,070	45.7	1,190	51.9	1,350	58.8
98	872	37.3	1,030	43.3	1,080	45.8	1,200	51.9	1,370	58.9
99	882	37.3	1,040	43.4	1,090	45.8	1,220	52	1,390	59
100	891	37.3	1,050	43.4	1,100	45.9	1,230	52	1,400	59
101	901	37.3	1,070	43.4	1,120	45.9	1,250	52.1	1,420	59.1
102	911	37.3	1,080	43.4	1,130	45.9	1,260	52.1	1,440	59.2
103	921	37.3	1,090	43.4	1,140	46	1,270	52.1	1,450	59.3
104	930	37.4	1,100	43.5	1,150	46	1,290	52.2	1,470	59.3
105	940	37.4	1,110	43.5	1,160	46	1,300	52.2	1,490	59.4
106	950	37.4	1,120	43.5	1,180	46.1	1,320	52.3	1,500	59.5
107	959	37.4	1,130	43.5	1,190	46.1	1,330	52.3	1,520	59.6
108	969	37.4	1,140	43.5	1,200	46.1	1,350	52.3	1,540	59.6
109	979	37.4	1,160	43.5	1,210	46.2	1,360	52.4	1,550	59.7
110	989	37.4	1,170	43.6	1,230	46.2	1,370	52.4	1,570	59.8
111	998	37.5	1,180	43.6	1,240	46.2	1,390	52.4	1,590	59.8
112	1,010	37.5	1,190	43.6	1,250	46.2	1,400	52.5	1,600	59.9
113	1,020	37.5	1,200	43.6	1,260	46.3	1,420	52.5	1,620	60
114	1,030	37.5	1,210	43.6	1,280	46.3	1,430	52.6	1,640	60
115	1,040	37.5	1,220	43.6	1,290	46.3	1,440	52.6	1,650	60.1
116	1,050	37.5	1,240	43.7	1,300	46.4	1,460	52.6	1,670	60.1
117	1,060	37.5	1,250	43.7	1,310	46.4	1,470	52.7	1,690	60.2
118	1,070	37.6	1,260	43.7	1,330	46.4	1,490	52.7	1,700	60.3
119	1,080	37.6	1,270	43.7	1,340	46.4	1,500	52.7	1,720	60.3
120	1,090	37.6	1,280	43.7	1,350	46.5	1,510	52.7	1,740	60.4
121	1,100	37.6	1,290	43.7	1,360	46.5	1,530	52.8	1,750	60.4
122	1,110	37.6	1,300	43.7	1,380	46.5	1,540	52.8	1,770	60.5
123	1,120	37.6	1,320	43.8	1,390	46.5	1,560	52.8	1,790	60.5
124	1,130	37.6	1,330	43.8	1,400	46.6	1,570	52.9	1,800	60.6
125	1,130	37.6	1,340	43.8	1,410	46.6	1,580	52.9	1,820	60.6
126	1,140	37.6	1,350	43.8	1,420	46.6	1,600	52.9	1,840	60.7
127	1,150	37.7	1,360	43.8	1,440	46.6	1,610	52.9	1,850	60.7
128	1,160	37.7	1,370	43.8	1,450	46.7	1,630	53	1,870	60.8
129	1,170	37.7	1,380	43.8	1,460	46.7	1,640	53	1,890	60.8
130	1,180	37.7	1,390	43.8	1,470	46.7	1,650	53	1,900	60.9
131	1,190	37.7	1,410	43.9	1,490	46.7	1,670	53.1	1,920	60.9
132	1,200	37.7	1,420	43.9	1,500	46.7	1,680	53.1	1,940	61
133	1,210	37.7	1,430	43.9	1,510	46.8	1,700	53.1	1,960	61
134	1,220	37.7	1,440	43.9	1,520	46.8	1,710	53.1	1,970	61.1
135	1,230	37.7	1,450	43.9	1,540	46.8	1,730	53.2	1,990	61.1
136	1,240	37.7	1,460	43.9	1,550	46.8	1,740	53.2	2,010	61.2
137	1,250	37.8	1,470	43.9	1,560	46.8	1,750	53.2	2,020	61.2
138	1,260	37.8	1,490	43.9	1,570	46.9	1,770	53.2	2,040	61.3
139	1,270	37.8	1,500	43.9	1,590	46.9	1,780	53.2	2,060	61.3

MICHIGAN DEPARTMENT OF TRANSPORTATION
BRIDGE ANALYSIS GUIDE

Simple Span Load Effects Without Impact (spans 140-300 feet) - Designated Loading

Span (ft)	Trk 1 M (ft*k)	Trk 1 V (k)	Trk 2 M (ft*k)	Trk 2 V (k)	Trk 3 M (ft*k)	Trk 3 V (k)	Trk 4 M (ft*k)	Trk 4 V (k)	Trk 5 M (ft*k)	Trk 5 V (k)	Type 3 M (ft*k)	Type 3 V (k)
140	1,100	32.4	1,560	45.6	1,770	51.7	2,170	63.3	2,560	75.6	1,600	47.3
141	1,110	32.4	1,570	45.6	1,780	51.7	2,190	63.3	2,580	75.7	1,610	47.4
142	1,120	32.4	1,590	45.7	1,790	51.7	2,210	63.4	2,610	75.8	1,620	47.4
143	1,130	32.4	1,600	45.7	1,810	51.7	2,220	63.4	2,630	75.8	1,630	47.4
144	1,130	32.4	1,610	45.7	1,820	51.7	2,240	63.4	2,650	75.9	1,650	47.4
145	1,140	32.4	1,620	45.7	1,830	51.8	2,260	63.4	2,670	75.9	1,660	47.4
146	1,150	32.5	1,630	45.7	1,850	51.8	2,270	63.5	2,690	76	1,670	47.5
147	1,160	32.5	1,640	45.7	1,860	51.8	2,290	63.5	2,710	76	1,680	47.5
148	1,170	32.5	1,660	45.7	1,880	51.8	2,310	63.5	2,730	76.1	1,700	47.5
149	1,180	32.5	1,670	45.7	1,890	51.8	2,320	63.6	2,750	76.1	1,710	47.5
150	1,180	32.5	1,680	45.7	1,900	51.8	2,340	63.6	2,770	76.2	1,720	47.5
155	1,230	32.5	1,740	45.8	1,970	51.9	2,420	63.7	2,880	76.5	1,780	47.6
160	1,270	32.5	1,800	45.8	2,040	52	2,510	63.8	2,980	76.7	1,850	47.7
165	1,310	32.6	1,860	45.9	2,110	52.1	2,590	63.9	3,090	76.9	1,910	47.7
170	1,350	32.6	1,920	45.9	2,170	52.1	2,680	64	3,190	77.1	1,970	47.8
175	1,390	32.6	1,980	46	2,240	52.2	2,760	64.1	3,300	77.3	2,030	47.9
180	1,430	32.6	2,040	46	2,310	52.3	2,850	64.2	3,400	77.5	2,100	47.9
185	1,480	32.7	2,100	46.1	2,380	52.3	2,930	64.3	3,510	77.7	2,160	48
190	1,520	32.7	2,150	46.1	2,450	52.4	3,010	64.4	3,610	77.8	2,220	48
195	1,560	32.7	2,210	46.1	2,510	52.4	3,100	64.5	3,720	78	2,280	48.1
200	1,600	32.7	2,270	46.2	2,580	52.5	3,180	64.5	3,820	78.2	2,350	48.1
205	1,640	32.7	2,330	46.2	2,650	52.5	3,270	64.6	3,930	78.3	2,410	48.2
210	1,680	32.7	2,390	46.2	2,720	52.6	3,350	64.7	4,030	78.4	2,470	48.2
215	1,730	32.8	2,450	46.2	2,790	52.6	3,440	64.7	4,140	78.6	2,530	48.3
220	1,770	32.8	2,510	46.3	2,850	52.7	3,520	64.8	4,240	78.7	2,600	48.3
225	1,810	32.8	2,570	46.3	2,920	52.7	3,600	64.9	4,350	78.8	2,660	48.3
230	1,850	32.8	2,630	46.3	2,990	52.7	3,690	64.9	4,450	78.9	2,720	48.4
235	1,890	32.8	2,690	46.3	3,060	52.8	3,770	65	4,560	79	2,780	48.4
240	1,940	32.8	2,750	46.4	3,130	52.8	3,860	65	4,660	79.1	2,850	48.5
245	1,980	32.8	2,810	46.4	3,190	52.8	3,940	65.1	4,770	79.2	2,910	48.5
250	2,020	32.8	2,870	46.4	3,260	52.9	4,030	65.1	4,870	79.3	2,970	48.5
255	2,060	32.9	2,920	46.4	3,330	52.9	4,110	65.2	4,980	79.4	3,030	48.5
260	2,100	32.9	2,980	46.4	3,400	52.9	4,190	65.2	5,080	79.5	3,100	48.6
265	2,140	32.9	3,040	46.5	3,470	53	4,280	65.2	5,190	79.6	3,160	48.6
270	2,190	32.9	3,100	46.5	3,530	53	4,360	65.3	5,290	79.7	3,220	48.6
275	2,230	32.9	3,160	46.5	3,600	53	4,450	65.3	5,400	79.7	3,280	48.6
280	2,270	32.9	3,220	46.5	3,670	53	4,530	65.4	5,500	79.8	3,350	48.7
285	2,310	32.9	3,280	46.5	3,740	53.1	4,620	65.4	5,610	79.9	3,410	48.7
290	2,350	32.9	3,340	46.5	3,810	53.1	4,700	65.4	5,710	80	3,470	48.7
295	2,390	32.9	3,400	46.6	3,870	53.1	4,780	65.5	5,820	80	3,530	48.7
300	2,440	32.9	3,460	46.6	3,940	53.1	4,870	65.5	5,920	80.1	3,600	48.8

MICHIGAN DEPARTMENT OF TRANSPORTATION
BRIDGE ANALYSIS GUIDE

Simple Span Load Effects Without Impact (spans 140-300 feet) - Designated Loading

Span (ft)	Trk 6		Trk 7		Trk 8		Trk 9		Trk 10		Trk 11	
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
140	2,970	87	3,360	98.5	2,740	80.4	1,650	48.3	2,050	61	2,550	74.4
141	2,990	87.1	3,390	98.7	2,760	80.5	1,660	48.3	2,070	61.1	2,570	74.4
142	3,020	87.2	3,420	98.8	2,790	80.6	1,670	48.3	2,080	61.1	2,590	74.5
143	3,040	87.3	3,450	99	2,810	80.6	1,690	48.3	2,100	61.1	2,620	74.6
144	3,070	87.4	3,480	99.1	2,830	80.7	1,700	48.4	2,110	61.1	2,640	74.6
145	3,100	87.5	3,510	99.2	2,850	80.8	1,710	48.4	2,130	61.2	2,660	74.7
146	3,120	87.6	3,540	99.4	2,880	80.9	1,730	48.4	2,150	61.2	2,680	74.7
147	3,150	87.7	3,570	99.5	2,900	80.9	1,740	48.4	2,160	61.2	2,700	74.8
148	3,170	87.8	3,600	99.6	2,920	81	1,750	48.4	2,180	61.3	2,720	74.9
149	3,200	87.9	3,630	99.8	2,950	81.1	1,760	48.5	2,200	61.3	2,740	74.9
150	3,220	88	3,660	99.9	2,970	81.1	1,780	48.5	2,210	61.3	2,760	75
155	3,350	88.4	3,800	101	3,080	81.5	1,840	48.6	2,290	61.5	2,870	75.2
160	3,480	88.8	3,950	101	3,200	81.8	1,910	48.7	2,380	61.6	2,970	75.5
165	3,600	89.2	4,100	102	3,310	82.1	1,970	48.7	2,460	61.7	3,070	75.7
170	3,730	89.6	4,250	102	3,430	82.4	2,030	48.8	2,540	61.8	3,180	76
175	3,860	89.9	4,400	103	3,540	82.6	2,100	48.9	2,620	61.9	3,280	76.2
180	3,980	90.2	4,550	103	3,650	82.9	2,160	49	2,700	62	3,390	76.4
185	4,110	90.5	4,700	104	3,770	83.1	2,230	49	2,780	62.1	3,490	76.6
190	4,240	90.8	4,850	104	3,880	83.3	2,290	49.1	2,870	62.2	3,600	76.7
195	4,360	91.1	5,000	104	4,000	83.5	2,360	49.1	2,950	62.3	3,700	76.9
200	4,490	91.3	5,150	105	4,110	83.7	2,420	49.2	3,030	62.3	3,800	77.1
205	4,620	91.6	5,300	105	4,220	83.9	2,480	49.3	3,110	62.4	3,910	77.2
210	4,740	91.8	5,450	105	4,340	84.1	2,550	49.3	3,190	62.5	4,010	77.4
215	4,870	92	5,600	106	4,450	84.2	2,610	49.4	3,270	62.6	4,120	77.5
220	5,000	92.2	5,740	106	4,570	84.4	2,680	49.4	3,360	62.6	4,220	77.7
225	5,120	92.4	5,890	106	4,680	84.6	2,740	49.4	3,440	62.7	4,320	77.8
230	5,250	92.6	6,040	107	4,800	84.7	2,810	49.5	3,520	62.7	4,430	77.9
235	5,380	92.8	6,190	107	4,910	84.9	2,870	49.5	3,600	62.8	4,530	78
240	5,500	93	6,340	107	5,020	85	2,930	49.6	3,680	62.8	4,640	78.1
245	5,630	93.2	6,490	107	5,140	85.1	3,000	49.6	3,770	62.9	4,740	78.2
250	5,760	93.3	6,640	108	5,250	85.2	3,060	49.6	3,850	63	4,850	78.3
255	5,880	93.5	6,790	108	5,370	85.4	3,130	49.7	3,930	63	4,950	78.4
260	6,010	93.7	6,940	108	5,480	85.5	3,190	49.7	4,010	63	5,050	78.5
265	6,140	93.8	7,090	108	5,600	85.6	3,250	49.7	4,090	63.1	5,160	78.6
270	6,260	93.9	7,240	109	5,710	85.7	3,320	49.8	4,170	63.1	5,260	78.7
275	6,390	94.1	7,390	109	5,820	85.8	3,380	49.8	4,260	63.2	5,370	78.8
280	6,520	94.2	7,540	109	5,940	85.9	3,450	49.8	4,340	63.2	5,470	78.9
285	6,640	94.3	7,680	109	6,050	86	3,510	49.9	4,420	63.3	5,580	79
290	6,770	94.5	7,830	109	6,170	86.1	3,580	49.9	4,500	63.3	5,680	79
295	6,900	94.6	7,980	109	6,280	86.2	3,640	49.9	4,580	63.3	5,780	79.1
300	7,020	94.7	8,130	110	6,390	86.3	3,700	49.9	4,660	63.4	5,890	79.2

MICHIGAN DEPARTMENT OF TRANSPORTATION
BRIDGE ANALYSIS GUIDE

Simple Span Load Effects Without Impact (spans 140-300 feet) - Designated Loading

Span (ft)	Trk 12	Trk 12	Trk 13	Trk 13	Trk 14	Trk 14	Trk 15	Trk 15	Trk 16	Trk 16	Trk 17	Trk 17
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
140	3,430	101	3,590	106	3,830	114	3,980	118	4,060	120	4,390	129
141	3,460	101	3,620	106	3,860	114	4,020	118	4,090	120	4,430	129
142	3,480	101	3,660	106	3,900	114	4,050	119	4,130	120	4,460	129
143	3,510	101	3,690	107	3,930	114	4,090	119	4,160	120	4,500	130
144	3,540	101	3,720	107	3,960	114	4,120	119	4,200	120	4,540	130
145	3,570	102	3,750	107	4,000	115	4,160	119	4,230	120	4,580	130
146	3,600	102	3,780	107	4,030	115	4,200	119	4,270	120	4,620	130
147	3,630	102	3,810	107	4,060	115	4,230	119	4,300	121	4,650	130
148	3,660	102	3,840	107	4,090	115	4,270	120	4,340	121	4,690	130
149	3,690	102	3,880	107	4,130	115	4,300	120	4,370	121	4,730	131
150	3,720	102	3,910	108	4,160	115	4,340	120	4,410	121	4,770	131
155	3,870	103	4,060	108	4,330	116	4,520	121	4,580	121	4,960	131
160	4,010	103	4,220	109	4,490	116	4,700	121	4,750	122	5,150	132
165	4,160	103	4,380	109	4,660	117	4,880	122	4,920	122	5,330	133
170	4,310	104	4,530	110	4,820	117	5,060	123	5,100	123	5,520	133
175	4,450	104	4,690	110	4,990	118	5,240	123	5,270	123	5,710	134
180	4,600	105	4,850	110	5,150	118	5,410	124	5,440	124	5,900	134
185	4,750	105	5,000	111	5,320	118	5,590	124	5,620	124	6,090	135
190	4,890	105	5,160	111	5,480	119	5,770	125	5,790	125	6,280	135
195	5,040	106	5,320	112	5,650	119	5,950	125	5,960	125	6,470	135
200	5,190	106	5,470	112	5,820	120	6,130	126	6,140	125	6,660	136
205	5,330	106	5,630	112	5,980	120	6,310	126	6,310	126	6,850	136
210	5,480	106	5,790	113	6,150	120	6,490	127	6,480	126	7,040	137
215	5,630	107	5,940	113	6,310	120	6,670	127	6,650	126	7,230	137
220	5,770	107	6,100	113	6,480	121	6,850	127	6,830	126	7,420	137
225	5,920	107	6,260	113	6,640	121	7,030	128	7,000	127	7,600	138
230	6,070	107	6,410	114	6,810	121	7,210	128	7,170	127	7,790	138
235	6,210	108	6,570	114	6,970	121	7,390	128	7,350	127	7,980	138
240	6,360	108	6,730	114	7,140	122	7,560	129	7,520	127	8,170	138
245	6,510	108	6,880	114	7,300	122	7,740	129	7,690	128	8,360	139
250	6,650	108	7,040	115	7,470	122	7,920	129	7,870	128	8,550	139
255	6,800	108	7,200	115	7,640	122	8,100	130	8,040	128	8,740	139
260	6,950	109	7,350	115	7,800	122	8,280	130	8,210	128	8,930	139
265	7,090	109	7,510	115	7,970	123	8,460	130	8,380	128	9,120	140
270	7,240	109	7,670	115	8,130	123	8,640	130	8,560	129	9,310	140
275	7,390	109	7,820	116	8,300	123	8,820	131	8,730	129	9,500	140
280	7,530	109	7,980	116	8,460	123	9,000	131	8,900	129	9,690	140
285	7,680	109	8,140	116	8,630	123	9,180	131	9,080	129	9,880	140
290	7,830	109	8,290	116	8,790	124	9,360	131	9,250	129	10,100	141
295	7,970	110	8,450	116	8,960	124	9,540	131	9,420	129	10,300	141
300	8,120	110	8,610	116	9,120	124	9,720	132	9,600	130	10,400	141

MICHIGAN DEPARTMENT OF TRANSPORTATION
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Simple Span Load Effects Without Impact (spans 140-300 feet) - Designated Loading

Span (ft)	Trk 18		3S2		3-3		Trk 19		Trk 20		Trk 21	
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
140	4,390	130	2,050	62.4	2,140	66.3	3,330	97.9	2,600	76.5	4,100	121
141	4,430	130	2,070	62.5	2,160	66.4	3,360	98	2,620	76.6	4,140	122
142	4,470	131	2,080	62.6	2,180	66.5	3,390	98.1	2,640	76.7	4,180	122
143	4,510	131	2,100	62.6	2,200	66.6	3,420	98.3	2,660	76.7	4,210	122
144	4,550	131	2,120	62.7	2,220	66.7	3,450	98.4	2,680	76.8	4,250	122
145	4,590	131	2,140	62.8	2,240	66.8	3,480	98.5	2,710	76.9	4,290	122
146	4,620	131	2,160	62.8	2,260	66.9	3,510	98.7	2,730	76.9	4,330	123
147	4,660	131	2,170	62.9	2,280	67	3,540	98.8	2,750	77	4,370	123
148	4,700	131	2,190	62.9	2,300	67.1	3,570	98.9	2,770	77.1	4,400	123
149	4,740	132	2,210	63	2,320	67.2	3,600	99	2,790	77.2	4,440	123
150	4,780	132	2,230	63.1	2,340	67.3	3,630	99.2	2,810	77.2	4,480	123
155	4,970	132	2,320	63.4	2,440	67.7	3,770	99.8	2,920	77.6	4,670	124
160	5,160	133	2,410	63.6	2,540	68.1	3,920	100	3,030	77.9	4,860	125
165	5,360	134	2,500	63.9	2,640	68.4	4,070	101	3,140	78.1	5,050	126
170	5,550	134	2,590	64.1	2,740	68.8	4,210	101	3,250	78.4	5,240	127
175	5,740	135	2,680	64.3	2,840	69.1	4,360	102	3,360	78.7	5,420	127
180	5,930	135	2,770	64.6	2,940	69.4	4,510	102	3,470	78.9	5,610	128
185	6,120	136	2,860	64.8	3,040	69.7	4,660	103	3,580	79.1	5,800	129
190	6,320	136	2,950	64.9	3,140	69.9	4,800	103	3,690	79.4	5,990	129
195	6,510	137	3,040	65.1	3,240	70.2	4,950	103	3,800	79.6	6,180	130
200	6,700	137	3,130	65.3	3,340	70.4	5,100	104	3,910	79.8	6,370	130
205	6,890	138	3,220	65.5	3,440	70.7	5,240	104	4,020	80	6,560	131
210	7,090	138	3,310	65.6	3,540	70.9	5,390	104	4,130	80.1	6,750	131
215	7,280	138	3,400	65.8	3,640	71.1	5,540	105	4,240	80.3	6,940	132
220	7,470	139	3,490	65.9	3,740	71.3	5,680	105	4,340	80.5	7,130	132
225	7,660	139	3,580	66	3,840	71.5	5,830	105	4,450	80.6	7,320	133
230	7,860	140	3,670	66.2	3,940	71.7	5,980	106	4,560	80.8	7,510	133
235	8,050	140	3,760	66.3	4,040	71.9	6,120	106	4,670	80.9	7,700	134
240	8,240	140	3,850	66.4	4,140	72	6,270	106	4,780	81	7,890	134
245	8,430	140	3,940	66.5	4,240	72.2	6,420	106	4,890	81.2	8,070	134
250	8,630	141	4,030	66.6	4,340	72.4	6,560	106	5,000	81.3	8,260	135
255	8,820	141	4,120	66.7	4,440	72.5	6,710	107	5,110	81.4	8,450	135
260	9,010	141	4,210	66.8	4,540	72.6	6,860	107	5,220	81.5	8,640	135
265	9,200	141	4,300	66.9	4,640	72.8	7,000	107	5,330	81.6	8,830	136
270	9,400	142	4,390	67	4,740	72.9	7,150	107	5,440	81.7	9,020	136
275	9,590	142	4,480	67.1	4,840	73	7,300	107	5,550	81.8	9,210	136
280	9,780	142	4,570	67.2	4,940	73.2	7,440	108	5,660	81.9	9,400	136
285	9,970	142	4,660	67.3	5,040	73.3	7,590	108	5,760	82	9,590	137
290	10,200	143	4,750	67.4	5,140	73.4	7,740	108	5,870	82.1	9,780	137
295	10,400	143	4,840	67.5	5,240	73.5	7,880	108	5,980	82.2	9,970	137
300	10,600	143	4,930	67.5	5,340	73.6	8,030	108	6,090	82.3	10,200	137

MICHIGAN DEPARTMENT OF TRANSPORTATION
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Simple Span Load Effects Without Impact (spans 140-300 feet) - Designated Loading

Span (ft)	Trk 22	Trk 22	Trk 23	Trk 23	Trk 24	Trk 24	Trk 25	Trk 25	HL-93	HL-93	HL-93	HL-93
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	Trk M (ft*k)	Trk V (k)	Lane M (ft*k)	Lane V (k)
140	4,330	125	4,320	128	3,380	102	4,470	128	2,240	67.2*	1,568	44.8
141	4,370	126	4,360	128	3,410	102	4,510	129	2,260	67.2*	1,590	45.1
142	4,410	126	4,390	128	3,440	102	4,550	129	2,280	67.3*	1,613	45.4
143	4,450	126	4,430	128	3,470	102	4,590	129	2,300	67.3*	1,636	45.8
144	4,490	126	4,470	129	3,510	102	4,630	129	2,310	67.3*	1,659	46.1
145	4,530	127	4,510	129	3,540	102	4,680	130	2,333*	67.4*	1,682	46.4
146	4,570	127	4,550	129	3,570	102	4,720	130	2,351*	67.4*	1,705	46.7
147	4,610	127	4,590	129	3,600	103	4,760	130	2,369*	67.4*	1,729	47.0
148	4,650	127	4,630	129	3,630	103	4,800	130	2,387*	67.5*	1,752	47.4
149	4,690	128	4,660	129	3,660	103	4,840	131	2,405*	67.5*	1,776	47.7
150	4,730	128	4,700	130	3,690	103	4,880	131	2,419*	67.5*	1,800	48.0
155	4,940	129	4,900	130	3,840	104	5,090	132	2,513*	67.7*	1,922	49.6
160	5,140	130	5,090	131	3,990	104	5,290	133	2,600*	67.8*	2,048	51.2
165	5,340	131	5,280	132	4,150	105	5,500	134	2,692*	68.0*	2,178	52.8
170	5,540	132	5,470	133	4,300	105	5,700	135	2,779*	68.0*	2,312	54.4
175	5,740	133	5,670	133	4,450	106	5,910	136	2,872*	68.2*	2,450	56.0
180	5,940	133	5,860	134	4,600	106	6,110	136	2,960*	68.3*	2,592	57.6
185	6,150	134	6,050	134	4,760	107	6,320	137	3,052*	68.4*	2,738	59.2
190	6,350	135	6,240	135	4,910	107	6,520	138	3,139*	68.5*	2,888	60.8
195	6,550	136	6,430	135	5,060	107	6,730	138	3,232*	68.6*	3,042	62.4
200	6,750	136	6,630	136	5,210	108	6,930	139	3,320*	68.6*	3,200	64.0
205	6,950	137	6,820	136	5,370	108	7,140	140	3,412*	68.7*	3,362	65.6
210	7,150	137	7,010	137	5,520	108	7,340	140	3,502*	68.8*	3,528	67.2
215	7,360	138	7,200	137	5,670	109	7,550	141	3,592*	68.9*	3,698	68.8
220	7,560	139	7,400	137	5,820	109	7,750	141	3,680*	68.9*	3,872	70.4
225	7,760	139	7,590	138	5,980	109	7,960	142	3,772*	69.0*	4,050	72.0
230	7,960	140	7,780	138	6,130	110	8,160	142	3,862*	69.1*	4,232	73.6
235	8,160	140	7,970	138	6,280	110	8,370	143	3,952*	69.1*	4,418	75.2
240	8,370	140	8,170	139	6,430	110	8,570	143	4,040*	69.2*	4,608	76.8
245	8,570	141	8,360	139	6,590	110	8,780	144	4,132*	69.3*	4,802	78.4
250	8,770	141	8,550	139	6,740	111	8,980	144	4,222*	69.3*	5,000	80.0
255	8,970	142	8,740	140	6,890	111	9,190	144	4,312*	69.4*	5,202	81.6
260	9,170	142	8,940	140	7,040	111	9,390	145	4,400*	69.4*	5,408	83.2
265	9,370	142	9,130	140	7,200	111	9,600	145	4,491*	69.5*	5,618	84.8
270	9,580	143	9,320	140	7,350	111	9,800	146	4,581*	69.5*	5,832	86.4
275	9,780	143	9,510	141	7,500	112	10,000	146	4,671*	69.6*	6,050	88.0
280	9,980	143	9,710	141	7,650	112	10,200	146	4,760*	69.6*	6,272	89.6
285	10,200	144	9,900	141	7,810	112	10,400	147	4,851*	69.6*	6,498	91.2
290	10,400	144	10,100	141	7,960	112	10,600	147	4,941*	69.7*	6,728	92.8
295	10,600	144	10,300	142	8,110	112	10,800	147	5,031*	69.7*	6,962	94.4
300	10,800	145	10,500	142	8,260	112	11,000	147	5,121*	69.8*	7,200	96.0

* HS-20 Lane Load Controls, See Page A-27

MICHIGAN DEPARTMENT OF TRANSPORTATION
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Simple Span Load Effects Without Impact (spans 140-300 feet) - Special Designated Loading

Span (ft)	Trk 1 M (ft*k)	Trk 1 V (k)	Trk 2 M (ft*k)	Trk 2 V (k)	Trk 9 M (ft*k)	Trk 9 V (k)	Trk 10 M (ft*k)	Trk 10 V (k)	Trk 11 M (ft*k)	Trk 11 V (k)
140	1,280	37.8	1,510	44	1,600	46.9	1,800	53.3	2,070	61.3
141	1,290	37.8	1,520	44	1,610	46.9	1,810	53.3	2,090	61.4
142	1,300	37.8	1,530	44	1,620	46.9	1,820	53.3	2,110	61.4
143	1,310	37.8	1,540	44	1,630	47	1,840	53.3	2,120	61.5
144	1,320	37.8	1,550	44	1,650	47	1,850	53.4	2,140	61.5
145	1,330	37.8	1,560	44	1,660	47	1,870	53.4	2,160	61.5
146	1,340	37.8	1,580	44	1,670	47	1,880	53.4	2,170	61.6
147	1,350	37.8	1,590	44	1,680	47	1,890	53.4	2,190	61.6
148	1,360	37.8	1,600	44	1,700	47	1,910	53.4	2,210	61.6
149	1,370	37.9	1,610	44	1,710	47.1	1,920	53.5	2,220	61.7
150	1,380	37.9	1,620	44.1	1,720	47.1	1,940	53.5	2,240	61.7
155	1,430	37.9	1,680	44.1	1,780	47.1	2,010	53.6	2,320	61.9
160	1,480	37.9	1,740	44.1	1,850	47.2	2,080	53.7	2,410	62.1
165	1,520	38	1,790	44.2	1,910	47.3	2,150	53.7	2,490	62.2
170	1,570	38	1,850	44.2	1,970	47.4	2,220	53.8	2,580	62.4
175	1,620	38	1,910	44.2	2,030	47.4	2,290	53.9	2,660	62.5
180	1,670	38.1	1,960	44.3	2,090	47.5	2,360	54	2,740	62.6
185	1,720	38.1	2,020	44.3	2,150	47.5	2,430	54	2,830	62.7
190	1,770	38.1	2,080	44.3	2,220	47.6	2,500	54.1	2,910	62.9
195	1,820	38.1	2,130	44.4	2,280	47.6	2,570	54.2	2,990	63
200	1,870	38.1	2,190	44.4	2,340	47.7	2,640	54.2	3,080	63.1
205	1,910	38.2	2,250	44.4	2,400	47.7	2,710	54.3	3,160	63.2
210	1,960	38.2	2,300	44.4	2,460	47.8	2,780	54.3	3,250	63.3
215	2,010	38.2	2,360	44.5	2,530	47.8	2,850	54.4	3,330	63.3
220	2,060	38.2	2,420	44.5	2,590	47.8	2,920	54.4	3,410	63.4
225	2,110	38.2	2,470	44.5	2,650	47.9	2,990	54.5	3,500	63.5
230	2,160	38.3	2,530	44.5	2,710	47.9	3,060	54.5	3,580	63.6
235	2,210	38.3	2,590	44.5	2,770	47.9	3,130	54.5	3,670	63.7
240	2,260	38.3	2,640	44.6	2,840	48	3,200	54.6	3,750	63.7
245	2,300	38.3	2,700	44.6	2,900	48	3,280	54.6	3,830	63.8
250	2,350	38.3	2,760	44.6	2,960	48	3,350	54.6	3,920	63.9
255	2,400	38.3	2,810	44.6	3,020	48.1	3,420	54.7	4,000	63.9
260	2,450	38.3	2,870	44.6	3,080	48.1	3,490	54.7	4,090	64
265	2,500	38.4	2,930	44.6	3,140	48.1	3,560	54.7	4,170	64.1
270	2,550	38.4	2,980	44.7	3,210	48.2	3,630	54.8	4,250	64.1
275	2,600	38.4	3,040	44.7	3,270	48.2	3,700	54.8	4,340	64.2
280	2,650	38.4	3,100	44.7	3,330	48.2	3,770	54.8	4,420	64.2
285	2,690	38.4	3,150	44.7	3,390	48.2	3,840	54.9	4,500	64.3
290	2,740	38.4	3,210	44.7	3,450	48.2	3,910	54.9	4,590	64.3
295	2,790	38.4	3,270	44.7	3,520	48.3	3,980	54.9	4,670	64.4
300	2,840	38.4	3,320	44.7	3,580	48.3	4,050	54.9	4,760	64.4

MICHIGAN DEPARTMENT OF TRANSPORTATION
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Simple Span Load Effects Without Impact (spans 5-300 feet) - HS-20 Lane Load

Span (ft)	HS-20 Lane M (ft*k)	HS-20 Lane V (k)	Span (ft)	HS-20 Lane M (ft*k)	HS-20 Lane V (k)	Span (ft)	HS-20 Lane M (ft*k)	HS-20 Lane V (k)	Span (ft)	HS-20 Lane M (ft*k)	HS-20 Lane V (k)
5	*	*	50	*	*	95	*	*	140	*	70.8
6	*	*	51	*	*	96	*	*	141	*	71.1
7	*	*	52	*	*	97	*	*	142	*	71.4
8	*	*	53	*	*	98	*	*	143	*	71.8
9	*	*	54	*	*	99	*	*	144	*	72.1
10	*	*	55	*	*	100	*	*	145	2,330	72.4
11	*	*	56	*	*	101	*	*	146	2,360	72.7
12	*	*	57	*	*	102	*	*	147	2,390	73
13	*	*	58	*	*	103	*	*	148	2,420	73.4
14	*	*	59	*	*	104	*	*	149	2,450	73.7
15	*	*	60	*	*	105	*	*	150	2,480	74
16	*	*	61	*	*	106	*	*	155	2,620	75.6
17	*	*	62	*	*	107	*	*	160	2,770	77.2
18	*	*	63	*	*	108	*	*	165	2,920	78.8
19	*	*	64	*	*	109	*	*	170	3,080	80.4
20	*	*	65	*	*	110	*	*	175	3,240	82
21	*	*	66	*	*	111	*	*	180	3,400	83.6
22	*	*	67	*	*	112	*	*	185	3,570	85.2
23	*	*	68	*	*	113	*	*	190	3,740	86.8
24	*	*	69	*	*	114	*	*	195	3,920	88.4
25	*	*	70	*	*	115	*	*	200	4,100	90
26	*	*	71	*	*	116	*	*	205	4,280	91.6
27	*	*	72	*	*	117	*	*	210	4,470	93.2
28	*	*	73	*	*	118	*	*	215	4,670	94.8
29	*	*	74	*	*	119	*	*	220	4,860	96.4
30	*	*	75	*	*	120	*	*	225	5,060	98
31	*	*	76	*	*	121	*	*	230	5,270	99.6
32	*	*	77	*	*	122	*	*	235	5,480	101
33	*	*	78	*	*	123	*	*	240	5,690	103
34	*	*	79	*	*	124	*	*	245	5,900	104
35	*	*	80	*	*	125	*	*	250	6,130	106
36	*	*	81	*	*	126	*	*	255	6,350	108
37	*	*	82	*	*	127	*	*	260	6,580	109
38	*	*	83	*	*	128	*	67	265	6,810	111
39	*	*	84	*	*	129	*	67.3	270	7,050	112
40	*	*	85	*	*	130	*	67.6	275	7,290	114
41	*	*	86	*	*	131	*	67.9	280	7,530	116
42	*	*	87	*	*	132	*	68.2	285	7,780	117
43	*	*	88	*	*	133	*	68.6	290	8,030	119
44	*	*	89	*	*	134	*	68.9	295	8,290	120
45	*	*	90	*	*	135	*	69.2	300	8,550	122
46	*	*	91	*	*	136	*	69.5			
47	*	*	92	*	*	137	*	69.8			
48	*	*	93	*	*	138	*	70.2			
49	*	*	94	*	*	139	*	70.5			

*HS-20 Truck controls, see appropriate table above

Appendix B: Simple-Span Load Effect Tables (Without Impact) - Federal Vehicles

Federal Vehicles.....	B-2
Simple Span Load Effects Without Impact (spans 5-49 feet) - SHV and EV Vehicles.....	B-3
Simple Span Load Effects Without Impact (spans 50-94 feet) - SHV and EV Vehicles.....	B-4
Simple Span Load Effects Without Impact (spans 95-139 feet) - SHV and EV Vehicles	B-5
Simple Span Load Effects Without Impact (spans 140-300 feet) - SHV and EV Vehicles	B-6

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Federal Vehicles

SU4

SU5

SU6

SU7

EV2

EV3

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Simple Span Load Effects Without Impact (spans 5-49 feet) - SHV and EV Vehicles

Span (ft)	SU4 M (ft*k)	SU4 V (k)	SU5 M (ft*k)	SU5 V (k)	SU6 M (ft*k)	SU6 V (k)	SU7 M (ft*k)	SU7 V (k)	EV2 M (ft*k)	EV2 V (k)	EV3 M (ft*k)	EV3 V (k)
5	21.3	20.4	21.3	20.4	21.3	20.4	21.3	20.4	41.9	33.5	38.8	37.2
6	25.5	22.7	25.5	22.7	25.5	22.7	25.5	22.7	50.3	33.5	46.5	41.3
7	30.4	24.3	30.4	24.3	30.4	24.3	30.4	24.3	58.6	33.5	55.4	44.3
8	38.3	25.5	38.3	25.5	38.3	25.5	38.3	25.5	67.0	33.5	69.8	46.5
9	46.3	27.3	46.3	27.3	46.3	27.3	46.3	27.3	75.4	33.5	84.4	48.2
10	55.8	28.8	55.8	28.8	55.8	28.8	55.8	28.8	83.8	33.5	99.2	49.6
11	66.2	30.0	66.2	30.0	66.2	30.0	66.2	30.0	92.1	33.5	114.1	50.7
12	76.6	31.0	76.6	31.0	76.6	31.0	76.6	31.0	100.5	33.5	129.2	51.7
13	87.1	31.9	87.1	32.5	87.1	32.5	87.1	32.5	108.9	33.5	144.3	52.5
14	97.5	32.6	97.5	33.7	97.5	33.7	97.5	33.7	117.3	33.5	159.4	53.1
15	108.0	33.2	108.0	34.8	108.8	34.8	108.8	34.8	125.6	33.5	174.6	53.7
16	118.5	33.8	118.5	35.8	121.1	35.8	121.1	35.8	134.0	35.0	189.9	54.3
17	128.9	34.2	130.7	36.6	133.4	36.6	133.4	36.6	142.4	36.3	205.2	54.7
18	139.4	34.7	143.2	37.3	147.3	37.3	147.3	37.3	150.8	37.5	220.4	55.1
19	149.9	35.7	155.7	38.0	161.8	38.0	161.8	38.0	159.1	38.6	235.8	55.5
20	160.4	36.6	168.2	38.6	176.3	38.6	176.3	38.6	167.5	39.5	251.1	57.0
21	170.9	37.4	180.7	39.1	190.8	39.1	190.8	39.1	175.9	40.4	266.5	58.4
22	181.3	38.2	193.2	39.6	205.2	39.6	205.2	39.6	184.3	41.1	281.8	59.6
23	191.8	38.9	205.7	40.6	219.7	40.6	220.4	40.6	192.6	41.9	297.2	60.8
24	202.3	39.5	218.2	41.5	234.2	41.5	236.8	41.5	201.0	42.5	312.6	61.8
25	212.8	40.1	230.7	42.3	248.7	42.3	253.1	42.3	209.4	43.1	328.0	62.8
26	223.3	40.6	243.2	43.1	263.2	43.0	269.5	43.0	217.8	43.7	343.4	63.7
27	233.8	41.1	255.6	43.8	277.7	43.7	285.9	43.7	229.0	44.2	358.8	64.5
28	246.9	41.6	268.1	44.4	292.2	44.3	302.4	44.3	242.6	44.6	374.2	65.3
29	260.3	42.0	280.6	45.0	306.7	44.9	318.8	44.9	256.3	45.1	389.6	66.0
30	273.7	42.4	293.1	45.6	321.2	45.5	335.2	45.5	270.0	45.5	408.4	66.7
31	287.1	42.8	305.6	46.1	335.7	46.1	351.6	46.1	283.8	45.9	429.7	67.3
32	300.5	43.1	318.1	46.6	350.2	46.8	368.1	46.8	297.6	46.3	451.0	67.9
33	313.9	43.5	330.6	47.1	364.7	47.5	384.5	47.5	311.4	46.6	472.4	68.4
34	327.4	43.8	344.1	47.5	379.2	48.1	400.9	48.1	325.3	46.9	493.7	68.9
35	340.8	44.1	359.4	47.9	393.7	48.7	417.4	48.8	339.2	47.2	515.1	69.4
36	354.2	44.3	374.7	48.3	410.9	49.3	433.8	49.6	353.1	47.5	536.5	69.9
37	367.7	44.6	390.0	48.7	428.2	49.9	451.9	50.3	367.1	47.8	557.8	70.3
38	381.1	44.8	405.3	49.1	445.5	50.4	471.2	51.1	381.1	48.0	579.2	70.7
39	394.6	45.1	420.7	49.4	462.8	50.9	490.6	51.7	395.1	48.3	600.6	71.1
40	408.0	45.3	436.0	49.7	480.1	51.3	510.0	52.4	409.1	48.5	622.0	71.5
41	421.5	45.5	451.4	50.0	497.4	51.8	529.3	53.0	423.1	48.7	643.4	71.9
42	434.9	45.7	466.7	50.3	514.8	52.2	548.7	53.6	437.2	48.9	664.8	72.2
43	448.4	45.9	482.1	50.6	532.1	52.6	568.1	54.1	451.2	49.1	686.2	72.5
44	461.8	46.1	497.5	50.8	549.4	53.0	587.4	54.7	465.3	49.3	707.7	72.8
45	475.3	46.3	512.8	51.1	566.7	53.3	606.8	55.2	479.4	49.5	729.1	73.1
46	488.8	46.4	528.2	51.3	584.0	53.7	626.1	55.7	493.5	49.7	750.5	73.4
47	502.2	46.6	543.6	51.5	601.4	54.0	645.5	56.1	507.6	49.8	771.9	73.7
48	515.7	46.8	559.0	51.8	618.7	54.4	664.9	56.6	521.7	50.0	793.4	73.9
49	529.2	46.9	574.4	52.0	636.0	54.7	684.2	57.0	535.9	50.2	814.8	74.2

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Span (ft)	SU4 M (ft*k)	SU4 V (k)	SU5 M (ft*k)	SU5 V (k)	SU6 M (ft*k)	SU6 V (k)	SU7 M (ft*k)	SU7 V (k)	EV2 M (ft*k)	EV2 V (k)	EV3 M (ft*k)	EV3 V (k)
50	542.6	47.0	589.8	52.2	653.4	55.0	703.6	57.4	550.0	50.3	836.2	74.4
51	556.1	47.2	605.2	52.4	670.7	55.3	723.0	57.8	564.2	50.4	857.7	74.6
52	569.6	47.3	620.6	52.5	688.0	55.5	742.4	58.2	578.3	50.6	879.1	74.9
53	583.0	47.4	636.0	52.7	705.4	55.8	761.7	58.5	592.5	50.7	900.5	75.1
54	596.5	47.6	651.4	52.9	722.7	56.0	781.1	58.9	606.7	50.8	922.0	75.3
55	610.0	47.7	666.9	53.1	740.0	56.3	800.5	59.2	620.9	51.0	943.4	75.5
56	623.4	47.8	682.3	53.2	757.4	56.5	819.8	59.6	635.1	51.1	964.9	75.6
57	636.9	47.9	697.7	53.4	774.7	56.8	839.2	59.9	649.3	51.2	986.3	75.8
58	650.4	48.0	713.1	53.5	792.1	57.0	858.6	60.2	663.5	51.3	1,008	76.0
59	663.9	48.1	728.6	53.7	809.4	57.2	877.9	60.5	677.7	51.4	1,029	76.2
60	677.3	48.2	744.0	53.8	826.8	57.4	897.3	60.8	691.9	51.5	1,051	76.3
61	690.8	48.3	759.4	53.9	844.1	57.6	916.7	61.0	706.1	51.6	1,072	76.5
62	704.3	48.4	774.9	54.1	861.5	57.8	936.0	61.3	720.3	51.7	1,094	76.7
63	717.8	48.5	790.3	54.2	878.8	58.0	955.4	61.6	734.6	51.8	1,115	76.8
64	731.3	48.6	805.8	54.3	896.1	58.1	974.8	61.8	748.8	51.9	1,137	76.9
65	744.7	48.7	821.2	54.4	913.5	58.3	994.2	62.0	763.0	52.0	1,158	77.1
66	758.2	48.7	836.6	54.6	930.8	58.5	1,014	62.3	777.3	52.1	1,179	77.2
67	771.7	48.8	852.1	54.7	948.2	58.7	1,033	62.5	791.5	52.1	1,201	77.3
68	785.2	48.9	867.5	54.8	965.6	58.8	1,052	62.7	805.8	52.2	1,222	77.5
69	798.7	49.0	883.0	54.9	982.9	59.0	1,072	62.9	820.0	52.3	1,244	77.6
70	812.2	49.0	898.4	55.0	1,000	59.1	1,091	63.1	834.3	52.4	1,265	77.7
71	825.6	49.1	913.9	55.1	1,018	59.3	1,110	63.4	848.6	52.4	1,287	77.8
72	839.1	49.2	929.3	55.2	1,035	59.4	1,130	63.5	862.8	52.5	1,308	77.9
73	852.6	49.2	944.8	55.3	1,052	59.5	1,149	63.7	877.1	52.6	1,330	78.1
74	866.1	49.3	960.2	55.4	1,070	59.7	1,168	63.9	891.4	52.6	1,351	78.2
75	879.6	49.4	975.7	55.4	1,087	59.8	1,188	64.1	905.6	52.7	1,373	78.3
76	893.1	49.4	991.2	55.5	1,104	59.9	1,207	64.3	919.9	52.8	1,394	78.4
77	906.6	49.5	1,007	55.6	1,122	60.1	1,227	64.5	934.2	52.8	1,416	78.5
78	920.0	49.5	1,022	55.7	1,139	60.2	1,246	64.6	948.5	52.9	1,437	78.6
79	933.5	49.6	1,038	55.8	1,156	60.3	1,265	64.8	962.8	52.9	1,459	78.7
80	947.0	49.7	1,053	55.9	1,174	60.4	1,285	64.9	977.0	53.0	1,480	78.8
81	960.5	49.7	1,068	55.9	1,191	60.5	1,304	65.1	991.3	53.1	1,501	78.8
82	974.0	49.8	1,084	56.0	1,209	60.6	1,323	65.2	1,006	53.1	1,523	78.9
83	987.5	49.8	1,099	56.1	1,226	60.7	1,343	65.4	1,020	53.2	1,544	79.0
84	1,001	49.9	1,115	56.1	1,243	60.9	1,362	65.5	1,034	53.2	1,566	79.1
85	1,014	49.9	1,130	56.2	1,261	61.0	1,382	65.7	1,048	53.3	1,587	79.2
86	1,028	50.0	1,146	56.3	1,278	61.1	1,401	65.8	1,063	53.3	1,609	79.3
87	1,041	50.0	1,161	56.3	1,295	61.1	1,420	66.0	1,077	53.4	1,630	79.3
88	1,055	50.1	1,177	56.4	1,313	61.2	1,440	66.1	1,091	53.4	1,652	79.4
89	1,068	50.1	1,192	56.5	1,330	61.3	1,459	66.2	1,106	53.5	1,673	79.5
90	1,082	50.1	1,208	56.5	1,347	61.4	1,478	66.3	1,120	53.5	1,695	79.6
91	1,095	50.2	1,223	56.6	1,365	61.5	1,498	66.5	1,134	53.5	1,716	79.6
92	1,109	50.2	1,239	56.7	1,382	61.6	1,517	66.6	1,149	53.6	1,738	79.7
93	1,122	50.3	1,254	56.7	1,400	61.7	1,537	66.7	1,163	53.6	1,759	79.8
94	1,136	50.3	1,270	56.8	1,417	61.8	1,556	66.8	1,177	53.7	1,781	79.8

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Span (ft)	SU4 M (ft*k)	SU4 V (k)	SU5 M (ft*k)	SU5 V (k)	SU6 M (ft*k)	SU6 V (k)	SU7 M (ft*k)	SU7 V (k)	EV2 M (ft*k)	EV2 V (k)	EV3 M (ft*k)	EV3 V (k)
95	1,149	50.3	1,285	56.8	1,434	61.9	1,575	66.9	1,192	53.7	1,802	79.9
96	1,163	50.4	1,301	56.9	1,452	61.9	1,595	67.0	1,206	53.8	1,824	80.0
97	1,176	50.4	1,316	56.9	1,469	62.0	1,614	67.1	1,220	53.8	1,845	80.0
98	1,190	50.5	1,331	57.0	1,486	62.1	1,633	67.2	1,234	53.8	1,867	80.1
99	1,203	50.5	1,347	57.0	1,504	62.2	1,653	67.4	1,249	53.9	1,888	80.1
100	1,217	50.5	1,362	57.1	1,521	62.2	1,672	67.5	1,263	53.9	1,910	80.2
101	1,230	50.6	1,378	57.1	1,538	62.3	1,692	67.6	1,277	53.9	1,931	80.3
102	1,244	50.6	1,393	57.2	1,556	62.4	1,711	67.7	1,292	54.0	1,953	80.3
103	1,257	50.6	1,409	57.2	1,573	62.4	1,730	67.7	1,306	54.0	1,974	80.4
104	1,271	50.7	1,424	57.3	1,591	62.5	1,750	67.8	1,320	54.0	1,996	80.4
105	1,284	50.7	1,440	57.3	1,608	62.6	1,769	67.9	1,335	54.1	2,017	80.5
106	1,298	50.7	1,455	57.4	1,625	62.6	1,788	68.0	1,349	54.1	2,039	80.5
107	1,311	50.8	1,471	57.4	1,643	62.7	1,808	68.1	1,363	54.1	2,060	80.6
108	1,325	50.8	1,486	57.4	1,660	62.8	1,827	68.2	1,378	54.2	2,081	80.6
109	1,338	50.8	1,502	57.5	1,677	62.8	1,847	68.3	1,392	54.2	2,103	80.7
110	1,352	50.8	1,517	57.5	1,695	62.9	1,866	68.4	1,406	54.2	2,124	80.7
111	1,365	50.9	1,533	57.6	1,712	63.0	1,885	68.5	1,421	54.3	2,146	80.8
112	1,379	50.9	1,548	57.6	1,729	63.0	1,905	68.5	1,435	54.3	2,167	80.8
113	1,392	50.9	1,564	57.7	1,747	63.1	1,924	68.6	1,449	54.3	2,189	80.9
114	1,406	51.0	1,579	57.7	1,764	63.1	1,943	68.7	1,464	54.3	2,210	80.9
115	1,419	51.0	1,595	57.7	1,782	63.2	1,963	68.8	1,478	54.4	2,232	81.0
116	1,433	51.0	1,610	57.8	1,799	63.2	1,982	68.8	1,492	54.4	2,253	81.0
117	1,446	51.0	1,626	57.8	1,816	63.3	2,002	68.9	1,507	54.4	2,275	81.0
118	1,460	51.1	1,641	57.8	1,834	63.3	2,021	69.0	1,521	54.5	2,296	81.1
119	1,473	51.1	1,657	57.9	1,851	63.4	2,040	69.1	1,535	54.5	2,318	81.1
120	1,487	51.1	1,672	57.9	1,868	63.4	2,060	69.1	1,550	54.5	2,339	81.2
121	1,500	51.1	1,687	57.9	1,886	63.5	2,079	69.2	1,564	54.5	2,361	81.2
122	1,514	51.2	1,703	58.0	1,903	63.5	2,098	69.3	1,578	54.6	2,382	81.3
123	1,527	51.2	1,718	58.0	1,920	63.6	2,118	69.3	1,593	54.6	2,404	81.3
124	1,541	51.2	1,734	58.0	1,938	63.6	2,137	69.4	1,607	54.6	2,425	81.3
125	1,554	51.2	1,749	58.1	1,955	63.7	2,157	69.5	1,621	54.6	2,447	81.4
126	1,568	51.2	1,765	58.1	1,973	63.7	2,176	69.5	1,636	54.6	2,468	81.4
127	1,581	51.3	1,780	58.1	1,990	63.8	2,195	69.6	1,650	54.7	2,490	81.4
128	1,595	51.3	1,796	58.2	2,007	63.8	2,215	69.7	1,664	54.7	2,511	81.5
129	1,608	51.3	1,811	58.2	2,025	63.9	2,234	69.7	1,679	54.7	2,533	81.5
130	1,622	51.3	1,827	58.2	2,042	63.9	2,253	69.8	1,693	54.7	2,554	81.5
131	1,635	51.3	1,842	58.2	2,059	64.0	2,273	69.8	1,707	54.8	2,576	81.6
132	1,649	51.4	1,858	58.3	2,077	64.0	2,292	69.9	1,722	54.8	2,597	81.6
133	1,662	51.4	1,873	58.3	2,094	64.0	2,312	69.9	1,736	54.8	2,619	81.6
134	1,676	51.4	1,889	58.3	2,112	64.1	2,331	70.0	1,750	54.8	2,640	81.7
135	1,689	51.4	1,904	58.4	2,129	64.1	2,350	70.1	1,765	54.8	2,662	81.7
136	1,703	51.4	1,920	58.4	2,146	64.2	2,370	70.1	1,779	54.9	2,683	81.7
137	1,716	51.5	1,935	58.4	2,164	64.2	2,389	70.2	1,793	54.9	2,705	81.8
138	1,730	51.5	1,951	58.4	2,181	64.2	2,408	70.2	1,808	54.9	2,726	81.8
139	1,743	51.5	1,966	58.5	2,198	64.3	2,428	70.3	1,822	54.9	2,748	81.8

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Simple Span Load Effects Without Impact (spans 140-300 feet) - SHV and EV Vehicles

Span (ft)	SU4 M (ft*k)	SU4 V (k)	SU5 M (ft*k)	SU5 V (k)	SU6 M (ft*k)	SU6 V (k)	SU7 M (ft*k)	SU7 V (k)	EV2 M (ft*k)	EV2 V (k)	EV3 M (ft*k)	EV3 V (k)
140	1,757	51.5	1,982	58.5	2,216	64.3	2,447	70.3	1,837	54.9	2,769	81.9
141	1,770	51.5	1,997	58.5	2,233	64.3	2,467	70.4	1,851	55.0	2,791	81.9
142	1,784	51.6	2,013	58.5	2,250	64.4	2,486	70.4	1,865	55.0	2,812	81.9
143	1,797	51.6	2,028	58.6	2,268	64.4	2,505	70.5	1,880	55.0	2,834	81.9
144	1,811	51.6	2,044	58.6	2,285	64.5	2,525	70.5	1,894	55.0	2,855	82.0
145	1,824	51.6	2,059	58.6	2,303	64.5	2,544	70.6	1,908	55.0	2,877	82.0
146	1,838	51.6	2,075	58.6	2,320	64.5	2,563	70.6	1,923	55.0	2,898	82.0
147	1,851	51.6	2,090	58.7	2,337	64.6	2,583	70.7	1,937	55.1	2,920	82.1
148	1,865	51.7	2,106	58.7	2,355	64.6	2,602	70.7	1,951	55.1	2,941	82.1
149	1,878	51.7	2,121	58.7	2,372	64.6	2,622	70.8	1,966	55.1	2,963	82.1
150	1,892	51.7	2,137	58.7	2,389	64.7	2,641	70.8	1,980	55.1	2,984	82.1
155	1,959	51.8	2,214	58.8	2,476	64.8	2,738	71.0	2,052	55.2	3,092	82.3
160	2,027	51.8	2,292	58.9	2,563	65.0	2,835	71.2	2,124	55.3	3,199	82.4
165	2,094	51.9	2,369	59.0	2,650	65.1	2,931	71.4	2,195	55.3	3,306	82.5
170	2,161	52.0	2,446	59.1	2,737	65.2	3,028	71.6	2,267	55.4	3,414	82.6
175	2,229	52.0	2,524	59.2	2,824	65.4	3,125	71.8	2,339	55.4	3,521	82.7
180	2,296	52.1	2,601	59.3	2,911	65.5	3,222	71.9	2,411	55.5	3,629	82.8
185	2,364	52.1	2,679	59.3	2,997	65.6	3,319	72.1	2,482	55.6	3,736	82.9
190	2,431	52.2	2,756	59.4	3,084	65.7	3,416	72.2	2,554	55.6	3,844	83.0
195	2,499	52.2	2,834	59.5	3,171	65.8	3,513	72.4	2,626	55.7	3,951	83.0
200	2,566	52.3	2,911	59.5	3,258	65.9	3,610	72.5	2,698	55.7	4,059	83.1
205	2,634	52.3	2,989	59.6	3,345	66.0	3,706	72.6	2,770	55.7	4,166	83.2
210	2,701	52.3	3,066	59.7	3,432	66.0	3,803	72.7	2,841	55.8	4,274	83.2
215	2,769	52.4	3,144	59.7	3,519	66.1	3,900	72.8	2,913	55.8	4,381	83.3
220	2,836	52.4	3,221	59.8	3,605	66.2	3,997	72.9	2,985	55.9	4,489	83.4
225	2,904	52.5	3,299	59.8	3,692	66.3	4,094	73.0	3,057	55.9	4,596	83.4
230	2,971	52.5	3,376	59.9	3,779	66.3	4,191	73.1	3,129	55.9	4,704	83.5
235	3,039	52.5	3,454	59.9	3,866	66.4	4,288	73.2	3,201	56.0	4,811	83.5
240	3,106	52.6	3,531	60.0	3,953	66.5	4,385	73.3	3,272	56.0	4,919	83.6
245	3,174	52.6	3,608	60.0	4,040	66.5	4,481	73.4	3,344	56.0	5,026	83.6
250	3,241	52.6	3,686	60.0	4,127	66.6	4,578	73.5	3,416	56.1	5,134	83.7
255	3,309	52.6	3,763	60.1	4,214	66.7	4,675	73.6	3,488	56.1	5,241	83.7
260	3,376	52.7	3,841	60.1	4,300	66.7	4,772	73.6	3,560	56.1	5,349	83.8
265	3,444	52.7	3,918	60.1	4,387	66.8	4,869	73.7	3,632	56.1	5,456	83.8
270	3,511	52.7	3,996	60.2	4,474	66.8	4,966	73.8	3,703	56.2	5,564	83.9
275	3,579	52.7	4,073	60.2	4,561	66.9	5,063	73.9	3,775	56.2	5,671	83.9
280	3,646	52.8	4,151	60.2	4,648	66.9	5,160	73.9	3,847	56.2	5,779	83.9
285	3,714	52.8	4,228	60.3	4,735	67.0	5,256	74.0	3,919	56.2	5,886	84.0
290	3,781	52.8	4,306	60.3	4,822	67.0	5,353	74.0	3,991	56.3	5,994	84.0
295	3,849	52.8	4,383	60.3	4,908	67.0	5,450	74.1	4,063	56.3	6,101	84.0
300	3,916	52.8	4,461	60.4	4,995	67.1	5,547	74.2	4,134	56.3	6,209	84.1

Appendix C: Simple-Span Load Effect Tables (Without Impact) - Michigan Standard Permit Vehicles

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Simple Span Load Effects Without Impact (spans 5-49 feet) - Standard Permit: Class A

Span (ft)	Veh 1 M (ft*k)	Veh 1 V (k)	Veh 2 M (ft*k)	Veh 2 V (k)	Veh 3 M (ft*k)	Veh 3 V (k)	Veh 4 M (ft*k)	Veh 4 V (k)	Veh 5 M (ft*k)	Veh 5 V (k)
5	72	60	72	60	72	60	72	60	72	60
6	90	60	90	60	90	60	90	60	90	60
7	103	60	103	60	103	60	103	60	103	60
8	120	60	120	60	120	60	120	60	120	60
9	133	60	133	60	133	60	133	60	133	60
10	150	60	150	60	150	60	150	60	150	60
11	164	60	164	60	164	60	164	60	164	60
12	180	60	180	60	180	60	180	60	180	65
13	194	60	194	60	194	60	194	60	194	69.2
14	210	60	210	60	210	60	210	60	210	72.9
15	224	60	224	60	224	60	224	64	224	76
16	240	60	240	60	240	60	240	67.5	240	78.8
17	254	60	254	60	254	60	254	70.6	254	81.2
18	270	60	270	60	270	60	270	73.3	270	83.3
19	284	60	284	60	284	60	284	75.8	287	85.3
20	300	60	300	60	300	60	300	78	315	87
21	314	60	314	60	314	62.9	314	80	343	88.6
22	330	60	330	60	330	65.5	330	81.8	371	90
23	344	60	344	60	344	67.8	344	83.5	399	91.3
24	360	60	360	60	360	70	360	85	428	92.5
25	374	60	374	60	374	72	389	86.4	456	93.6
26	390	60	390	62.3	390	73.8	415	87.7	485	94.6
27	404	60	404	64.4	404	75.6	444	88.9	513	95.6
28	420	60	420	66.4	420	77.1	471	90	542	96.4
29	434	60	434	68.3	434	78.6	501	91	571	97.2
30	450	60	450	70	450	80	528	92	600	98
31	465	61.9	465	71.6	465	81.3	557	92.9	629	98.7
32	480	63.8	480	73.1	480	82.5	585	93.8	658	99.4
33	495	65.5	495	74.5	495	83.6	615	94.5	687	100
34	510	67.1	510	75.9	510	84.7	642	95.3	716	101
35	525	68.6	525	77.1	535	85.7	672	96	746	101
36	540	70	540	78.3	563	86.7	700	96.7	775	102
37	555	71.4	555	79.5	590	87.6	730	97.3	804	102
38	570	72.6	570	80.5	619	88.4	758	97.9	834	103
39	585	73.8	585	81.5	646	89.2	788	98.5	863	103
40	600	75	600	82.5	675	90	816	99	893	104
41	615	76.1	615	83.4	702	90.7	846	99.5	922	104
42	630	77.1	630	84.3	731	91.4	874	100	951	104
43	645	78.1	649	85.1	759	92.1	904	100	981	105
44	660	79.1	676	85.9	788	92.7	933	101	1,010	105
45	675	80	704	86.7	816	93.3	963	101	1,040	105
46	690	80.9	732	87.4	845	93.9	991	102	1,070	106
47	705	81.7	760	88.1	873	94.5	1,020	102	1,100	106
48	720	82.5	788	88.8	903	95	1,050	103	1,130	106
49	735	83.3	816	89.4	931	95.5	1,080	103	1,160	107

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Simple Span Load Effects Without Impact (spans 5-49 feet) - Standard Permit: Class A

Span (ft)	Veh 6 M (ft*k)	Veh 6 V (k)	Veh 7 M (ft*k)	Veh 7 V (k)	Veh 8 M (ft*k)	Veh 8 V (k)	Veh 9 M (ft*k)	Veh 9 V (k)	Veh 10 M (ft*k)	Veh 10 V (k)
5	50.4	50.4	57.5	50.6	42.5	37.4	41.3	36.3	36.3	31.9
6	63	56	69	57.5	51	42.5	49.5	41.3	43.5	36.3
7	72	60	80.5	62.4	59.5	46.1	57.8	44.8	50.8	39.4
8	94.5	63	94.9	66.1	70.1	48.9	68.1	47.4	59.8	41.7
9	112	65.3	116	69	85.9	51	83.4	49.5	73.3	43.5
10	134	67.2	138	71.3	102	56.1	99	54.5	87	47.9
11	153	68.7	160	73.2	128	60.3	124	58.5	109	51.4
12	175	70	182	74.8	151	63.8	146	61.9	131	54.4
13	194	71.1	204	76.1	179	66.7	173	64.7	152	56.9
14	216	72	227	77.2	202	69.2	196	67.2	174	60.1
15	235	72.8	249	78.2	230	71.4	223	69.3	196	63.8
16	257	73.5	272	79.1	253	73.3	246	71.2	218	67.1
17	277	76.6	294	80.5	281	75	272	72.8	241	69.9
18	299	79.3	317	82.4	305	76.5	296	74.3	269	72.5
19	318	81.8	340	84.1	332	77.8	322	75.6	298	74.8
20	340	84	362	85.7	356	79.1	345	77.7	326	76.9
21	360	86	385	87.1	383	80.1	371	79.7	355	78.7
22	382	87.8	408	89.4	407	82.2	395	81.5	384	80.4
23	402	89.5	431	91.5	434	84.1	421	83.1	412	82
24	429	91	453	93.4	458	85.9	444	85	441	83.4
25	460	92.4	477	95.2	485	87.4	470	87.1	470	84.7
26	491	93.7	506	96.9	509	89.4	494	89.1	499	86.3
27	523	94.9	535	98.4	536	91.6	520	90.9	527	88.1
28	554	96	564	99.8	560	93.7	545	92.6	556	89.8
29	585	97	592	101	587	95.6	575	94.9	585	91.5
30	616	98	621	102	611	97.4	604	97	614	92.9
31	648	98.9	650	104	638	99.1	634	99	643	95
32	679	99.8	684	105	667	101	663	101	672	96.9
33	710	101	718	106	697	102	693	103	700	98.7
34	741	101	752	107	729	104	723	104	730	100
35	773	102	786	107	759	105	755	106	764	102
36	804	103	821	108	791	106	789	107	798	104
37	835	103	855	109	822	107	823	109	832	106
38	867	104	889	110	856	108	858	110	866	108
39	898	104	923	111	893	109	898	111	901	110
40	929	105	958	111	929	110	937	112	935	112
41	961	106	992	112	967	111	977	113	973	113
42	992	106	1,030	113	1,000	112	1,020	115	1,010	115
43	1,020	106	1,060	113	1,040	113	1,060	116	1,050	116
44	1,050	107	1,090	114	1,080	114	1,090	117	1,090	118
45	1,090	107	1,130	114	1,120	115	1,130	117	1,130	119
46	1,120	108	1,160	115	1,150	116	1,170	118	1,170	120
47	1,150	108	1,200	115	1,190	116	1,210	119	1,210	121
48	1,180	109	1,230	116	1,230	117	1,250	120	1,250	123
49	1,210	109	1,270	116	1,270	118	1,290	121	1,300	124

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Simple Span Load Effects Without Impact (spans 5-49 feet) - Standard Permit: Class A

Span (ft)	Veh 11 M (ft*k)	Veh 11 V (k)	Veh 12 M (ft*k)	Veh 12 V (k)	Veh 13 M (ft*k)	Veh 13 V (k)	Veh 14 M (ft*k)	Veh 14 V (k)	Veh 15 M (ft*k)	Veh 15 V (k)
5	72	60	52.8	52.8	54	54	39.6	39.6	33.6	33.6
6	90	60	66	58.7	67.5	60	49.5	44	42	37.3
7	103	60	75.4	62.9	77.1	64.3	56.6	47.1	48	40
8	120	60	99	66	101	67.5	74.3	49.5	63	42
9	133	60	117	68.4	120	70	88	55	74.7	46.7
10	150	60	141	70.4	144	72	116	59.4	98	50.4
11	164	60	160	72	164	73.6	138	63	117	53.5
12	180	60	183	73.3	188	75	165	66	140	56
13	194	64.6	203	74.5	208	76.2	188	68.5	159	60.3
14	210	68.6	226	76.5	231	77.1	215	70.7	182	64
15	224	72	246	78.2	252	78	238	72.6	202	67.2
16	240	75	270	79.8	276	78.8	264	74.3	231	70
17	254	77.6	290	81.1	296	80.3	287	75.7	257	72.5
18	270	80	313	82.3	320	81.7	314	77	286	74.7
19	284	82.1	333	83.4	341	82.9	337	78.2	312	76.6
20	300	84	359	84.3	365	84	363	79.2	342	78.4
21	320	85.7	385	85.2	386	85	387	80.8	368	80
22	349	87.3	411	86	409	85.9	413	82.2	397	81.5
23	376	88.7	436	86.7	430	86.7	436	83.5	424	82.8
24	405	90	462	87.4	454	87.5	462	84.7	453	84
25	432	91.2	488	88	475	88.2	486	85.8	479	85.7
26	462	92.3	513	88.6	503	88.8	512	86.8	508	87.2
27	489	93.3	539	89.1	528	89.4	535	87.8	535	88.7
28	519	94.3	565	89.6	555	90	561	88.6	564	90
29	546	95.2	590	91	580	90.5	585	89.4	591	91.2
30	576	96	616	93.9	608	91	611	90.2	620	92.4
31	604	96.8	642	96.5	633	91.5	634	90.9	647	93.5
32	634	97.5	667	99	660	91.9	663	91.6	676	94.5
33	662	98.2	693	101	685	92.3	690	92.2	703	95.5
34	692	98.8	719	104	713	92.6	719	92.8	735	96.4
35	720	99.4	744	106	738	95.1	746	93.3	766	97.2
36	750	100	770	108	765	97.5	775	93.9	798	98
37	778	101	796	109	791	99.7	802	94.4	829	98.8
38	808	103	821	112	818	102	831	94.8	861	99.5
39	837	105	847	114	843	104	858	95.6	892	100
40	867	107	873	116	870	106	887	97.4	924	101
41	896	108	898	117	896	108	914	99	955	101
42	926	110	927	119	923	109	943	101	987	102
43	954	112	973	121	948	111	970	104	1,020	103
44	985	113	1,020	122	975	113	999	106	1,050	103
45	1,010	115	1,060	124	1,000	114	1,030	108	1,080	105
46	1,040	116	1,110	125	1,030	116	1,050	110	1,110	107
47	1,070	117	1,160	127	1,050	117	1,080	112	1,140	108
48	1,100	119	1,200	128	1,080	119	1,110	113	1,180	110
49	1,130	120	1,250	129	1,110	121	1,140	115	1,210	112

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Simple Span Load Effects Without Impact (spans 5-49 feet) - Standard Permit: Class A

Span (ft)	Veh 16	Veh 16	Veh 17	Veh 17	Veh 18	Veh 18	Veh 19	Veh 19	Veh 20	Veh 20
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
5	35.1	29.4	32.3	30.1	40.8	40.8	37.1	33.2	35.3	33.5
6	41	32.8	38.7	33.7	51	45.3	44.6	37.5	42.5	37.3
7	50.1	36.1	45.2	36.2	58.3	48.6	52	40.7	49.6	40.1
8	61.4	38.6	56.4	38.2	76.5	51	63.9	43	62.8	42.2
9	77.2	42.1	68.6	41.6	90.7	52.9	78	46.2	76.1	46.4
10	96.2	46.3	85.9	45.2	109	54.4	95.5	50.5	96.6	50.2
11	119	49.8	105	48.1	124	55.6	119	54	118	53.4
12	139	52.7	125	50.5	142	56.7	140	56.9	139	56
13	161	56.2	144	53.6	157	57.5	163	59.4	160	59.9
14	181	60.2	163	57.1	175	58.3	185	61.5	182	63.7
15	204	63.6	183	60.2	190	58.9	208	63.4	203	67
16	230	66.7	205	62.9	208	59.5	230	65	229	69.9
17	259	69.4	230	65.3	224	60.7	252	66.4	256	72.4
18	285	71.8	256	67.4	242	61.7	274	67.7	285	74.7
19	315	73.9	281	69.3	258	62.6	297	68.8	312	76.7
20	341	75.8	307	71	275	64.6	319	69.8	341	78.5
21	370	77.6	332	72.5	291	66.4	341	70.7	368	80.2
22	397	79.1	358	73.9	309	68	363	71.6	397	81.7
23	426	80.6	383	75.2	325	71	386	72.3	424	83.1
24	453	81.9	409	76.3	343	73.7	408	73.2	453	84.3
25	482	83.4	434	77.4	359	76.2	431	74.3	481	85.5
26	509	84.9	463	79	380	78.5	453	76.1	509	86.5
27	538	86.4	495	81.5	399	80.6	475	77.6	537	87.5
28	565	87.7	527	84.2	419	82.6	497	79.2	565	88.4
29	594	89	560	86.6	443	84.4	520	81.6	593	89.3
30	621	90.2	592	88.9	468	86.1	542	83.8	622	90.1
31	651	91.3	624	91	496	87.7	564	85.9	650	90.8
32	681	92.3	658	93	527	89.3	586	87.9	678	91.5
33	711	93.3	695	94.9	560	90.7	609	89.7	706	92.4
34	741	94.2	734	96.6	592	92	631	91.4	735	93.8
35	771	95.1	772	98.3	626	93.6	653	93.1	762	95.2
36	801	95.9	811	99.9	657	95.1	683	94.6	791	96.5
37	831	96.6	848	101	691	96.5	711	96.1	819	97.7
38	861	97.4	888	103	723	97.8	741	97.4	847	98.9
39	891	98.1	925	105	760	99.1	777	98.7	875	100
40	922	98.7	964	106	795	100	814	100	904	101
41	954	99.3	1,000	108	832	101	850	101	932	102
42	984	99.9	1,040	109	868	103	888	102	960	103
43	1,020	101	1,080	111	905	104	924	103	988	104
44	1,050	101	1,120	112	940	105	961	104	1,020	105
45	1,080	102	1,160	113	977	106	997	105	1,040	106
46	1,110	104	1,200	114	1,010	106	1,030	106	1,070	107
47	1,140	106	1,230	116	1,050	107	1,070	107	1,110	108
48	1,170	107	1,270	117	1,090	108	1,110	108	1,140	109
49	1,200	109	1,310	118	1,120	109	1,140	109	1,180	110

MICHIGAN DEPARTMENT OF TRANSPORTATION
BRIDGE ANALYSIS GUIDE

Simple Span Load Effects Without Impact (spans 50-94 feet) - Standard Permit: Class A

Span (ft)	Veh 1 M (ft*k)	Veh 1 V (k)	Veh 2 M (ft*k)	Veh 2 V (k)	Veh 3 M (ft*k)	Veh 3 V (k)	Veh 4 M (ft*k)	Veh 4 V (k)	Veh 5 M (ft*k)	Veh 5 V (k)
50	750	84	844	90	960	96	1,110	103	1,190	107
51	765	84.7	872	90.6	988	96.5	1,140	104	1,220	107
52	789	85.4	900	91.2	1,020	96.9	1,170	104	1,250	107
53	817	86	928	91.7	1,050	97.4	1,200	104	1,280	108
54	844	86.7	957	92.2	1,080	97.8	1,230	104	1,310	108
55	873	87.3	985	92.7	1,100	98.2	1,260	105	1,340	108
56	900	87.9	1,010	93.2	1,130	98.6	1,290	105	1,370	108
57	928	88.4	1,040	93.7	1,160	98.9	1,320	105	1,400	108
58	956	89	1,070	94.1	1,190	99.3	1,340	106	1,430	109
59	984	89.5	1,100	94.6	1,220	99.7	1,370	106	1,460	109
60	1,010	90	1,130	95	1,250	100	1,400	106	1,490	109
61	1,040	90.5	1,160	95.4	1,280	100	1,430	106	1,510	109
62	1,070	91	1,190	95.8	1,310	101	1,460	106	1,540	109
63	1,100	91.4	1,210	96.2	1,340	101	1,490	107	1,570	110
64	1,130	91.9	1,240	96.6	1,370	101	1,520	107	1,600	110
65	1,150	92.3	1,270	96.9	1,400	102	1,550	107	1,630	110
66	1,180	92.7	1,300	97.3	1,430	102	1,580	107	1,660	110
67	1,210	93.1	1,330	97.6	1,450	102	1,610	107	1,690	110
68	1,240	93.5	1,360	97.9	1,480	102	1,640	108	1,720	110
69	1,270	93.9	1,390	98.3	1,510	103	1,670	108	1,750	110
70	1,300	94.3	1,420	98.6	1,540	103	1,700	108	1,780	111
71	1,330	94.6	1,450	98.9	1,570	103	1,730	108	1,810	111
72	1,350	95	1,480	99.2	1,600	103	1,760	108	1,840	111
73	1,380	95.3	1,500	99.5	1,630	104	1,790	108	1,870	111
74	1,410	95.7	1,530	99.7	1,660	104	1,820	109	1,900	111
75	1,440	96	1,560	100	1,690	104	1,850	109	1,930	111
76	1,470	96.3	1,590	100	1,720	104	1,880	109	1,960	111
77	1,500	96.6	1,620	101	1,750	104	1,910	109	1,990	111
78	1,530	96.9	1,650	101	1,780	105	1,940	109	2,020	112
79	1,560	97.2	1,680	101	1,810	105	1,970	109	2,050	112
80	1,580	97.5	1,710	101	1,840	105	2,000	110	2,080	112
81	1,610	97.8	1,740	101	1,870	105	2,030	110	2,110	112
82	1,640	98	1,770	102	1,900	105	2,060	110	2,140	112
83	1,670	98.3	1,800	102	1,930	106	2,090	110	2,170	112
84	1,700	98.6	1,830	102	1,960	106	2,120	110	2,200	112
85	1,730	98.8	1,860	102	1,980	106	2,150	110	2,230	112
86	1,760	99.1	1,880	103	2,010	106	2,180	110	2,260	112
87	1,790	99.3	1,910	103	2,040	106	2,210	110	2,290	112
88	1,820	99.5	1,940	103	2,070	106	2,240	110	2,320	113
89	1,850	99.8	1,970	103	2,100	107	2,270	111	2,350	113
90	1,870	100	2,000	103	2,130	107	2,300	111	2,380	113
91	1,900	100	2,030	104	2,160	107	2,330	111	2,410	113
92	1,930	100	2,060	104	2,190	107	2,360	111	2,440	113
93	1,960	101	2,090	104	2,220	107	2,390	111	2,470	113
94	1,990	101	2,120	104	2,250	107	2,420	111	2,500	113

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Simple Span Load Effects Without Impact (spans 50-94 feet) - Standard Permit: Class A

Span (ft)	Veh 6 M (ft*k)	Veh 6 V (k)	Veh 7 M (ft*k)	Veh 7 V (k)	Veh 8 M (ft*k)	Veh 8 V (k)	Veh 9 M (ft*k)	Veh 9 V (k)	Veh 10 M (ft*k)	Veh 10 V (k)
50	1,240	109	1,300	117	1,300	118	1,330	122	1,340	125
51	1,270	110	1,340	117	1,340	119	1,370	122	1,380	126
52	1,310	110	1,370	117	1,380	119	1,410	123	1,430	127
53	1,340	110	1,400	118	1,410	120	1,450	124	1,470	128
54	1,370	110	1,440	118	1,450	121	1,490	124	1,510	129
55	1,400	111	1,470	119	1,490	121	1,530	125	1,560	129
56	1,430	111	1,510	119	1,530	122	1,570	126	1,600	130
57	1,460	111	1,540	119	1,560	122	1,610	126	1,650	131
58	1,490	112	1,580	120	1,600	123	1,650	127	1,690	132
59	1,530	112	1,610	120	1,640	123	1,690	127	1,730	133
60	1,560	112	1,640	120	1,680	124	1,730	128	1,780	133
61	1,590	112	1,680	120	1,710	124	1,770	128	1,820	134
62	1,620	112	1,710	121	1,750	124	1,810	129	1,870	135
63	1,650	113	1,750	121	1,790	125	1,850	129	1,910	135
64	1,680	113	1,780	121	1,830	125	1,890	130	1,950	136
65	1,710	113	1,820	122	1,860	126	1,920	130	2,000	137
66	1,750	113	1,850	122	1,900	126	1,960	131	2,040	137
67	1,780	113	1,890	122	1,940	126	2,000	131	2,080	138
68	1,810	114	1,920	122	1,980	127	2,040	131	2,130	139
69	1,840	114	1,950	123	2,010	127	2,080	132	2,170	139
70	1,870	114	1,990	123	2,050	127	2,120	132	2,220	140
71	1,900	114	2,020	123	2,090	128	2,160	132	2,260	140
72	1,930	114	2,060	123	2,130	128	2,200	133	2,300	141
73	1,970	114	2,090	123	2,160	128	2,240	133	2,350	141
74	2,000	115	2,130	124	2,200	128	2,280	134	2,390	142
75	2,030	115	2,160	124	2,240	129	2,320	134	2,440	142
76	2,060	115	2,200	124	2,270	129	2,360	134	2,480	143
77	2,090	115	2,230	124	2,310	129	2,400	134	2,520	143
78	2,120	115	2,260	124	2,350	130	2,440	135	2,570	143
79	2,160	115	2,300	124	2,390	130	2,480	135	2,610	144
80	2,190	116	2,330	125	2,420	130	2,520	135	2,660	144
81	2,220	116	2,370	125	2,460	130	2,560	136	2,700	145
82	2,250	116	2,400	125	2,500	131	2,600	136	2,740	145
83	2,280	116	2,440	125	2,540	131	2,640	136	2,790	145
84	2,310	116	2,470	125	2,570	131	2,680	136	2,830	146
85	2,340	116	2,510	125	2,610	131	2,720	137	2,880	146
86	2,380	116	2,540	126	2,650	131	2,760	137	2,920	147
87	2,410	116	2,570	126	2,690	132	2,790	137	2,960	147
88	2,440	116	2,610	126	2,720	132	2,830	137	3,010	147
89	2,470	117	2,640	126	2,760	132	2,870	138	3,050	148
90	2,500	117	2,680	126	2,800	132	2,910	138	3,100	148
91	2,530	117	2,710	126	2,840	132	2,950	138	3,140	148
92	2,560	117	2,750	126	2,870	133	2,990	138	3,180	149
93	2,600	117	2,780	127	2,910	133	3,030	139	3,230	149
94	2,630	117	2,820	127	2,950	133	3,070	139	3,270	149

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Simple Span Load Effects Without Impact (spans 50-94 feet) - Standard Permit: Class A

Span (ft)	Veh 11 M (ft*k)	Veh 11 V (k)	Veh 12 M (ft*k)	Veh 12 V (k)	Veh 13 M (ft*k)	Veh 13 V (k)	Veh 14 M (ft*k)	Veh 14 V (k)	Veh 15 M (ft*k)	Veh 15 V (k)
50	1,160	121	1,300	131	1,130	122	1,170	117	1,240	114
51	1,200	122	1,340	132	1,160	124	1,190	118	1,270	116
52	1,250	123	1,390	133	1,210	125	1,220	120	1,300	118
53	1,290	125	1,440	134	1,260	126	1,250	121	1,330	120
54	1,340	126	1,480	135	1,300	128	1,280	123	1,370	122
55	1,380	127	1,530	136	1,350	129	1,310	125	1,400	124
56	1,430	128	1,580	137	1,400	130	1,330	126	1,430	126
57	1,470	128	1,620	138	1,440	131	1,370	128	1,460	128
58	1,510	129	1,670	139	1,490	132	1,410	129	1,490	129
59	1,560	130	1,720	140	1,540	133	1,450	131	1,520	131
60	1,600	131	1,760	141	1,590	134	1,500	132	1,550	133
61	1,650	132	1,810	141	1,630	135	1,550	133	1,580	134
62	1,690	133	1,860	142	1,680	136	1,600	134	1,620	136
63	1,740	133	1,900	143	1,730	137	1,650	136	1,670	137
64	1,780	134	1,950	144	1,780	138	1,700	137	1,710	139
65	1,830	135	2,000	144	1,820	139	1,760	138	1,760	140
66	1,870	135	2,040	145	1,870	140	1,810	139	1,810	142
67	1,920	136	2,090	146	1,920	141	1,860	140	1,860	143
68	1,960	137	2,140	146	1,970	141	1,910	141	1,910	145
69	2,010	137	2,180	147	2,010	142	1,960	142	1,960	146
70	2,050	138	2,230	148	2,060	143	2,010	143	2,020	147
71	2,100	139	2,280	148	2,110	144	2,060	144	2,070	149
72	2,140	139	2,330	149	2,160	144	2,120	145	2,130	150
73	2,190	140	2,370	149	2,200	145	2,170	146	2,190	151
74	2,230	140	2,420	150	2,250	146	2,220	147	2,250	152
75	2,280	141	2,470	151	2,300	146	2,270	148	2,310	153
76	2,320	141	2,510	151	2,350	147	2,320	149	2,370	155
77	2,370	142	2,560	152	2,400	148	2,380	149	2,420	156
78	2,410	142	2,610	152	2,440	148	2,430	150	2,480	157
79	2,460	143	2,650	153	2,490	149	2,480	151	2,540	158
80	2,500	143	2,700	153	2,540	149	2,530	152	2,600	159
81	2,550	144	2,750	154	2,590	150	2,580	152	2,660	160
82	2,590	144	2,800	154	2,640	151	2,630	153	2,720	161
83	2,630	145	2,840	154	2,680	151	2,690	154	2,780	162
84	2,680	145	2,890	155	2,730	152	2,740	155	2,830	163
85	2,720	145	2,940	155	2,780	152	2,790	155	2,890	163
86	2,770	146	2,990	156	2,830	153	2,840	156	2,950	164
87	2,810	146	3,030	156	2,880	153	2,890	157	3,010	165
88	2,860	147	3,080	157	2,920	154	2,950	157	3,070	166
89	2,900	147	3,130	157	2,970	154	3,000	158	3,130	167
90	2,950	147	3,170	157	3,020	155	3,050	158	3,190	168
91	2,990	148	3,220	158	3,070	155	3,100	159	3,240	168
92	3,040	148	3,270	158	3,120	155	3,150	159	3,300	169
93	3,080	148	3,320	158	3,160	156	3,210	160	3,360	170
94	3,130	149	3,360	159	3,210	156	3,260	161	3,420	171

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Simple Span Load Effects Without Impact (spans 50-94 feet) - Standard Permit: Class A

Span (ft)	Veh 16	Veh 16	Veh 17	Veh 17	Veh 18	Veh 18	Veh 19	Veh 19	Veh 20	Veh 20
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
50	1,230	111	1,350	119	1,160	110	1,180	110	1,210	111
51	1,260	113	1,390	120	1,200	110	1,220	110	1,250	112
52	1,300	114	1,430	121	1,230	111	1,260	111	1,280	112
53	1,330	116	1,470	122	1,270	112	1,300	112	1,320	113
54	1,360	118	1,520	123	1,300	112	1,340	113	1,350	114
55	1,390	120	1,560	123	1,340	113	1,380	113	1,390	114
56	1,420	122	1,600	124	1,380	114	1,420	114	1,430	115
57	1,450	124	1,640	125	1,410	116	1,460	114	1,460	116
58	1,480	126	1,680	126	1,450	117	1,500	115	1,500	116
59	1,510	128	1,730	127	1,490	119	1,540	116	1,530	117
60	1,540	130	1,770	127	1,520	120	1,580	116	1,570	117
61	1,580	131	1,810	128	1,560	122	1,620	117	1,600	118
62	1,610	133	1,850	129	1,600	123	1,660	117	1,640	119
63	1,650	135	1,900	129	1,630	124	1,700	118	1,680	119
64	1,690	136	1,940	130	1,670	125	1,730	119	1,710	120
65	1,740	138	1,980	131	1,710	127	1,770	120	1,750	120
66	1,780	139	2,020	131	1,740	128	1,810	121	1,790	120
67	1,830	141	2,070	132	1,780	129	1,850	122	1,830	121
68	1,880	142	2,110	132	1,820	130	1,890	123	1,860	121
69	1,930	144	2,150	133	1,850	132	1,930	124	1,900	122
70	1,970	145	2,190	133	1,890	133	1,970	125	1,940	124
71	2,030	147	2,240	134	1,930	135	2,010	126	1,980	125
72	2,080	148	2,280	134	1,960	136	2,050	128	2,010	127
73	2,140	149	2,320	135	2,010	138	2,090	129	2,050	128
74	2,200	151	2,360	135	2,060	140	2,130	130	2,090	130
75	2,260	152	2,400	136	2,120	141	2,170	131	2,130	131
76	2,310	153	2,450	137	2,170	143	2,210	132	2,160	133
77	2,370	154	2,490	139	2,220	145	2,250	133	2,200	135
78	2,430	156	2,530	140	2,280	146	2,290	134	2,240	136
79	2,490	157	2,570	142	2,330	148	2,330	135	2,280	138
80	2,550	158	2,620	143	2,380	150	2,370	136	2,310	139
81	2,610	159	2,660	145	2,440	151	2,410	137	2,350	141
82	2,670	160	2,700	146	2,490	153	2,450	138	2,390	142
83	2,730	161	2,740	147	2,540	154	2,490	139	2,430	143
84	2,790	162	2,790	149	2,600	155	2,530	140	2,460	145
85	2,850	163	2,830	150	2,650	157	2,570	141	2,500	146
86	2,910	164	2,870	151	2,710	158	2,610	143	2,540	147
87	2,970	165	2,910	152	2,760	160	2,640	144	2,580	148
88	3,030	166	2,960	154	2,810	161	2,680	146	2,610	150
89	3,090	166	3,000	155	2,870	163	2,720	147	2,650	151
90	3,150	167	3,040	156	2,920	164	2,760	148	2,690	152
91	3,210	168	3,080	157	2,970	165	2,800	150	2,730	153
92	3,270	169	3,130	158	3,040	167	2,840	151	2,780	154
93	3,330	170	3,180	159	3,110	168	2,880	152	2,840	156
94	3,390	171	3,230	160	3,180	169	2,920	154	2,900	157

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Simple Span Load Effects Without Impact (spans 95-139 feet) - Standard Permit: Class A

Span (ft)	Veh 1 M (ft*k)	Veh 1 V (k)	Veh 2 M (ft*k)	Veh 2 V (k)	Veh 3 M (ft*k)	Veh 3 V (k)	Veh 4 M (ft*k)	Veh 4 V (k)	Veh 5 M (ft*k)	Veh 5 V (k)
95	2,020	101	2,150	104	2,280	107	2,450	111	2,530	113
96	2,050	101	2,180	104	2,310	108	2,480	111	2,560	113
97	2,080	101	2,210	105	2,340	108	2,510	111	2,590	113
98	2,110	102	2,240	105	2,370	108	2,530	111	2,620	113
99	2,140	102	2,270	105	2,400	108	2,560	112	2,650	113
100	2,170	102	2,300	105	2,430	108	2,590	112	2,680	113
101	2,200	102	2,330	105	2,460	108	2,620	112	2,710	113
102	2,230	102	2,360	105	2,490	108	2,650	112	2,740	114
103	2,260	103	2,390	105	2,520	108	2,680	112	2,770	114
104	2,280	103	2,420	106	2,550	108	2,710	112	2,800	114
105	2,310	103	2,440	106	2,580	109	2,740	112	2,830	114
106	2,340	103	2,470	106	2,610	109	2,770	112	2,860	114
107	2,370	103	2,500	106	2,640	109	2,800	112	2,890	114
108	2,400	103	2,530	106	2,670	109	2,830	112	2,920	114
109	2,430	103	2,560	106	2,700	109	2,860	112	2,950	114
110	2,460	104	2,590	106	2,730	109	2,890	112	2,980	114
111	2,490	104	2,620	106	2,760	109	2,920	112	3,010	114
112	2,520	104	2,650	107	2,790	109	2,950	113	3,040	114
113	2,550	104	2,680	107	2,820	109	2,980	113	3,070	114
114	2,580	104	2,710	107	2,850	109	3,010	113	3,100	114
115	2,610	104	2,740	107	2,880	110	3,040	113	3,130	114
116	2,640	104	2,770	107	2,910	110	3,070	113	3,160	114
117	2,670	105	2,800	107	2,940	110	3,100	113	3,190	114
118	2,700	105	2,830	107	2,970	110	3,130	113	3,220	114
119	2,730	105	2,860	107	2,990	110	3,160	113	3,250	114
120	2,760	105	2,890	108	3,030	110	3,190	113	3,280	115
121	2,790	105	2,920	108	3,050	110	3,220	113	3,310	115
122	2,820	105	2,950	108	3,080	110	3,250	113	3,340	115
123	2,840	105	2,980	108	3,110	110	3,280	113	3,370	115
124	2,870	105	3,010	108	3,140	110	3,310	113	3,400	115
125	2,900	106	3,040	108	3,170	110	3,340	113	3,430	115
126	2,930	106	3,070	108	3,200	110	3,370	113	3,460	115
127	2,960	106	3,100	108	3,230	111	3,400	113	3,490	115
128	2,990	106	3,130	108	3,260	111	3,430	113	3,520	115
129	3,020	106	3,160	108	3,290	111	3,460	113	3,550	115
130	3,050	106	3,190	108	3,320	111	3,490	114	3,580	115
131	3,080	106	3,220	109	3,350	111	3,520	114	3,610	115
132	3,110	106	3,250	109	3,380	111	3,550	114	3,640	115
133	3,140	106	3,280	109	3,410	111	3,580	114	3,670	115
134	3,170	107	3,300	109	3,440	111	3,610	114	3,700	115
135	3,200	107	3,330	109	3,470	111	3,640	114	3,730	115
136	3,230	107	3,360	109	3,500	111	3,670	114	3,760	115
137	3,260	107	3,390	109	3,530	111	3,700	114	3,790	115
138	3,290	107	3,420	109	3,560	111	3,730	114	3,820	115
139	3,320	107	3,450	109	3,590	111	3,760	114	3,850	115

MICHIGAN DEPARTMENT OF TRANSPORTATION
BRIDGE ANALYSIS GUIDE

Simple Span Load Effects Without Impact (spans 95-139 feet) - Standard Permit: Class A

Span (ft)	Veh 6 M (ft*k)	Veh 6 V (k)	Veh 7 M (ft*k)	Veh 7 V (k)	Veh 8 M (ft*k)	Veh 8 V (k)	Veh 9 M (ft*k)	Veh 9 V (k)	Veh 10 M (ft*k)	Veh 10 V (k)
95	2,660	117	2,850	127	2,990	133	3,110	139	3,320	149
96	2,690	117	2,880	127	3,020	133	3,150	139	3,360	150
97	2,720	117	2,920	127	3,060	133	3,190	139	3,400	150
98	2,750	117	2,950	127	3,100	134	3,230	140	3,450	150
99	2,780	118	2,990	127	3,130	134	3,270	140	3,490	151
100	2,820	118	3,020	127	3,170	134	3,310	140	3,540	151
101	2,850	118	3,060	127	3,210	134	3,350	140	3,580	151
102	2,880	118	3,090	128	3,250	134	3,390	140	3,620	151
103	2,910	118	3,130	128	3,280	134	3,430	141	3,670	152
104	2,940	118	3,160	128	3,320	135	3,470	141	3,710	152
105	2,970	118	3,190	128	3,360	135	3,510	141	3,760	152
106	3,000	118	3,230	128	3,400	135	3,550	141	3,800	152
107	3,040	118	3,260	128	3,430	135	3,590	141	3,850	153
108	3,070	118	3,300	128	3,470	135	3,630	141	3,890	153
109	3,100	118	3,330	128	3,510	135	3,670	142	3,930	153
110	3,130	118	3,370	128	3,550	135	3,700	142	3,980	153
111	3,160	118	3,400	128	3,580	135	3,740	142	4,020	153
112	3,190	119	3,440	128	3,620	136	3,780	142	4,070	154
113	3,230	119	3,470	129	3,660	136	3,820	142	4,110	154
114	3,260	119	3,500	129	3,700	136	3,860	142	4,150	154
115	3,290	119	3,540	129	3,730	136	3,900	142	4,200	154
116	3,320	119	3,570	129	3,770	136	3,940	143	4,240	154
117	3,350	119	3,610	129	3,810	136	3,980	143	4,290	155
118	3,380	119	3,640	129	3,850	136	4,020	143	4,330	155
119	3,410	119	3,680	129	3,880	136	4,060	143	4,370	155
120	3,450	119	3,710	129	3,920	137	4,100	143	4,420	155
121	3,480	119	3,750	129	3,960	137	4,140	143	4,460	155
122	3,510	119	3,780	129	3,990	137	4,180	143	4,510	156
123	3,540	119	3,820	129	4,030	137	4,220	143	4,550	156
124	3,570	119	3,850	129	4,070	137	4,260	144	4,600	156
125	3,600	119	3,880	129	4,110	137	4,300	144	4,640	156
126	3,630	119	3,920	130	4,140	137	4,340	144	4,680	156
127	3,670	119	3,950	130	4,180	137	4,380	144	4,730	156
128	3,700	119	3,990	130	4,220	137	4,420	144	4,770	157
129	3,730	119	4,020	130	4,260	137	4,460	144	4,820	157
130	3,760	120	4,060	130	4,290	138	4,500	144	4,860	157
131	3,790	120	4,090	130	4,330	138	4,540	144	4,900	157
132	3,820	120	4,130	130	4,370	138	4,580	144	4,950	157
133	3,860	120	4,160	130	4,410	138	4,620	145	4,990	157
134	3,890	120	4,190	130	4,440	138	4,650	145	5,040	157
135	3,920	120	4,230	130	4,480	138	4,690	145	5,080	158
136	3,950	120	4,260	130	4,520	138	4,730	145	5,120	158
137	3,980	120	4,300	130	4,560	138	4,770	145	5,170	158
138	4,010	120	4,330	130	4,590	138	4,810	145	5,210	158
139	4,040	120	4,370	130	4,630	138	4,850	145	5,260	158

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Simple Span Load Effects Without Impact (spans 95-139 feet) - Standard Permit: Class A

Span (ft)	Veh 11 M (ft*k)	Veh 11 V (k)	Veh 12 M (ft*k)	Veh 12 V (k)	Veh 13 M (ft*k)	Veh 13 V (k)	Veh 14 M (ft*k)	Veh 14 V (k)	Veh 15 M (ft*k)	Veh 15 V (k)
95	3,170	149	3,410	159	3,260	157	3,310	161	3,480	171
96	3,220	149	3,460	159	3,310	157	3,360	162	3,540	172
97	3,260	150	3,510	160	3,360	157	3,420	162	3,600	173
98	3,310	150	3,550	160	3,410	158	3,470	163	3,660	173
99	3,350	150	3,600	160	3,450	158	3,520	163	3,710	174
100	3,400	151	3,650	161	3,500	159	3,570	164	3,770	175
101	3,440	151	3,690	161	3,550	159	3,620	164	3,830	175
102	3,490	151	3,740	161	3,600	159	3,680	165	3,890	176
103	3,530	151	3,790	161	3,650	160	3,730	165	3,950	176
104	3,580	152	3,840	162	3,690	160	3,780	165	4,010	177
105	3,620	152	3,880	162	3,740	160	3,830	166	4,070	178
106	3,670	152	3,930	162	3,790	161	3,890	166	4,130	178
107	3,710	153	3,980	163	3,840	161	3,940	167	4,190	179
108	3,760	153	4,030	163	3,890	161	3,990	167	4,240	179
109	3,800	153	4,070	163	3,940	162	4,040	168	4,300	180
110	3,850	153	4,120	163	3,980	162	4,100	168	4,360	180
111	3,890	154	4,170	164	4,030	162	4,150	168	4,420	181
112	3,940	154	4,220	164	4,080	162	4,200	169	4,480	181
113	3,980	154	4,260	164	4,130	163	4,250	169	4,540	182
114	4,030	154	4,310	164	4,180	163	4,300	169	4,600	182
115	4,070	154	4,360	165	4,230	163	4,360	170	4,660	183
116	4,120	155	4,410	165	4,270	164	4,410	170	4,720	183
117	4,160	155	4,450	165	4,320	164	4,460	171	4,780	184
118	4,210	155	4,500	165	4,370	164	4,510	171	4,830	184
119	4,250	155	4,550	165	4,420	164	4,570	171	4,890	185
120	4,300	156	4,600	166	4,470	165	4,620	172	4,950	185
121	4,340	156	4,640	166	4,520	165	4,670	172	5,010	186
122	4,390	156	4,690	166	4,560	165	4,720	172	5,070	186
123	4,430	156	4,740	166	4,610	165	4,780	173	5,130	186
124	4,480	156	4,790	166	4,660	166	4,830	173	5,190	187
125	4,520	156	4,830	167	4,710	166	4,880	173	5,250	187
126	4,570	157	4,880	167	4,760	166	4,930	173	5,310	188
127	4,610	157	4,930	167	4,810	166	4,990	174	5,370	188
128	4,660	157	4,980	167	4,860	167	5,040	174	5,430	188
129	4,700	157	5,020	167	4,900	167	5,090	174	5,480	189
130	4,750	157	5,070	168	4,950	167	5,140	175	5,540	189
131	4,790	158	5,120	168	5,000	167	5,200	175	5,600	190
132	4,840	158	5,170	168	5,050	167	5,250	175	5,660	190
133	4,880	158	5,210	168	5,100	168	5,300	175	5,720	190
134	4,930	158	5,260	168	5,150	168	5,350	176	5,780	191
135	4,970	158	5,310	168	5,190	168	5,410	176	5,840	191
136	5,020	158	5,360	169	5,240	168	5,460	176	5,900	191
137	5,060	159	5,400	169	5,290	168	5,510	176	5,960	192
138	5,110	159	5,450	169	5,340	169	5,560	177	6,020	192
139	5,150	159	5,500	169	5,390	169	5,620	177	6,080	192

MICHIGAN DEPARTMENT OF TRANSPORTATION
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Simple Span Load Effects Without Impact (spans 95-139 feet) - Standard Permit: Class A

Span (ft)	Veh 16		Veh 17		Veh 18		Veh 19		Veh 20	
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
95	3,450	171	3,290	161	3,240	170	2,960	155	2,970	158
96	3,510	172	3,350	162	3,320	171	3,000	156	3,030	159
97	3,570	173	3,410	163	3,380	173	3,040	157	3,100	160
98	3,630	174	3,470	164	3,450	174	3,080	158	3,160	161
99	3,690	174	3,530	165	3,520	175	3,120	159	3,220	162
100	3,750	175	3,590	166	3,590	176	3,160	160	3,290	163
101	3,810	176	3,660	167	3,660	177	3,200	161	3,350	164
102	3,870	176	3,730	168	3,730	178	3,250	162	3,420	165
103	3,930	177	3,800	169	3,800	179	3,300	163	3,480	166
104	3,990	178	3,860	170	3,870	180	3,350	164	3,550	167
105	4,050	178	3,930	170	3,940	181	3,410	165	3,610	168
106	4,110	179	4,000	171	4,010	182	3,460	166	3,680	169
107	4,170	180	4,070	172	4,080	183	3,510	167	3,740	170
108	4,230	180	4,130	173	4,150	184	3,570	168	3,810	171
109	4,290	181	4,200	174	4,220	185	3,630	169	3,870	171
110	4,350	181	4,270	174	4,290	186	3,690	170	3,940	172
111	4,420	182	4,340	175	4,360	187	3,750	171	4,000	173
112	4,480	182	4,400	176	4,430	187	3,820	172	4,060	174
113	4,540	183	4,470	177	4,500	188	3,880	173	4,130	175
114	4,600	184	4,540	177	4,570	189	3,950	173	4,190	176
115	4,660	184	4,610	178	4,640	190	4,020	174	4,260	176
116	4,720	185	4,670	179	4,710	191	4,090	175	4,320	177
117	4,780	185	4,740	179	4,780	192	4,160	176	4,390	178
118	4,840	186	4,810	180	4,850	192	4,230	177	4,450	179
119	4,900	186	4,880	181	4,920	193	4,290	177	4,520	179
120	4,960	187	4,940	181	4,990	194	4,360	178	4,580	180
121	5,020	187	5,010	182	5,060	195	4,430	179	4,650	181
122	5,080	188	5,080	183	5,130	195	4,500	180	4,710	181
123	5,140	188	5,150	183	5,200	196	4,570	180	4,780	182
124	5,200	188	5,210	184	5,270	197	4,640	181	4,840	183
125	5,260	189	5,280	184	5,340	197	4,700	182	4,910	183
126	5,320	189	5,350	185	5,410	198	4,770	182	4,970	184
127	5,380	190	5,420	186	5,480	199	4,840	183	5,040	185
128	5,440	190	5,480	186	5,550	199	4,910	184	5,100	185
129	5,500	191	5,550	187	5,620	200	4,980	184	5,170	186
130	5,560	191	5,620	187	5,700	201	5,050	185	5,230	186
131	5,620	191	5,690	188	5,760	201	5,110	186	5,300	187
132	5,680	192	5,760	188	5,840	202	5,180	186	5,370	188
133	5,750	192	5,820	189	5,910	203	5,250	187	5,430	188
134	5,810	193	5,890	190	5,980	203	5,320	187	5,500	189
135	5,870	193	5,960	190	6,050	204	5,390	188	5,560	189
136	5,930	193	6,030	191	6,120	204	5,460	189	5,630	190
137	5,990	194	6,090	191	6,190	205	5,530	189	5,690	190
138	6,050	194	6,160	192	6,260	205	5,590	190	5,760	191
139	6,110	194	6,230	193	6,330	206	5,660	190	5,820	191

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Simple Span Load Effects Without Impact (spans 140-300 feet) - Standard Permit: Class A

Span (ft)	Veh 1 M (ft*k)	Veh 1 V (k)	Veh 2 M (ft*k)	Veh 2 V (k)	Veh 3 M (ft*k)	Veh 3 V (k)	Veh 4 M (ft*k)	Veh 4 V (k)	Veh 5 M (ft*k)	Veh 5 V (k)
140	3,350	107	3,480	109	3,620	111	3,790	114	3,880	115
141	3,380	107	3,510	109	3,650	111	3,820	114	3,910	115
142	3,410	107	3,540	109	3,680	112	3,850	114	3,940	115
143	3,440	107	3,570	110	3,710	112	3,880	114	3,970	115
144	3,470	108	3,600	110	3,740	112	3,910	114	4,000	115
145	3,500	108	3,630	110	3,770	112	3,940	114	4,030	115
146	3,530	108	3,660	110	3,800	112	3,970	114	4,060	115
147	3,560	108	3,690	110	3,830	112	4,000	114	4,090	116
148	3,590	108	3,720	110	3,860	112	4,030	114	4,120	116
149	3,620	108	3,750	110	3,890	112	4,060	114	4,150	116
150	3,640	108	3,780	110	3,920	112	4,090	114	4,180	116
155	3,790	108	3,930	110	4,070	112	4,240	115	4,330	116
160	3,940	109	4,080	111	4,220	113	4,390	115	4,480	116
165	4,090	109	4,230	111	4,370	113	4,540	115	4,630	116
170	4,240	109	4,380	111	4,520	113	4,690	115	4,780	116
175	4,390	110	4,530	111	4,670	113	4,840	115	4,930	116
180	4,540	110	4,680	112	4,820	113	4,990	115	5,080	116
185	4,690	110	4,830	112	4,970	114	5,140	115	5,220	116
190	4,840	111	4,970	112	5,120	114	5,290	116	5,370	117
195	4,980	111	5,120	112	5,270	114	5,440	116	5,520	117
200	5,130	111	5,270	113	5,420	114	5,590	116	5,670	117
205	5,280	111	5,420	113	5,560	114	5,740	116	5,820	117
210	5,430	111	5,570	113	5,710	114	5,890	116	5,970	117
215	5,580	112	5,720	113	5,860	114	6,040	116	6,120	117
220	5,730	112	5,870	113	6,010	115	6,190	116	6,270	117
225	5,880	112	6,020	113	6,160	115	6,340	116	6,420	117
230	6,030	112	6,170	113	6,310	115	6,490	116	6,570	117
235	6,180	112	6,320	114	6,460	115	6,640	116	6,720	117
240	6,330	113	6,470	114	6,610	115	6,790	117	6,870	117
245	6,480	113	6,620	114	6,760	115	6,940	117	7,020	117
250	6,630	113	6,770	114	6,910	115	7,090	117	7,170	117
255	6,780	113	6,920	114	7,060	115	7,240	117	7,320	117
260	6,930	113	7,070	114	7,210	115	7,390	117	7,470	117
265	7,080	113	7,220	114	7,360	115	7,540	117	7,620	118
270	7,220	113	7,370	114	7,510	116	7,690	117	7,770	118
275	7,370	113	7,520	115	7,660	116	7,840	117	7,920	118
280	7,520	114	7,670	115	7,810	116	7,990	117	8,070	118
285	7,670	114	7,820	115	7,960	116	8,140	117	8,220	118
290	7,820	114	7,970	115	8,110	116	8,280	117	8,370	118
295	7,970	114	8,120	115	8,260	116	8,430	117	8,520	118
300	8,120	114	8,270	115	8,410	116	8,580	117	8,670	118

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Simple Span Load Effects Without Impact (spans 140-300 feet) - Standard Permit: Class A

Span (ft)	Veh 6 M (ft*k)	Veh 6 V (k)	Veh 7 M (ft*k)	Veh 7 V (k)	Veh 8 M (ft*k)	Veh 8 V (k)	Veh 9 M (ft*k)	Veh 9 V (k)	Veh 10 M (ft*k)	Veh 10 V (k)
140	4,080	120	4,400	130	4,670	138	4,890	145	5,300	158
141	4,110	120	4,440	130	4,710	138	4,930	145	5,350	158
142	4,140	120	4,470	130	4,740	139	4,970	145	5,390	159
143	4,170	120	4,500	131	4,780	139	5,010	146	5,430	159
144	4,200	120	4,540	131	4,820	139	5,050	146	5,480	159
145	4,230	120	4,570	131	4,850	139	5,090	146	5,520	159
146	4,260	120	4,610	131	4,890	139	5,130	146	5,570	159
147	4,300	120	4,640	131	4,930	139	5,170	146	5,610	159
148	4,330	120	4,680	131	4,970	139	5,210	146	5,650	159
149	4,360	120	4,710	131	5,000	139	5,250	146	5,700	159
150	4,390	120	4,750	131	5,040	139	5,290	146	5,740	160
155	4,550	121	4,920	131	5,230	139	5,490	147	5,960	160
160	4,710	121	5,090	131	5,420	140	5,680	147	6,180	161
165	4,860	121	5,260	132	5,600	140	5,880	147	6,410	161
170	5,020	121	5,440	132	5,790	140	6,080	148	6,630	162
175	5,180	121	5,610	132	5,980	141	6,280	148	6,850	162
180	5,340	121	5,780	132	6,160	141	6,480	148	7,070	162
185	5,490	121	5,950	132	6,350	141	6,670	148	7,290	163
190	5,650	122	6,130	132	6,540	141	6,870	149	7,510	163
195	5,810	122	6,300	133	6,720	142	7,070	149	7,730	164
200	5,970	122	6,470	133	6,910	142	7,270	149	7,950	164
205	6,120	122	6,640	133	7,100	142	7,470	149	8,170	164
210	6,280	122	6,820	133	7,290	142	7,660	150	8,390	164
215	6,440	122	6,990	133	7,470	142	7,860	150	8,610	165
220	6,590	122	7,160	133	7,660	142	8,060	150	8,840	165
225	6,750	122	7,330	133	7,850	143	8,260	150	9,060	165
230	6,910	122	7,510	133	8,030	143	8,460	150	9,280	166
235	7,070	122	7,680	133	8,220	143	8,650	151	9,500	166
240	7,220	123	7,850	134	8,410	143	8,850	151	9,720	166
245	7,380	123	8,020	134	8,590	143	9,050	151	9,940	166
250	7,540	123	8,200	134	8,780	143	9,250	151	10,200	166
255	7,700	123	8,370	134	8,970	143	9,450	151	10,400	167
260	7,850	123	8,540	134	9,160	144	9,640	151	10,600	167
265	8,010	123	8,710	134	9,340	144	9,840	151	10,800	167
270	8,170	123	8,890	134	9,530	144	10,000	152	11,000	167
275	8,330	123	9,060	134	9,720	144	10,200	152	11,300	167
280	8,480	123	9,230	134	9,900	144	10,400	152	11,500	168
285	8,640	123	9,400	134	10,100	144	10,600	152	11,700	168
290	8,800	123	9,570	134	10,300	144	10,800	152	11,900	168
295	8,960	123	9,750	134	10,500	144	11,000	152	12,200	168
300	9,110	123	9,920	134	10,700	144	11,200	152	12,400	168

MICHIGAN DEPARTMENT OF TRANSPORTATION
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Simple Span Load Effects Without Impact (spans 140-300 feet) - Standard Permit: Class A

Span (ft)	Veh 11 M (ft*k)	Veh 11 V (k)	Veh 12 M (ft*k)	Veh 12 V (k)	Veh 13 M (ft*k)	Veh 13 V (k)	Veh 14 M (ft*k)	Veh 14 V (k)	Veh 15 M (ft*k)	Veh 15 V (k)
140	5,200	159	5,550	169	5,440	169	5,670	177	6,140	193
141	5,240	159	5,590	169	5,490	169	5,720	177	6,190	193
142	5,290	159	5,640	169	5,530	169	5,770	178	6,250	193
143	5,330	159	5,690	170	5,580	170	5,830	178	6,310	194
144	5,380	160	5,740	170	5,630	170	5,880	178	6,370	194
145	5,420	160	5,780	170	5,680	170	5,930	178	6,430	194
146	5,470	160	5,830	170	5,730	170	5,980	179	6,490	195
147	5,510	160	5,880	170	5,780	170	6,040	179	6,550	195
148	5,560	160	5,930	170	5,820	170	6,090	179	6,610	195
149	5,600	160	5,970	170	5,870	171	6,140	179	6,670	195
150	5,650	160	6,020	171	5,920	171	6,190	179	6,730	196
155	5,870	161	6,260	171	6,160	171	6,460	180	7,020	197
160	6,100	162	6,500	172	6,410	172	6,720	181	7,320	198
165	6,320	162	6,730	172	6,650	173	6,980	182	7,620	200
170	6,540	163	6,970	173	6,890	174	7,240	183	7,910	201
175	6,770	163	7,210	173	7,140	174	7,510	184	8,210	202
180	6,990	164	7,450	174	7,380	175	7,770	185	8,510	203
185	7,220	164	7,680	174	7,620	175	8,030	185	8,800	204
190	7,440	165	7,920	175	7,860	176	8,300	186	9,100	205
195	7,670	165	8,160	175	8,110	176	8,560	187	9,400	205
200	7,890	165	8,400	176	8,350	177	8,820	187	9,690	206
205	8,120	166	8,640	176	8,590	177	9,090	188	9,990	207
210	8,340	166	8,870	176	8,840	178	9,350	189	10,300	208
215	8,570	166	9,110	177	9,080	178	9,610	189	10,600	209
220	8,790	167	9,350	177	9,320	178	9,880	190	10,900	209
225	9,020	167	9,590	177	9,570	179	10,100	190	11,200	210
230	9,240	167	9,830	178	9,810	179	10,400	191	11,500	210
235	9,470	167	10,100	178	10,100	179	10,700	191	11,800	211
240	9,690	168	10,300	178	10,300	180	10,900	191	12,100	212
245	9,920	168	10,500	178	10,500	180	11,200	192	12,400	212
250	10,100	168	10,800	179	10,800	180	11,500	192	12,700	213
255	10,400	168	11,000	179	11,000	181	11,700	193	13,000	213
260	10,600	169	11,300	179	11,300	181	12,000	193	13,300	214
265	10,800	169	11,500	179	11,500	181	12,200	193	13,600	214
270	11,000	169	11,700	180	11,800	182	12,500	194	13,800	215
275	11,300	169	12,000	180	12,000	182	12,800	194	14,100	215
280	11,500	170	12,200	180	12,200	182	13,000	194	14,400	215
285	11,700	170	12,400	180	12,500	182	13,300	195	14,700	216
290	11,900	170	12,700	180	12,700	182	13,600	195	15,000	216
295	12,200	170	12,900	180	13,000	183	13,800	195	15,300	217
300	12,400	170	13,200	181	13,200	183	14,100	195	15,600	217

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Simple Span Load Effects Without Impact (spans 140-300 feet) - Standard Permit: Class A

Span (ft)	Veh 16 M (ft*k)	Veh 16 V (k)	Veh 17 M (ft*k)	Veh 17 V (k)	Veh 18 M (ft*k)	Veh 18 V (k)	Veh 19 M (ft*k)	Veh 19 V (k)	Veh 20 M (ft*k)	Veh 20 V (k)
140	6,170	195	6,300	193	6,400	207	5,730	191	5,890	192
141	6,230	195	6,370	194	6,470	207	5,800	191	5,950	193
142	6,290	196	6,430	194	6,540	208	5,870	192	6,020	193
143	6,350	196	6,500	195	6,610	208	5,940	192	6,080	194
144	6,410	196	6,570	195	6,680	209	6,000	193	6,150	194
145	6,470	197	6,640	196	6,750	209	6,070	194	6,210	194
146	6,530	197	6,700	196	6,820	210	6,140	194	6,280	195
147	6,590	197	6,770	197	6,890	210	6,210	195	6,340	195
148	6,650	198	6,840	197	6,960	211	6,280	195	6,410	196
149	6,720	198	6,910	198	7,030	211	6,350	196	6,470	196
150	6,780	198	6,970	198	7,100	212	6,420	196	6,540	197
155	7,080	200	7,310	201	7,450	214	6,760	198	6,870	199
160	7,380	201	7,650	203	7,810	216	7,100	200	7,190	201
165	7,690	202	7,990	205	8,160	218	7,450	202	7,520	203
170	7,990	204	8,330	207	8,510	220	7,790	204	7,850	205
175	8,290	205	8,670	209	8,860	222	8,130	206	8,180	206
180	8,600	206	9,010	211	9,210	224	8,480	208	8,500	208
185	8,900	207	9,350	212	9,570	225	8,830	209	8,830	210
190	9,210	208	9,690	214	9,920	227	9,170	211	9,160	211
195	9,510	209	10,000	216	10,300	228	9,520	212	9,490	212
200	9,810	210	10,400	217	10,600	230	9,860	214	9,820	214
205	10,100	211	10,700	218	11,000	231	10,200	215	10,100	215
210	10,400	211	11,000	220	11,300	232	10,600	216	10,500	216
215	10,700	212	11,400	220	11,700	233	10,900	218	10,800	217
220	11,000	213	11,700	221	12,000	234	11,200	219	11,100	218
225	11,300	214	12,100	222	12,400	236	11,600	220	11,500	219
230	11,600	214	12,400	223	12,700	237	11,900	221	11,800	220
235	11,900	215	12,700	224	13,100	238	12,300	222	12,100	221
240	12,300	215	13,100	225	13,500	239	12,600	223	12,500	222
245	12,600	216	13,400	226	13,800	239	13,000	224	12,800	223
250	12,900	217	13,800	227	14,200	240	13,300	225	13,100	224
255	13,200	217	14,100	228	14,500	241	13,700	225	13,400	225
260	13,500	218	14,500	229	14,900	242	14,000	226	13,800	225
265	13,800	218	14,800	230	15,200	243	14,400	227	14,100	226
270	14,100	219	15,100	230	15,600	244	14,700	228	14,400	227
275	14,400	219	15,500	231	15,900	244	15,100	229	14,800	227
280	14,700	220	15,800	232	16,300	245	15,400	230	15,100	228
285	15,000	220	16,200	233	16,600	246	15,700	231	15,400	229
290	15,300	220	16,500	233	17,000	246	16,100	231	15,800	229
295	15,600	221	16,800	234	17,300	247	16,400	232	16,100	230
300	15,900	221	17,200	235	17,700	248	16,800	233	16,400	230

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BRIDGE ANALYSIS GUIDE

Simple Span Load Effects Without Impact (spans 5-49 feet) - Standard Permit: Class B

Span (ft)	Veh 1 M (ft*k)	Veh 1 V (k)	Veh 2 M (ft*k)	Veh 2 V (k)	Veh 3 M (ft*k)	Veh 3 V (k)	Veh 4 M (ft*k)	Veh 4 V (k)	Veh 5 M (ft*k)	Veh 5 V (k)
5	72	60	72	60	70.8	59	64.8	54	62.4	52
6	90	60	90	60	88.5	59	81	54	78	52
7	103	60	103	60	101	59	92.6	54	89.1	52
8	120	60	120	60	118	59	108	54	104	52
9	133	60	133	60	131	59	120	54	116	52
10	150	60	150	60	148	59	135	54	130	52
11	164	60	164	60	161	59	147	54	142	52
12	180	60	180	60	177	59	162	54	156	56.3
13	194	60	194	60	191	59	174	54	168	60
14	210	60	210	60	207	59	189	54	182	63.1
15	224	60	224	60	220	59	202	57.6	194	65.9
16	240	60	240	60	236	59	216	60.8	208	68.3
17	254	60	254	60	250	59	229	63.5	220	70.4
18	270	60	270	60	266	59	243	66	234	72.2
19	284	60	284	60	279	59	256	68.2	249	73.9
20	300	60	300	60	295	59	270	70.2	273	75.4
21	314	60	314	60	309	61.8	283	72	297	76.8
22	330	60	330	60	325	64.4	297	73.6	321	78
23	344	60	344	60	339	66.7	310	75.1	346	79.1
24	360	60	360	60	354	68.8	324	76.5	371	80.2
25	374	60	374	60	368	70.8	350	77.8	395	81.1
26	390	60	390	62.3	384	72.6	374	78.9	420	82
27	404	60	404	64.4	398	74.3	400	80	445	82.8
28	420	60	420	66.4	413	75.9	424	81	470	83.6
29	434	60	434	68.3	427	77.3	451	81.9	495	84.3
30	450	60	450	70	443	78.7	475	82.8	520	84.9
31	465	61.9	465	71.6	457	79.9	502	83.6	545	85.5
32	480	63.8	480	73.1	472	81.1	527	84.4	570	86.1
33	495	65.5	495	74.5	486	82.2	553	85.1	596	86.7
34	510	67.1	510	75.9	502	83.3	578	85.8	621	87.2
35	525	68.6	525	77.1	526	84.3	605	86.4	646	87.7
36	540	70	540	78.3	554	85.2	630	87	672	88.1
37	555	71.4	555	79.5	580	86.1	657	87.6	697	88.5
38	570	72.6	570	80.5	609	86.9	682	88.1	723	88.9
39	585	73.8	585	81.5	635	87.7	709	88.6	748	89.3
40	600	75	600	82.5	664	88.5	734	89.1	774	89.7
41	615	76.1	615	83.4	691	89.2	761	89.6	799	90
42	630	77.1	630	84.3	719	89.9	787	90	825	90.4
43	645	78.1	649	85.1	746	90.6	814	90.4	850	90.7
44	660	79.1	676	85.9	775	91.2	839	90.8	876	91
45	675	80	704	86.7	802	91.8	866	91.2	901	91.3
46	690	80.9	732	87.4	831	92.3	892	91.6	927	91.6
47	705	81.7	760	88.1	859	92.9	919	91.9	953	91.8
48	720	82.5	788	88.8	887	93.4	945	92.3	978	92.1
49	735	83.3	816	89.4	915	93.9	972	92.6	1,000	92.3

MICHIGAN DEPARTMENT OF TRANSPORTATION
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Simple Span Load Effects Without Impact (spans 5-49 feet) - Standard Permit: Class B

Span (ft)	Veh 6 M (ft*k)	Veh 6 V (k)	Veh 7 M (ft*k)	Veh 7 V (k)	Veh 8 M (ft*k)	Veh 8 V (k)	Veh 9 M (ft*k)	Veh 9 V (k)	Veh 10 M (ft*k)	Veh 10 V (k)
5	43.2	43.2	47.5	41.8	36.3	31.9	33.8	29.7	30	26.4
6	54	48	57	47.5	43.5	36.3	40.5	33.8	36	30
7	61.7	51.4	66.5	51.6	50.8	39.4	47.3	36.6	42	32.6
8	81	54	78.4	54.6	59.8	41.7	55.7	38.8	49.5	34.5
9	96	56	96.1	57	73.3	43.5	68.3	40.5	60.7	36
10	115	57.6	114	58.9	87	47.9	81	44.6	72	39.6
11	131	58.9	132	60.5	109	51.4	101	47.9	90	42.5
12	150	60	150	61.8	129	54.4	120	50.6	108	45
13	166	60.9	169	62.8	152	56.9	142	53	126	47.1
14	185	61.7	187	63.8	172	59	161	55	144	49.7
15	202	62.4	206	64.6	196	60.9	182	56.7	162	52.8
16	221	63	224	65.3	216	62.5	201	58.2	180	55.5
17	237	65.6	243	66.5	239	64	223	59.6	199	57.9
18	256	68	262	68.1	260	65.3	242	60.8	223	60
19	273	70.1	281	69.5	283	66.4	263	61.8	246	61.9
20	292	72	299	70.8	303	67.4	282	63.6	270	63.6
21	309	73.7	318	71.9	326	68.4	304	65.2	294	65.1
22	327	75.3	337	73.8	347	70.1	323	66.6	317	66.5
23	344	76.7	356	75.6	370	71.7	344	68	341	67.8
24	368	78	374	77.2	391	73.2	364	69.5	365	69
25	395	79.2	394	78.7	413	74.6	385	71.3	389	70.1
26	421	80.3	418	80	434	76.2	404	72.9	413	71.4
27	448	81.3	442	81.3	457	78.1	425	74.4	436	72.9
28	474	82.3	466	82.4	478	79.9	446	75.8	460	74.4
29	502	83.2	489	83.5	500	81.6	470	77.6	484	75.7
30	528	84	513	84.6	521	83.1	495	79.4	508	76.9
31	555	84.8	537	85.5	544	84.5	519	81	532	78.6
32	582	85.5	565	86.4	569	85.9	543	82.5	556	80.2
33	609	86.2	593	87.2	595	87.1	567	83.9	580	81.7
34	635	86.8	622	88	622	88.3	591	85.3	604	83.1
35	662	87.4	649	88.8	648	89.4	617	86.6	632	84.7
36	689	88	678	89.5	675	90.5	646	87.8	661	86.4
37	716	88.5	706	90.1	701	91.5	673	88.9	689	88
38	743	89.1	735	90.8	730	92.5	702	90	717	89.6
39	770	89.5	763	91.3	762	93.4	735	91	745	91
40	797	90	791	91.9	793	94.2	767	91.9	773	92.4
41	824	90.4	819	92.5	824	95	799	92.9	805	93.7
42	850	90.9	848	93	856	95.8	831	93.7	837	95
43	877	91.3	876	93.5	888	96.5	864	94.6	870	96.2
44	904	91.6	905	93.9	920	97.2	896	95.4	902	97.3
45	931	92	933	94.4	952	97.9	928	96.1	934	98.4
46	958	92.3	961	94.8	984	98.6	960	96.8	966	99.4
47	985	92.7	989	95.2	1,020	99.2	993	97.5	1,000	100
48	1,010	93	1,020	95.6	1,050	99.8	1,020	98.2	1,040	101
49	1,040	93.3	1,050	96	1,080	100	1,060	98.9	1,070	102

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Simple Span Load Effects Without Impact (spans 5-49 feet) - Standard Permit: Class B

Span (ft)	Veh 11 M (ft*k)	Veh 11 V (k)	Veh 12 M (ft*k)	Veh 12 V (k)	Veh 13 M (ft*k)	Veh 13 V (k)	Veh 14 M (ft*k)	Veh 14 V (k)	Veh 15 M (ft*k)	Veh 15 V (k)
5	63.6	53	44.4	44.4	46.8	46.8	33.6	33.6	28.8	28.8
6	79.5	53	55.5	49.3	58.5	52	42	37.3	36	32
7	90.9	53	63.4	52.9	66.9	55.7	48	40	41.1	34.3
8	106	53	83.3	55.5	87.8	58.5	63	42	54	36
9	118	53	98.7	57.6	104	60.7	74.7	46.7	64	40
10	133	53	118	59.2	125	62.4	98	50.4	84	43.2
11	145	53	135	60.5	142	63.8	117	53.5	100	45.8
12	159	53	154	61.7	163	65	140	56	120	48
13	171	57.1	171	62.6	180	66	159	58.2	137	51.7
14	186	60.6	190	64.3	201	66.9	182	60	156	54.9
15	198	63.6	207	65.8	218	67.6	202	61.6	173	57.6
16	212	66.3	227	67.1	239	68.3	224	63	198	60
17	224	68.6	244	68.2	257	69.6	244	64.2	220	62.1
18	239	70.7	263	69.2	277	70.8	266	65.3	245	64
19	251	72.5	280	70.1	296	71.8	286	66.3	268	65.7
20	265	74.2	302	70.9	316	72.8	308	67.2	293	67.2
21	283	75.7	324	71.7	334	73.7	328	68.5	315	68.6
22	308	77.1	345	72.3	355	74.5	350	69.7	340	69.8
23	332	78.3	367	72.9	373	75.2	370	70.9	363	71
24	358	79.5	389	73.5	393	75.8	392	71.9	388	72
25	382	80.6	410	74	412	76.4	412	72.8	411	73.4
26	408	81.5	432	74.5	436	77	434	73.7	436	74.8
27	432	82.4	453	74.9	457	77.5	454	74.5	459	76
28	458	83.3	475	75.3	481	78	476	75.2	483	77.1
29	482	84.1	496	76.6	503	78.4	496	75.9	506	78.2
30	509	84.8	518	78.9	527	78.9	518	76.5	531	79.2
31	533	85.5	539	81.2	549	79.3	538	77.1	554	80.1
32	560	86.1	561	83.3	572	79.6	563	77.7	579	81
33	585	86.7	583	85.2	594	80	586	78.2	602	81.8
34	611	87.3	604	87.1	618	80.3	610	78.7	630	82.6
35	636	87.8	626	88.8	640	82.5	633	79.2	656	83.3
36	663	88.3	648	90.4	663	84.5	658	79.6	684	84
37	688	88.8	669	92	685	86.4	681	80.1	710	84.6
38	714	90.7	691	93.8	709	88.3	705	80.5	738	85.3
39	739	92.4	712	95.5	731	90	728	81.1	764	85.8
40	766	94.1	734	97.1	754	91.7	753	82.6	792	86.4
41	791	95.7	755	98.7	776	93.2	776	84	818	86.9
42	818	97.2	780	100	800	94.7	800	86	846	87.4
43	843	98.6	818	102	822	96.1	823	87.9	872	87.9
44	870	100	857	103	845	97.5	848	89.7	900	88.4
45	895	101	895	104	867	98.8	871	91.5	926	89.6
46	922	103	935	105	891	100	895	93.1	954	91.3
47	947	104	973	107	913	102	918	94.7	980	92.9
48	974	105	1,010	108	936	103	943	96.3	1,010	94.5
49	999	106	1,050	109	958	105	966	97.7	1,030	96

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Simple Span Load Effects Without Impact (spans 5-49 feet) - Standard Permit: Class B

Span (ft)	Veh 16 M (ft*k)	Veh 16 V (k)	Veh 17 M (ft*k)	Veh 17 V (k)	Veh 18 M (ft*k)	Veh 18 V (k)	Veh 19 M (ft*k)	Veh 19 V (k)	Veh 20 M (ft*k)	Veh 20 V (k)
5	29.3	24.5	27.5	25.7	34.8	34.8	31.4	28	30.2	28.6
6	34.1	27.3	33	28.7	43.5	38.7	37.7	31.7	36.3	31.9
7	41.8	30.1	38.5	30.9	49.7	41.4	43.9	34.4	42.4	34.3
8	51.2	32.2	48.1	32.5	65.3	43.5	54	36.3	53.7	36
9	64.4	35.1	58.5	35.4	77.3	45.1	65.9	39	65	39.7
10	80.1	38.6	73.3	38.5	92.8	46.4	80.7	42.7	82.6	43
11	99.5	41.5	89.7	41	105	47.5	100	45.6	101	45.7
12	116	43.9	106	43.1	121	48.3	119	48.1	119	47.9
13	135	46.8	123	45.7	134	49.1	138	50.2	137	51.2
14	151	50.1	139	48.7	149	49.7	156	52	155	54.5
15	170	53	156	51.3	162	50.3	176	53.5	173	57.3
16	192	55.6	175	53.6	178	50.8	194	54.9	196	59.7
17	216	57.8	196	55.6	191	51.7	213	56.1	219	61.9
18	238	59.8	218	57.4	206	52.6	232	57.2	244	63.9
19	262	61.6	239	59.1	220	53.4	251	58.1	267	65.6
20	284	63.2	261	60.5	235	55.1	269	59	291	67.2
21	309	64.6	283	61.8	249	56.6	289	59.8	315	68.6
22	331	65.9	305	63	264	58	307	60.5	339	69.9
23	355	67.1	327	64.1	277	60.5	326	61.1	363	71
24	377	68.3	349	65.1	292	62.8	345	61.8	387	72.1
25	402	69.5	370	66	306	65	364	62.8	411	73.1
26	424	70.8	394	67.3	324	66.9	382	64.3	435	74
27	448	72	422	69.5	340	68.7	402	65.6	459	74.8
28	471	73.1	449	71.8	358	70.4	420	66.9	484	75.6
29	495	74.2	477	73.8	378	72	439	69	507	76.4
30	517	75.2	504	75.8	399	73.5	458	70.8	532	77
31	542	76.1	532	77.6	423	74.8	477	72.6	555	77.7
32	567	76.9	561	79.3	450	76.1	495	74.3	580	78.3
33	592	77.7	593	80.9	478	77.3	514	75.8	604	79
34	617	78.5	626	82.4	505	78.5	533	77.3	628	80.3
35	642	79.2	658	83.8	534	79.8	552	78.6	652	81.4
36	667	79.9	692	85.1	561	81.1	577	79.9	676	82.5
37	692	80.5	723	86.4	589	82.3	601	81.2	700	83.6
38	717	81.1	757	87.7	617	83.4	626	82.3	725	84.5
39	743	81.7	789	89.2	648	84.5	656	83.5	748	85.5
40	768	82.3	822	90.5	678	85.6	688	84.5	773	86.4
41	795	82.8	854	91.9	710	86.5	718	85.5	797	87.2
42	820	83.3	888	93.1	740	87.5	750	86.5	821	88.2
43	847	83.8	920	94.3	772	88.3	781	87.4	845	89.1
44	872	84.2	954	95.4	802	89.2	812	88.2	869	90
45	898	85.4	986	96.5	833	90	843	89.1	893	90.9
46	924	86.7	1,020	97.6	864	90.8	875	89.9	918	91.7
47	950	88	1,050	98.6	896	91.5	905	90.6	947	92.5
48	976	89.2	1,080	99.5	926	92.2	937	91.3	978	93.3
49	1,000	90.6	1,120	100	958	92.9	967	92	1,010	94

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Simple Span Load Effects Without Impact (spans 50-94 feet) - Standard Permit: Class B

Span (ft)	Veh 1 M (ft*k)	Veh 1 V (k)	Veh 2 M (ft*k)	Veh 2 V (k)	Veh 3 M (ft*k)	Veh 3 V (k)	Veh 4 M (ft*k)	Veh 4 V (k)	Veh 5 M (ft*k)	Veh 5 V (k)
50	750	84	844	90	944	94.4	998	92.9	1,030	92.6
51	765	84.7	872	90.6	972	94.9	1,020	93.2	1,060	92.8
52	789	85.4	900	91.2	1,000	95.3	1,050	93.5	1,080	93
53	817	86	928	91.7	1,030	95.7	1,080	93.7	1,110	93.2
54	844	86.7	957	92.2	1,060	96.1	1,100	94	1,130	93.4
55	873	87.3	985	92.7	1,090	96.5	1,130	94.3	1,160	93.6
56	900	87.9	1,010	93.2	1,110	96.9	1,160	94.5	1,180	93.8
57	928	88.4	1,040	93.7	1,140	97.3	1,180	94.7	1,210	94
58	956	89	1,070	94.1	1,170	97.7	1,210	95	1,240	94.1
59	984	89.5	1,100	94.6	1,200	98	1,240	95.2	1,260	94.3
60	1,010	90	1,130	95	1,230	98.3	1,260	95.4	1,290	94.5
61	1,040	90.5	1,160	95.4	1,260	98.7	1,290	95.6	1,310	94.6
62	1,070	91	1,190	95.8	1,290	99	1,320	95.8	1,340	94.8
63	1,100	91.4	1,210	96.2	1,310	99.3	1,340	96	1,360	94.9
64	1,130	91.9	1,240	96.6	1,340	99.6	1,370	96.2	1,390	95.1
65	1,150	92.3	1,270	96.9	1,370	99.8	1,400	96.4	1,420	95.2
66	1,180	92.7	1,300	97.3	1,400	100	1,420	96.5	1,440	95.3
67	1,210	93.1	1,330	97.6	1,430	100	1,450	96.7	1,470	95.5
68	1,240	93.5	1,360	97.9	1,460	101	1,480	96.9	1,490	95.6
69	1,270	93.9	1,390	98.3	1,490	101	1,500	97	1,520	95.7
70	1,300	94.3	1,420	98.6	1,520	101	1,530	97.2	1,550	95.8
71	1,330	94.6	1,450	98.9	1,550	101	1,560	97.4	1,570	95.9
72	1,350	95	1,480	99.2	1,570	102	1,580	97.5	1,600	96.1
73	1,380	95.3	1,500	99.5	1,600	102	1,610	97.6	1,620	96.2
74	1,410	95.7	1,530	99.7	1,630	102	1,640	97.8	1,650	96.3
75	1,440	96	1,560	100	1,660	102	1,660	97.9	1,670	96.4
76	1,470	96.3	1,590	100	1,690	102	1,690	98.1	1,700	96.5
77	1,500	96.6	1,620	101	1,720	103	1,720	98.2	1,730	96.6
78	1,530	96.9	1,650	101	1,750	103	1,740	98.3	1,750	96.7
79	1,560	97.2	1,680	101	1,780	103	1,770	98.4	1,780	96.8
80	1,580	97.5	1,710	101	1,810	103	1,800	98.6	1,800	96.9
81	1,610	97.8	1,740	101	1,840	103	1,830	98.7	1,830	96.9
82	1,640	98	1,770	102	1,860	104	1,850	98.8	1,860	97
83	1,670	98.3	1,800	102	1,890	104	1,880	98.9	1,880	97.1
84	1,700	98.6	1,830	102	1,920	104	1,910	99	1,910	97.2
85	1,730	98.8	1,860	102	1,950	104	1,930	99.1	1,930	97.3
86	1,760	99.1	1,880	103	1,980	104	1,960	99.2	1,960	97.3
87	1,790	99.3	1,910	103	2,010	104	1,990	99.3	1,980	97.4
88	1,820	99.5	1,940	103	2,040	105	2,010	99.4	2,010	97.5
89	1,850	99.8	1,970	103	2,070	105	2,040	99.5	2,040	97.6
90	1,870	100	2,000	103	2,100	105	2,070	99.6	2,060	97.6
91	1,900	100	2,030	104	2,130	105	2,090	99.7	2,090	97.7
92	1,930	100	2,060	104	2,160	105	2,120	99.8	2,110	97.8
93	1,960	101	2,090	104	2,180	105	2,150	99.9	2,140	97.8
94	1,990	101	2,120	104	2,210	105	2,170	100	2,170	97.9

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Simple Span Load Effects Without Impact (spans 50-94 feet) - Standard Permit: Class B

Span (ft)	Veh 6 M (ft*k)	Veh 6 V (k)	Veh 7 M (ft*k)	Veh 7 V (k)	Veh 8 M (ft*k)	Veh 8 V (k)	Veh 9 M (ft*k)	Veh 9 V (k)	Veh 10 M (ft*k)	Veh 10 V (k)
50	1,070	93.6	1,070	96.3	1,110	101	1,090	99.5	1,110	103
51	1,090	93.9	1,100	96.7	1,140	101	1,120	100	1,140	104
52	1,120	94.2	1,130	97	1,170	102	1,150	101	1,180	105
53	1,150	94.4	1,160	97.3	1,210	102	1,190	101	1,220	106
54	1,170	94.7	1,190	97.6	1,240	103	1,220	102	1,250	106
55	1,200	94.9	1,220	97.9	1,270	103	1,250	102	1,290	107
56	1,230	95.1	1,250	98.2	1,300	104	1,280	103	1,330	108
57	1,250	95.4	1,270	98.5	1,330	104	1,320	103	1,360	109
58	1,280	95.6	1,300	98.8	1,370	105	1,350	104	1,400	109
59	1,310	95.8	1,330	99	1,400	105	1,380	104	1,430	110
60	1,340	96	1,360	99.3	1,430	105	1,410	104	1,470	110
61	1,360	96.2	1,390	99.5	1,460	106	1,450	105	1,510	111
62	1,390	96.4	1,420	99.8	1,490	106	1,480	105	1,540	112
63	1,420	96.6	1,440	100	1,530	106	1,510	106	1,580	112
64	1,440	96.8	1,470	100	1,560	107	1,540	106	1,620	113
65	1,470	96.9	1,500	100	1,590	107	1,570	106	1,650	113
66	1,500	97.1	1,530	101	1,620	107	1,610	107	1,690	114
67	1,520	97.3	1,560	101	1,650	108	1,640	107	1,720	114
68	1,550	97.4	1,590	101	1,690	108	1,670	107	1,760	115
69	1,580	97.6	1,610	101	1,720	108	1,700	108	1,800	115
70	1,600	97.7	1,640	101	1,750	109	1,740	108	1,830	116
71	1,630	97.9	1,670	102	1,780	109	1,770	108	1,870	116
72	1,660	98	1,700	102	1,810	109	1,800	109	1,910	116
73	1,690	98.1	1,730	102	1,840	109	1,830	109	1,940	117
74	1,710	98.3	1,760	102	1,880	110	1,870	109	1,980	117
75	1,740	98.4	1,790	102	1,910	110	1,900	110	2,020	118
76	1,770	98.5	1,810	102	1,940	110	1,930	110	2,050	118
77	1,790	98.6	1,840	103	1,970	110	1,960	110	2,090	118
78	1,820	98.8	1,870	103	2,000	110	2,000	110	2,130	119
79	1,850	98.9	1,900	103	2,040	111	2,030	111	2,160	119
80	1,870	99	1,930	103	2,070	111	2,060	111	2,200	119
81	1,900	99.1	1,960	103	2,100	111	2,090	111	2,230	120
82	1,930	99.2	1,980	103	2,130	111	2,120	111	2,270	120
83	1,960	99.3	2,010	103	2,160	112	2,160	111	2,310	120
84	1,980	99.4	2,040	103	2,200	112	2,190	112	2,340	121
85	2,010	99.5	2,070	104	2,230	112	2,220	112	2,380	121
86	2,040	99.6	2,100	104	2,260	112	2,250	112	2,420	121
87	2,060	99.7	2,130	104	2,290	112	2,290	112	2,450	122
88	2,090	99.8	2,160	104	2,320	112	2,320	112	2,490	122
89	2,120	99.9	2,180	104	2,350	113	2,350	113	2,530	122
90	2,140	100	2,210	104	2,390	113	2,380	113	2,560	122
91	2,170	100	2,240	104	2,420	113	2,420	113	2,600	123
92	2,200	100	2,270	104	2,450	113	2,450	113	2,640	123
93	2,230	100	2,300	105	2,480	113	2,480	113	2,670	123
94	2,250	100	2,330	105	2,510	113	2,510	114	2,710	123

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Simple Span Load Effects Without Impact (spans 50-94 feet) - Standard Permit: Class B

Span (ft)	Veh 11	Veh 11	Veh 12	Veh 12	Veh 13	Veh 13	Veh 14	Veh 14	Veh 15	Veh 15
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
50	1,030	107	1,090	110	982	106	990	99.1	1,060	97.9
51	1,060	108	1,130	111	1,010	107	1,010	100	1,090	99.8
52	1,100	109	1,170	112	1,050	108	1,040	102	1,120	102
53	1,140	110	1,210	113	1,090	109	1,060	103	1,140	103
54	1,180	111	1,250	114	1,130	111	1,090	104	1,170	105
55	1,220	112	1,290	114	1,170	112	1,110	106	1,200	106
56	1,260	113	1,320	115	1,210	113	1,130	107	1,220	108
57	1,300	113	1,360	116	1,250	114	1,160	108	1,250	109
58	1,340	114	1,400	117	1,290	115	1,190	110	1,280	111
59	1,380	115	1,440	117	1,330	115	1,230	111	1,300	112
60	1,420	116	1,480	118	1,370	116	1,270	112	1,330	114
61	1,460	116	1,520	119	1,420	117	1,320	113	1,360	115
62	1,500	117	1,560	120	1,460	118	1,360	114	1,390	116
63	1,540	118	1,600	120	1,500	119	1,400	115	1,430	118
64	1,580	118	1,640	121	1,540	120	1,450	116	1,470	119
65	1,610	119	1,680	121	1,580	120	1,490	117	1,510	120
66	1,650	120	1,720	122	1,620	121	1,530	118	1,550	122
67	1,690	120	1,760	123	1,660	122	1,580	119	1,590	123
68	1,730	121	1,800	123	1,700	123	1,620	120	1,640	124
69	1,770	121	1,840	124	1,750	123	1,660	121	1,680	125
70	1,810	122	1,880	124	1,790	124	1,710	122	1,730	126
71	1,850	122	1,920	125	1,830	125	1,750	122	1,780	127
72	1,890	123	1,960	125	1,870	125	1,800	123	1,830	129
73	1,930	123	1,990	126	1,910	126	1,840	124	1,880	130
74	1,970	124	2,030	126	1,950	126	1,880	125	1,930	131
75	2,010	124	2,070	127	1,990	127	1,930	125	1,980	132
76	2,050	125	2,110	127	2,040	127	1,970	126	2,030	132
77	2,090	125	2,150	127	2,080	128	2,020	127	2,080	133
78	2,130	126	2,190	128	2,120	129	2,060	127	2,130	134
79	2,170	126	2,230	128	2,160	129	2,100	128	2,180	135
80	2,210	127	2,270	129	2,200	130	2,150	129	2,230	136
81	2,250	127	2,310	129	2,240	130	2,190	129	2,280	137
82	2,290	127	2,350	130	2,280	130	2,240	130	2,330	138
83	2,330	128	2,390	130	2,330	131	2,280	131	2,380	139
84	2,370	128	2,430	130	2,370	131	2,320	131	2,430	139
85	2,410	128	2,470	131	2,410	132	2,370	132	2,480	140
86	2,450	129	2,510	131	2,450	132	2,410	132	2,530	141
87	2,490	129	2,550	131	2,490	133	2,460	133	2,580	142
88	2,530	129	2,590	132	2,530	133	2,500	133	2,630	142
89	2,570	130	2,630	132	2,580	134	2,540	134	2,680	143
90	2,610	130	2,670	132	2,620	134	2,590	134	2,730	144
91	2,640	130	2,710	133	2,660	134	2,630	135	2,780	144
92	2,680	131	2,750	133	2,700	135	2,680	135	2,830	145
93	2,720	131	2,790	133	2,740	135	2,720	136	2,880	146
94	2,760	131	2,830	133	2,780	135	2,770	136	2,930	146

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Span (ft)	Veh 16		Veh 17		Veh 18		Veh 19		Veh 20	
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
50	1,030	92.2	1,150	101	988	93.6	999	92.7	1,040	94.7
51	1,050	93.8	1,180	102	1,020	94.2	1,030	93.3	1,070	95.4
52	1,080	95.3	1,220	103	1,050	94.8	1,070	94	1,100	96
53	1,110	96.9	1,260	104	1,080	95.4	1,100	94.6	1,130	96.6
54	1,130	98.6	1,290	105	1,110	96	1,130	95.1	1,160	97.2
55	1,160	100	1,330	105	1,140	96.5	1,170	95.7	1,190	97.8
56	1,180	102	1,360	106	1,180	97.4	1,200	96.2	1,220	98.4
57	1,210	104	1,400	107	1,210	98.7	1,230	96.7	1,250	98.9
58	1,230	105	1,440	107	1,240	100	1,270	97.2	1,280	99.4
59	1,260	107	1,470	108	1,270	101	1,300	97.7	1,310	99.9
60	1,290	108	1,510	109	1,300	102	1,330	98.2	1,340	100
61	1,310	110	1,540	109	1,330	104	1,370	98.6	1,370	101
62	1,340	111	1,580	110	1,360	105	1,400	99.1	1,400	101
63	1,380	112	1,620	110	1,390	106	1,430	99.7	1,430	102
64	1,410	113	1,650	111	1,420	107	1,470	100	1,460	102
65	1,450	115	1,690	111	1,460	108	1,500	101	1,500	103
66	1,480	116	1,730	112	1,490	109	1,530	102	1,530	103
67	1,520	117	1,760	112	1,520	110	1,570	103	1,560	103
68	1,560	119	1,800	113	1,550	111	1,600	104	1,590	104
69	1,600	120	1,830	113	1,580	112	1,630	105	1,620	105
70	1,650	121	1,870	114	1,610	114	1,670	106	1,660	106
71	1,690	122	1,910	114	1,640	115	1,700	107	1,690	107
72	1,730	123	1,940	115	1,670	116	1,730	108	1,720	108
73	1,780	125	1,980	115	1,710	118	1,770	109	1,750	110
74	1,830	126	2,010	115	1,760	119	1,800	110	1,790	111
75	1,880	127	2,050	116	1,800	121	1,830	111	1,820	112
76	1,930	128	2,090	117	1,850	122	1,870	111	1,850	114
77	1,980	129	2,120	118	1,900	124	1,900	112	1,880	115
78	2,030	130	2,160	119	1,940	125	1,930	113	1,910	116
79	2,080	131	2,200	121	1,990	126	1,970	114	1,950	118
80	2,130	131	2,230	122	2,030	128	2,000	115	1,980	119
81	2,180	132	2,270	123	2,080	129	2,030	116	2,010	120
82	2,230	133	2,300	124	2,120	130	2,070	117	2,040	121
83	2,280	134	2,340	126	2,170	131	2,100	118	2,070	123
84	2,330	135	2,380	127	2,220	133	2,130	119	2,110	124
85	2,380	136	2,410	128	2,260	134	2,170	120	2,140	125
86	2,430	136	2,450	129	2,310	135	2,200	121	2,170	126
87	2,480	137	2,480	130	2,350	136	2,230	122	2,200	127
88	2,530	138	2,520	131	2,400	138	2,270	123	2,240	128
89	2,580	139	2,560	132	2,450	139	2,300	124	2,270	129
90	2,630	139	2,590	133	2,490	140	2,340	125	2,300	130
91	2,680	140	2,630	134	2,540	141	2,370	127	2,330	131
92	2,730	141	2,660	135	2,590	142	2,400	128	2,380	132
93	2,780	142	2,710	136	2,650	143	2,440	129	2,430	133
94	2,830	142	2,760	137	2,710	144	2,470	130	2,480	134

MICHIGAN DEPARTMENT OF TRANSPORTATION
BRIDGE ANALYSIS GUIDE

Simple Span Load Effects Without Impact (spans 95-139 feet) - Standard Permit: Class B

Span (ft)	Veh 1 M (ft*k)	Veh 1 V (k)	Veh 2 M (ft*k)	Veh 2 V (k)	Veh 3 M (ft*k)	Veh 3 V (k)	Veh 4 M (ft*k)	Veh 4 V (k)	Veh 5 M (ft*k)	Veh 5 V (k)
95	2,020	101	2,150	104	2,240	106	2,200	100	2,190	98
96	2,050	101	2,180	104	2,270	106	2,230	100	2,220	98
97	2,080	101	2,210	105	2,300	106	2,250	100	2,240	98.1
98	2,110	102	2,240	105	2,330	106	2,280	100	2,270	98.2
99	2,140	102	2,270	105	2,360	106	2,310	100	2,300	98.2
100	2,170	102	2,300	105	2,390	106	2,330	100	2,320	98.3
101	2,200	102	2,330	105	2,420	106	2,360	101	2,350	98.3
102	2,230	102	2,360	105	2,450	106	2,390	101	2,370	98.4
103	2,260	103	2,390	105	2,480	107	2,420	101	2,400	98.4
104	2,280	103	2,420	106	2,510	107	2,440	101	2,430	98.5
105	2,310	103	2,440	106	2,540	107	2,470	101	2,450	98.6
106	2,340	103	2,470	106	2,560	107	2,500	101	2,480	98.6
107	2,370	103	2,500	106	2,590	107	2,520	101	2,500	98.7
108	2,400	103	2,530	106	2,620	107	2,550	101	2,530	98.7
109	2,430	103	2,560	106	2,650	107	2,580	101	2,560	98.8
110	2,460	104	2,590	106	2,680	107	2,600	101	2,580	98.8
111	2,490	104	2,620	106	2,710	107	2,630	101	2,610	98.8
112	2,520	104	2,650	107	2,740	107	2,660	101	2,630	98.9
113	2,550	104	2,680	107	2,770	108	2,680	101	2,660	98.9
114	2,580	104	2,710	107	2,800	108	2,710	101	2,680	99
115	2,610	104	2,740	107	2,830	108	2,740	101	2,710	99
116	2,640	104	2,770	107	2,860	108	2,770	101	2,740	99.1
117	2,670	105	2,800	107	2,890	108	2,790	102	2,760	99.1
118	2,700	105	2,830	107	2,920	108	2,820	102	2,790	99.2
119	2,730	105	2,860	107	2,950	108	2,850	102	2,810	99.2
120	2,760	105	2,890	108	2,970	108	2,870	102	2,840	99.2
121	2,790	105	2,920	108	3,000	108	2,900	102	2,870	99.3
122	2,820	105	2,950	108	3,030	108	2,930	102	2,890	99.3
123	2,840	105	2,980	108	3,060	108	2,950	102	2,920	99.3
124	2,870	105	3,010	108	3,090	108	2,980	102	2,940	99.4
125	2,900	106	3,040	108	3,120	109	3,010	102	2,970	99.4
126	2,930	106	3,070	108	3,150	109	3,030	102	3,000	99.5
127	2,960	106	3,100	108	3,180	109	3,060	102	3,020	99.5
128	2,990	106	3,130	108	3,210	109	3,090	102	3,050	99.5
129	3,020	106	3,160	108	3,240	109	3,120	102	3,070	99.6
130	3,050	106	3,190	108	3,270	109	3,140	102	3,100	99.6
131	3,080	106	3,220	109	3,300	109	3,170	102	3,130	99.6
132	3,110	106	3,250	109	3,330	109	3,200	102	3,150	99.7
133	3,140	106	3,280	109	3,360	109	3,220	102	3,180	99.7
134	3,170	107	3,300	109	3,390	109	3,250	102	3,200	99.7
135	3,200	107	3,330	109	3,410	109	3,280	102	3,230	99.8
136	3,230	107	3,360	109	3,440	109	3,300	102	3,260	99.8
137	3,260	107	3,390	109	3,470	109	3,330	102	3,280	99.8
138	3,290	107	3,420	109	3,500	109	3,360	103	3,310	99.9
139	3,320	107	3,450	109	3,530	110	3,380	103	3,330	99.9

MICHIGAN DEPARTMENT OF TRANSPORTATION
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Simple Span Load Effects Without Impact (spans 95-139 feet) - Standard Permit: Class B

Span (ft)	Veh 6 M (ft*k)	Veh 6 V (k)	Veh 7 M (ft*k)	Veh 7 V (k)	Veh 8 M (ft*k)	Veh 8 V (k)	Veh 9 M (ft*k)	Veh 9 V (k)	Veh 10 M (ft*k)	Veh 10 V (k)
95	2,280	100	2,350	105	2,550	114	2,550	114	2,740	124
96	2,310	101	2,380	105	2,580	114	2,580	114	2,780	124
97	2,330	101	2,410	105	2,610	114	2,610	114	2,820	124
98	2,360	101	2,440	105	2,640	114	2,640	114	2,850	124
99	2,390	101	2,470	105	2,670	114	2,680	114	2,890	125
100	2,410	101	2,500	105	2,710	114	2,710	115	2,930	125
101	2,440	101	2,530	105	2,740	114	2,740	115	2,960	125
102	2,470	101	2,550	105	2,770	115	2,770	115	3,000	125
103	2,490	101	2,580	105	2,800	115	2,800	115	3,040	125
104	2,520	101	2,610	106	2,830	115	2,840	115	3,070	126
105	2,550	101	2,640	106	2,870	115	2,870	115	3,110	126
106	2,580	101	2,670	106	2,900	115	2,900	115	3,150	126
107	2,600	101	2,700	106	2,930	115	2,930	116	3,180	126
108	2,630	101	2,720	106	2,960	115	2,970	116	3,220	126
109	2,660	101	2,750	106	2,990	115	3,000	116	3,260	127
110	2,680	101	2,780	106	3,020	115	3,030	116	3,290	127
111	2,710	102	2,810	106	3,060	116	3,060	116	3,330	127
112	2,740	102	2,840	106	3,090	116	3,100	116	3,360	127
113	2,760	102	2,870	106	3,120	116	3,130	116	3,400	127
114	2,790	102	2,900	106	3,150	116	3,160	116	3,440	127
115	2,820	102	2,920	106	3,180	116	3,190	116	3,470	128
116	2,850	102	2,950	106	3,220	116	3,230	117	3,510	128
117	2,870	102	2,980	106	3,250	116	3,260	117	3,550	128
118	2,900	102	3,010	107	3,280	116	3,290	117	3,580	128
119	2,930	102	3,040	107	3,310	116	3,320	117	3,620	128
120	2,950	102	3,070	107	3,340	116	3,360	117	3,660	128
121	2,980	102	3,090	107	3,380	117	3,390	117	3,690	129
122	3,010	102	3,120	107	3,410	117	3,420	117	3,730	129
123	3,030	102	3,150	107	3,440	117	3,450	117	3,770	129
124	3,060	102	3,180	107	3,470	117	3,480	117	3,800	129
125	3,090	102	3,210	107	3,500	117	3,520	118	3,840	129
126	3,120	102	3,240	107	3,530	117	3,550	118	3,880	129
127	3,140	102	3,270	107	3,570	117	3,580	118	3,910	129
128	3,170	102	3,290	107	3,600	117	3,610	118	3,950	130
129	3,200	102	3,320	107	3,630	117	3,650	118	3,990	130
130	3,220	102	3,350	107	3,660	117	3,680	118	4,020	130
131	3,250	103	3,380	107	3,690	117	3,710	118	4,060	130
132	3,280	103	3,410	107	3,730	117	3,740	118	4,100	130
133	3,300	103	3,440	107	3,760	118	3,780	118	4,130	130
134	3,330	103	3,460	107	3,790	118	3,810	118	4,170	130
135	3,360	103	3,490	107	3,820	118	3,840	118	4,200	130
136	3,390	103	3,520	108	3,850	118	3,870	119	4,240	131
137	3,410	103	3,550	108	3,890	118	3,910	119	4,280	131
138	3,440	103	3,580	108	3,920	118	3,940	119	4,310	131
139	3,470	103	3,610	108	3,950	118	3,970	119	4,350	131

MICHIGAN DEPARTMENT OF TRANSPORTATION
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Simple Span Load Effects Without Impact (spans 95-139 feet) - Standard Permit: Class B

Span (ft)	Veh 11	Veh 11	Veh 12	Veh 12	Veh 13	Veh 13	Veh 14	Veh 14	Veh 15	Veh 15
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
95	2,800	132	2,870	134	2,830	136	2,810	137	2,980	147
96	2,840	132	2,910	134	2,870	136	2,850	137	3,030	147
97	2,880	132	2,950	134	2,910	136	2,900	138	3,080	148
98	2,920	133	2,990	135	2,950	137	2,940	138	3,130	149
99	2,960	133	3,030	135	2,990	137	2,990	138	3,180	149
100	3,000	133	3,070	135	3,030	137	3,030	139	3,230	150
101	3,040	133	3,110	135	3,080	138	3,080	139	3,280	150
102	3,080	134	3,150	136	3,120	138	3,120	140	3,340	151
103	3,120	134	3,190	136	3,160	138	3,160	140	3,390	151
104	3,160	134	3,230	136	3,200	139	3,210	140	3,440	152
105	3,200	134	3,270	136	3,240	139	3,250	141	3,490	152
106	3,240	135	3,310	136	3,290	139	3,300	141	3,540	153
107	3,280	135	3,350	137	3,330	139	3,340	141	3,590	153
108	3,320	135	3,390	137	3,370	140	3,390	142	3,640	154
109	3,360	135	3,430	137	3,410	140	3,430	142	3,690	154
110	3,400	135	3,470	137	3,450	140	3,470	142	3,740	155
111	3,440	136	3,510	138	3,500	141	3,520	143	3,790	155
112	3,480	136	3,550	138	3,540	141	3,560	143	3,840	155
113	3,520	136	3,590	138	3,580	141	3,610	143	3,890	156
114	3,560	136	3,630	138	3,620	141	3,650	144	3,940	156
115	3,600	136	3,660	138	3,660	142	3,700	144	3,990	157
116	3,640	137	3,700	139	3,700	142	3,740	144	4,040	157
117	3,680	137	3,740	139	3,750	142	3,790	145	4,090	158
118	3,720	137	3,780	139	3,790	142	3,830	145	4,140	158
119	3,760	137	3,820	139	3,830	142	3,870	145	4,190	158
120	3,800	137	3,860	139	3,870	143	3,920	146	4,250	159
121	3,840	138	3,900	139	3,910	143	3,960	146	4,300	159
122	3,880	138	3,940	140	3,960	143	4,010	146	4,350	159
123	3,910	138	3,980	140	4,000	143	4,050	146	4,400	160
124	3,950	138	4,020	140	4,040	144	4,100	147	4,450	160
125	3,990	138	4,060	140	4,080	144	4,140	147	4,500	161
126	4,030	138	4,100	140	4,120	144	4,190	147	4,550	161
127	4,070	139	4,140	140	4,170	144	4,230	147	4,600	161
128	4,110	139	4,180	141	4,210	144	4,270	148	4,650	162
129	4,150	139	4,220	141	4,250	145	4,320	148	4,700	162
130	4,190	139	4,260	141	4,290	145	4,360	148	4,750	162
131	4,230	139	4,300	141	4,330	145	4,410	148	4,800	163
132	4,270	139	4,340	141	4,380	145	4,450	149	4,850	163
133	4,310	139	4,380	141	4,420	145	4,500	149	4,900	163
134	4,350	140	4,420	141	4,460	145	4,540	149	4,950	163
135	4,390	140	4,460	142	4,500	146	4,590	149	5,010	164
136	4,430	140	4,500	142	4,540	146	4,630	150	5,060	164
137	4,470	140	4,540	142	4,590	146	4,680	150	5,110	164
138	4,510	140	4,580	142	4,630	146	4,720	150	5,160	165
139	4,550	140	4,620	142	4,670	146	4,760	150	5,210	165

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Simple Span Load Effects Without Impact (spans 95-139 feet) - Standard Permit: Class B

Span (ft)	Veh 16 M (ft*k)	Veh 16 V (k)	Veh 17 M (ft*k)	Veh 17 V (k)	Veh 18 M (ft*k)	Veh 18 V (k)	Veh 19 M (ft*k)	Veh 19 V (k)	Veh 20 M (ft*k)	Veh 20 V (k)
95	2,880	143	2,800	137	2,770	145	2,500	131	2,540	135
96	2,930	143	2,850	138	2,830	146	2,540	132	2,590	136
97	2,980	144	2,900	139	2,890	147	2,570	133	2,650	137
98	3,030	145	2,960	140	2,950	148	2,600	134	2,700	138
99	3,080	145	3,010	141	3,010	149	2,640	135	2,760	139
100	3,130	146	3,070	142	3,070	150	2,670	135	2,810	140
101	3,180	146	3,120	142	3,120	151	2,710	136	2,870	140
102	3,230	147	3,180	143	3,180	152	2,750	137	2,920	141
103	3,280	148	3,240	144	3,240	153	2,790	138	2,980	142
104	3,330	148	3,290	145	3,300	154	2,830	139	3,030	143
105	3,380	149	3,350	145	3,360	154	2,880	140	3,090	144
106	3,430	149	3,410	146	3,420	155	2,920	141	3,140	144
107	3,480	150	3,470	147	3,480	156	2,970	141	3,200	145
108	3,530	150	3,520	147	3,540	157	3,020	142	3,250	146
109	3,580	151	3,580	148	3,600	158	3,070	143	3,310	147
110	3,630	151	3,640	149	3,660	158	3,120	144	3,370	147
111	3,680	152	3,700	149	3,720	159	3,170	144	3,420	148
112	3,730	152	3,750	150	3,780	160	3,230	145	3,480	149
113	3,780	153	3,810	151	3,840	161	3,280	146	3,530	149
114	3,830	153	3,870	151	3,900	161	3,340	147	3,590	150
115	3,880	153	3,930	152	3,960	162	3,400	147	3,640	151
116	3,930	154	3,990	152	4,020	163	3,460	148	3,700	151
117	3,980	154	4,040	153	4,080	163	3,510	149	3,750	152
118	4,030	155	4,100	154	4,140	164	3,570	149	3,810	153
119	4,080	155	4,160	154	4,200	165	3,630	150	3,860	153
120	4,130	155	4,220	155	4,260	165	3,690	151	3,920	154
121	4,180	156	4,270	155	4,320	166	3,740	151	3,980	155
122	4,230	156	4,330	156	4,380	167	3,800	152	4,030	155
123	4,280	157	4,390	156	4,440	167	3,860	152	4,090	156
124	4,330	157	4,450	157	4,500	168	3,920	153	4,140	156
125	4,380	157	4,500	157	4,560	168	3,980	154	4,200	157
126	4,430	158	4,560	158	4,620	169	4,030	154	4,250	157
127	4,490	158	4,620	158	4,680	170	4,090	155	4,310	158
128	4,540	159	4,680	159	4,740	170	4,150	155	4,370	158
129	4,590	159	4,740	159	4,800	171	4,210	156	4,420	159
130	4,640	159	4,790	160	4,860	171	4,260	156	4,480	159
131	4,690	160	4,850	160	4,920	172	4,320	157	4,530	160
132	4,740	160	4,910	161	4,980	172	4,380	157	4,590	160
133	4,790	160	4,970	161	5,040	173	4,440	158	4,640	161
134	4,840	161	5,020	162	5,100	173	4,500	158	4,700	161
135	4,890	161	5,080	162	5,160	174	4,550	159	4,760	162
136	4,940	161	5,140	163	5,220	174	4,610	159	4,810	162
137	4,990	161	5,200	163	5,280	175	4,670	160	4,870	163
138	5,040	162	5,250	164	5,340	175	4,730	160	4,920	163
139	5,090	162	5,310	164	5,400	176	4,790	161	4,980	164

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Simple Span Load Effects Without Impact (spans 140-300 feet) - Standard Permit: Class B

Span (ft)	Veh 1 M (ft*k)	Veh 1 V (k)	Veh 2 M (ft*k)	Veh 2 V (k)	Veh 3 M (ft*k)	Veh 3 V (k)	Veh 4 M (ft*k)	Veh 4 V (k)	Veh 5 M (ft*k)	Veh 5 V (k)
140	3,350	107	3,480	109	3,560	110	3,410	103	3,360	99.9
141	3,380	107	3,510	109	3,590	110	3,440	103	3,390	99.9
142	3,410	107	3,540	109	3,620	110	3,470	103	3,410	100
143	3,440	107	3,570	110	3,650	110	3,490	103	3,440	100
144	3,470	108	3,600	110	3,680	110	3,520	103	3,460	100
145	3,500	108	3,630	110	3,710	110	3,550	103	3,490	100
146	3,530	108	3,660	110	3,740	110	3,570	103	3,520	100
147	3,560	108	3,690	110	3,770	110	3,600	103	3,540	100
148	3,590	108	3,720	110	3,800	110	3,630	103	3,570	100
149	3,620	108	3,750	110	3,830	110	3,650	103	3,590	100
150	3,640	108	3,780	110	3,850	110	3,680	103	3,620	100
155	3,790	108	3,930	110	4,000	110	3,820	103	3,750	100
160	3,940	109	4,080	111	4,150	111	3,950	103	3,880	100
165	4,090	109	4,230	111	4,300	111	4,090	103	4,010	101
170	4,240	109	4,380	111	4,440	111	4,220	104	4,140	101
175	4,390	110	4,530	111	4,590	111	4,350	104	4,270	101
180	4,540	110	4,680	112	4,740	111	4,490	104	4,400	101
185	4,690	110	4,830	112	4,880	112	4,620	104	4,530	101
190	4,840	111	4,970	112	5,030	112	4,760	104	4,660	101
195	4,980	111	5,120	112	5,180	112	4,890	104	4,790	101
200	5,130	111	5,270	113	5,320	112	5,030	104	4,920	101
205	5,280	111	5,420	113	5,470	112	5,160	104	5,050	101
210	5,430	111	5,570	113	5,620	112	5,300	104	5,180	101
215	5,580	112	5,720	113	5,770	113	5,430	104	5,310	101
220	5,730	112	5,870	113	5,910	113	5,570	105	5,440	101
225	5,880	112	6,020	113	6,060	113	5,700	105	5,570	101
230	6,030	112	6,170	113	6,210	113	5,840	105	5,700	102
235	6,180	112	6,320	114	6,350	113	5,970	105	5,830	102
240	6,330	113	6,470	114	6,500	113	6,110	105	5,960	102
245	6,480	113	6,620	114	6,650	113	6,240	105	6,090	102
250	6,630	113	6,770	114	6,800	113	6,380	105	6,220	102
255	6,780	113	6,920	114	6,940	113	6,510	105	6,350	102
260	6,930	113	7,070	114	7,090	113	6,650	105	6,480	102
265	7,080	113	7,220	114	7,240	114	6,780	105	6,610	102
270	7,220	113	7,370	114	7,390	114	6,920	105	6,740	102
275	7,370	113	7,520	115	7,530	114	7,050	105	6,870	102
280	7,520	114	7,670	115	7,680	114	7,190	105	7,000	102
285	7,670	114	7,820	115	7,830	114	7,320	105	7,130	102
290	7,820	114	7,970	115	7,980	114	7,460	105	7,260	102
295	7,970	114	8,120	115	8,120	114	7,590	105	7,390	102
300	8,120	114	8,270	115	8,270	114	7,730	105	7,520	102

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Simple Span Load Effects Without Impact (spans 140-300 feet) - Standard Permit: Class B

Span (ft)	Veh 6 M (ft*k)	Veh 6 V (k)	Veh 7 M (ft*k)	Veh 7 V (k)	Veh 8 M (ft*k)	Veh 8 V (k)	Veh 9 M (ft*k)	Veh 9 V (k)	Veh 10 M (ft*k)	Veh 10 V (k)
140	3,490	103	3,640	108	3,980	118	4,000	119	4,390	131
141	3,520	103	3,660	108	4,010	118	4,040	119	4,420	131
142	3,550	103	3,690	108	4,050	118	4,070	119	4,460	131
143	3,570	103	3,720	108	4,080	118	4,100	119	4,500	131
144	3,600	103	3,750	108	4,110	118	4,130	119	4,530	131
145	3,630	103	3,780	108	4,140	118	4,160	119	4,570	132
146	3,660	103	3,810	108	4,170	118	4,200	119	4,610	132
147	3,680	103	3,840	108	4,200	119	4,230	119	4,640	132
148	3,710	103	3,860	108	4,240	119	4,260	119	4,680	132
149	3,740	103	3,890	108	4,270	119	4,290	119	4,720	132
150	3,760	103	3,920	108	4,300	119	4,330	120	4,750	132
155	3,900	103	4,060	108	4,460	119	4,490	120	4,940	132
160	4,030	104	4,210	108	4,620	119	4,650	120	5,120	133
165	4,170	104	4,350	109	4,780	120	4,810	120	5,300	133
170	4,300	104	4,490	109	4,940	120	4,970	121	5,480	134
175	4,440	104	4,630	109	5,100	120	5,140	121	5,670	134
180	4,570	104	4,780	109	5,260	120	5,300	121	5,850	134
185	4,710	104	4,920	109	5,420	120	5,460	121	6,030	135
190	4,840	104	5,060	109	5,580	121	5,620	122	6,220	135
195	4,980	104	5,200	109	5,740	121	5,780	122	6,400	135
200	5,110	104	5,350	110	5,900	121	5,950	122	6,580	136
205	5,250	104	5,490	110	6,050	121	6,110	122	6,760	136
210	5,380	105	5,630	110	6,210	121	6,270	122	6,950	136
215	5,520	105	5,770	110	6,370	121	6,430	123	7,130	136
220	5,650	105	5,920	110	6,530	122	6,590	123	7,310	137
225	5,790	105	6,060	110	6,690	122	6,760	123	7,500	137
230	5,920	105	6,200	110	6,850	122	6,920	123	7,680	137
235	6,060	105	6,340	110	7,010	122	7,080	123	7,860	137
240	6,190	105	6,480	110	7,170	122	7,240	123	8,040	137
245	6,330	105	6,630	110	7,330	122	7,400	123	8,230	138
250	6,460	105	6,770	110	7,490	122	7,570	124	8,410	138
255	6,600	105	6,910	111	7,650	122	7,730	124	8,590	138
260	6,730	105	7,050	111	7,810	122	7,890	124	8,780	138
265	6,870	105	7,200	111	7,970	123	8,050	124	8,960	138
270	7,000	105	7,340	111	8,130	123	8,210	124	9,140	138
275	7,140	105	7,480	111	8,290	123	8,380	124	9,330	139
280	7,270	105	7,620	111	8,450	123	8,540	124	9,510	139
285	7,410	105	7,770	111	8,610	123	8,700	124	9,690	139
290	7,540	106	7,910	111	8,770	123	8,860	124	9,870	139
295	7,680	106	8,050	111	8,930	123	9,020	124	10,100	139
300	7,810	106	8,190	111	9,090	123	9,190	125	10,200	139

MICHIGAN DEPARTMENT OF TRANSPORTATION
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Simple Span Load Effects Without Impact (spans 140-300 feet) - Standard Permit: Class B

Span (ft)	Veh 11 M (ft*k)	Veh 11 V (k)	Veh 12 M (ft*k)	Veh 12 V (k)	Veh 13 M (ft*k)	Veh 13 V (k)	Veh 14 M (ft*k)	Veh 14 V (k)	Veh 15 M (ft*k)	Veh 15 V (k)
140	4,590	140	4,660	142	4,710	146	4,810	150	5,260	165
141	4,630	141	4,700	142	4,750	147	4,850	151	5,310	165
142	4,670	141	4,740	143	4,800	147	4,900	151	5,360	166
143	4,710	141	4,780	143	4,840	147	4,940	151	5,410	166
144	4,750	141	4,820	143	4,880	147	4,990	151	5,460	166
145	4,790	141	4,860	143	4,920	147	5,030	151	5,510	167
146	4,830	141	4,900	143	4,960	147	5,080	152	5,560	167
147	4,870	141	4,940	143	5,010	148	5,120	152	5,610	167
148	4,910	141	4,980	143	5,050	148	5,170	152	5,660	167
149	4,950	142	5,020	143	5,090	148	5,210	152	5,720	168
150	4,990	142	5,060	143	5,130	148	5,250	152	5,770	168
155	5,190	142	5,260	144	5,340	149	5,480	153	6,020	169
160	5,380	143	5,460	145	5,550	149	5,700	154	6,270	170
165	5,580	143	5,660	145	5,760	150	5,920	155	6,530	171
170	5,780	144	5,860	145	5,970	150	6,150	155	6,780	172
175	5,980	144	6,060	146	6,180	151	6,370	156	7,040	173
180	6,180	145	6,260	146	6,390	151	6,590	157	7,290	174
185	6,380	145	6,460	147	6,610	152	6,820	157	7,540	175
190	6,580	145	6,660	147	6,820	152	7,040	158	7,800	175
195	6,770	146	6,860	147	7,030	153	7,260	158	8,050	176
200	6,970	146	7,060	148	7,240	153	7,490	159	8,310	177
205	7,170	146	7,260	148	7,450	154	7,710	160	8,560	177
210	7,370	147	7,460	148	7,660	154	7,930	160	8,820	178
215	7,570	147	7,660	149	7,870	154	8,160	160	9,070	179
220	7,770	147	7,860	149	8,080	155	8,380	161	9,320	179
225	7,970	147	8,060	149	8,290	155	8,600	161	9,580	180
230	8,170	148	8,260	149	8,500	155	8,830	162	9,830	180
235	8,360	148	8,460	150	8,710	156	9,050	162	10,100	181
240	8,560	148	8,660	150	8,920	156	9,270	162	10,300	181
245	8,760	148	8,860	150	9,130	156	9,500	163	10,600	182
250	8,960	149	9,060	150	9,350	156	9,720	163	10,900	182
255	9,160	149	9,260	150	9,560	157	9,950	163	11,100	183
260	9,360	149	9,460	151	9,770	157	10,200	164	11,400	183
265	9,560	149	9,660	151	9,980	157	10,400	164	11,600	183
270	9,750	149	9,860	151	10,200	157	10,600	164	11,900	184
275	9,950	150	10,100	151	10,400	158	10,800	165	12,100	184
280	10,200	150	10,300	151	10,600	158	11,100	165	12,400	185
285	10,400	150	10,500	151	10,800	158	11,300	165	12,600	185
290	10,500	150	10,700	152	11,000	158	11,500	165	12,900	185
295	10,700	150	10,900	152	11,200	158	11,700	166	13,100	186
300	10,900	150	11,100	152	11,500	158	12,000	166	13,400	186

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Simple Span Load Effects Without Impact (spans 140-300 feet) - Standard Permit: Class B

Span (ft)	Veh 16 M (ft*k)	Veh 16 V (k)	Veh 17 M (ft*k)	Veh 17 V (k)	Veh 18 M (ft*k)	Veh 18 V (k)	Veh 19 M (ft*k)	Veh 19 V (k)	Veh 20 M (ft*k)	Veh 20 V (k)
140	5,140	162	5,370	165	5,460	176	4,840	161	5,030	164
141	5,190	163	5,430	165	5,520	177	4,900	162	5,090	165
142	5,240	163	5,490	166	5,580	177	4,960	162	5,150	165
143	5,290	163	5,540	166	5,640	178	5,020	163	5,200	165
144	5,340	164	5,600	167	5,700	178	5,070	163	5,260	166
145	5,390	164	5,660	167	5,760	178	5,130	164	5,310	166
146	5,440	164	5,720	167	5,820	179	5,190	164	5,370	167
147	5,500	164	5,770	168	5,880	179	5,250	164	5,420	167
148	5,550	165	5,830	168	5,940	180	5,310	165	5,480	168
149	5,600	165	5,890	169	6,000	180	5,360	165	5,540	168
150	5,650	165	5,950	169	6,060	181	5,420	166	5,590	168
155	5,900	166	6,240	171	6,360	183	5,710	168	5,870	170
160	6,150	168	6,530	173	6,660	184	6,000	169	6,150	172
165	6,410	169	6,820	175	6,960	186	6,290	171	6,430	174
170	6,660	170	7,100	177	7,260	188	6,580	173	6,710	175
175	6,910	171	7,390	178	7,560	189	6,870	174	6,990	177
180	7,170	172	7,680	180	7,860	191	7,170	176	7,270	178
185	7,420	172	7,970	181	8,160	192	7,460	177	7,550	179
190	7,670	173	8,260	183	8,460	193	7,750	178	7,830	180
195	7,930	174	8,550	184	8,760	195	8,040	180	8,120	182
200	8,180	175	8,840	185	9,060	196	8,340	181	8,400	183
205	8,430	175	9,130	186	9,360	197	8,630	182	8,680	184
210	8,690	176	9,420	187	9,670	198	8,920	183	8,960	185
215	8,940	177	9,710	187	9,970	199	9,210	184	9,240	186
220	9,190	177	10,000	188	10,300	200	9,500	185	9,520	187
225	9,450	178	10,300	189	10,600	201	9,800	186	9,810	187
230	9,700	179	10,600	190	10,900	202	10,100	187	10,100	188
235	9,960	179	10,900	191	11,200	203	10,400	187	10,400	189
240	10,200	180	11,200	192	11,500	203	10,700	188	10,700	190
245	10,500	180	11,500	193	11,800	204	11,000	189	10,900	191
250	10,700	181	11,700	194	12,100	205	11,300	190	11,200	191
255	11,000	181	12,000	194	12,400	206	11,500	190	11,500	192
260	11,200	181	12,300	195	12,700	206	11,800	191	11,800	193
265	11,500	182	12,600	196	13,000	207	12,100	192	12,100	193
270	11,700	182	12,900	196	13,300	208	12,400	193	12,300	194
275	12,000	183	13,200	197	13,600	208	12,700	193	12,600	194
280	12,200	183	13,500	198	13,900	209	13,000	194	12,900	195
285	12,500	183	13,800	198	14,200	210	13,300	195	13,200	196
290	12,700	184	14,100	199	14,500	210	13,600	196	13,500	196
295	13,000	184	14,400	200	14,800	211	13,900	196	13,800	197
300	13,300	184	14,600	200	15,100	211	14,200	197	14,000	197

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Simple Span Load Effects Without Impact (spans 5-49 feet) - Standard Permit: Class C

Span (ft)	Veh 1 M (ft*k)	Veh 1 V (k)	Veh 2 M (ft*k)	Veh 2 V (k)	Veh 3 M (ft*k)	Veh 3 V (k)	Veh 4 M (ft*k)	Veh 4 V (k)	Veh 5 M (ft*k)	Veh 5 V (k)
5	72	60	72	60	68.4	57	58.8	49	52.8	44
6	90	60	90	60	85.5	57	73.5	49	66	44
7	103	60	103	60	97.7	57	84	49	75.4	44
8	120	60	120	60	114	57	98	49	88	44
9	133	60	133	60	127	57	109	49	97.8	44
10	150	60	150	60	143	57	123	49	110	44
11	164	60	164	60	155	57	134	49	120	44
12	180	60	180	60	171	57	147	49	132	47.7
13	194	60	194	60	184	57	158	49	142	50.8
14	210	60	210	60	200	57	172	49	154	53.4
15	224	60	224	60	213	57	183	52.3	164	55.7
16	240	60	240	60	228	57	196	55.1	176	57.8
17	254	60	254	60	241	57	208	57.6	186	59.5
18	270	60	270	60	257	57	221	59.9	198	61.1
19	284	60	284	60	270	57	232	61.9	211	62.5
20	300	60	300	60	285	57	245	63.7	231	63.8
21	314	60	314	60	299	59.7	257	65.3	251	65
22	330	60	330	60	314	62.2	270	66.8	272	66
23	344	60	344	60	327	64.4	281	68.2	293	67
24	360	60	360	60	342	66.5	294	69.4	314	67.8
25	374	60	374	60	356	68.4	318	70.6	334	68.6
26	390	60	390	62.3	371	70.2	339	71.6	355	69.4
27	404	60	404	64.4	384	71.8	363	72.6	376	70.1
28	420	60	420	66.4	399	73.3	385	73.5	398	70.7
29	434	60	434	68.3	413	74.7	409	74.3	419	71.3
30	450	60	450	70	428	76	431	75.1	440	71.9
31	465	61.9	465	71.6	441	77.2	455	75.9	461	72.4
32	480	63.8	480	73.1	456	78.4	478	76.6	483	72.9
33	495	65.5	495	74.5	470	79.5	502	77.2	504	73.3
34	510	67.1	510	75.9	485	80.5	525	77.8	525	73.8
35	525	68.6	525	77.1	508	81.4	549	78.4	547	74.2
36	540	70	540	78.3	535	82.3	572	78.9	568	74.6
37	555	71.4	555	79.5	561	83.2	596	79.5	590	74.9
38	570	72.6	570	80.5	588	84	619	79.9	611	75.3
39	585	73.8	585	81.5	614	84.8	643	80.4	633	75.6
40	600	75	600	82.5	641	85.5	666	80.9	655	75.9
41	615	76.1	615	83.4	667	86.2	691	81.3	676	76.2
42	630	77.1	630	84.3	695	86.9	714	81.7	698	76.5
43	645	78.1	649	85.1	721	87.5	738	82	719	76.7
44	660	79.1	676	85.9	749	88.1	762	82.4	741	77
45	675	80	704	86.7	775	88.7	786	82.8	763	77.2
46	690	80.9	732	87.4	803	89.2	810	83.1	784	77.5
47	705	81.7	760	88.1	830	89.7	834	83.4	806	77.7
48	720	82.5	788	88.8	857	90.3	858	83.7	828	77.9
49	735	83.3	816	89.4	884	90.7	882	84	849	78.1

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Simple Span Load Effects Without Impact (spans 5-49 feet) - Standard Permit: Class C

Span (ft)	Veh 6 M (ft*k)	Veh 6 V (k)	Veh 7 M (ft*k)	Veh 7 V (k)	Veh 8 M (ft*k)	Veh 8 V (k)	Veh 9 M (ft*k)	Veh 9 V (k)	Veh 10 M (ft*k)	Veh 10 V (k)
5	36	36	38.8	34.1	30	26.4	27.5	24.2	25	22
6	45	40	46.5	38.8	36	30	33	27.5	30	25
7	51.4	42.9	54.3	42.1	42	32.6	38.5	29.9	35	27.1
8	67.5	45	63.9	44.6	49.5	34.5	45.4	31.6	41.3	28.8
9	80	46.7	78.4	46.5	60.7	36	55.6	33	50.6	30
10	96	48	93	48.1	72	39.6	66	36.3	60	33
11	109	49.1	108	49.3	90	42.5	82.5	39	75	35.5
12	125	50	123	50.4	107	45	97.6	41.3	90	37.5
13	138	50.8	138	51.3	126	47.1	116	43.2	105	39.2
14	154	51.4	153	52	143	48.9	131	44.8	120	41.4
15	168	52	168	52.7	162	50.4	149	46.2	135	44
16	184	52.5	183	53.3	179	51.8	164	47.4	150	46.3
17	198	54.7	198	54.3	198	52.9	182	48.5	166	48.2
18	213	56.7	214	55.5	215	54	197	49.5	186	50
19	227	58.4	229	56.7	234	54.9	215	50.4	205	51.6
20	243	60	244	57.7	251	55.8	230	51.8	225	53
21	257	61.4	259	58.7	270	56.6	248	53.1	245	54.3
22	273	62.7	275	60.2	287	58	263	54.3	265	55.5
23	287	63.9	290	61.7	306	59.4	281	55.4	284	56.5
24	306	65	305	63	323	60.6	296	56.7	304	57.5
25	329	66	322	64.2	342	61.7	314	58.1	324	58.4
26	351	66.9	341	65.3	359	63.1	329	59.4	344	59.5
27	373	67.8	360	66.3	378	64.7	347	60.6	364	60.8
28	395	68.6	380	67.3	395	66.1	364	61.8	384	62
29	418	69.3	399	68.1	414	67.5	383	63.3	403	63.1
30	440	70	419	69	431	68.8	403	64.7	423	64.1
31	463	70.6	438	69.8	450	69.9	423	66	443	65.5
32	485	71.3	461	70.5	471	71.1	442	67.2	463	66.8
33	507	71.8	484	71.2	492	72.1	462	68.4	483	68.1
34	529	72.4	507	71.8	515	73.1	482	69.5	504	69.3
35	552	72.9	530	72.4	536	74	503	70.5	527	70.6
36	574	73.3	553	73	559	74.9	526	71.5	551	72
37	597	73.8	576	73.5	580	75.7	549	72.4	574	73.4
38	619	74.2	599	74	604	76.5	572	73.3	598	74.6
39	642	74.6	622	74.5	631	77.3	599	74.1	621	75.8
40	664	75	645	75	656	78	625	74.9	645	77
41	686	75.4	668	75.4	682	78.6	651	75.7	671	78.1
42	709	75.7	692	75.8	709	79.3	677	76.4	698	79.1
43	731	76	715	76.2	735	79.9	704	77.1	725	80.1
44	753	76.4	738	76.6	761	80.5	730	77.7	751	81.1
45	776	76.7	761	77	788	81	756	78.3	779	82
46	798	77	784	77.3	814	81.6	783	78.9	805	82.9
47	821	77.2	807	77.7	840	82.1	809	79.5	834	83.7
48	843	77.5	830	78	867	82.6	835	80	864	84.5
49	866	77.8	853	78.3	893	83	862	80.5	894	85.3

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Simple Span Load Effects Without Impact (spans 5-49 feet) - Standard Permit: Class C

Span (ft)	Veh 11 M (ft*k)	Veh 11 V (k)	Veh 12 M (ft*k)	Veh 12 V (k)	Veh 13 M (ft*k)	Veh 13 V (k)	Veh 14 M (ft*k)	Veh 14 V (k)	Veh 15 M (ft*k)	Veh 15 V (k)
5	55.2	46	37.2	37.2	40.8	40.8	28.8	28.8	24	24
6	69	46	46.5	41.3	51	45.3	36	32	30	26.7
7	78.9	46	53.1	44.3	58.3	48.6	41.1	34.3	34.3	28.6
8	92	46	69.8	46.5	76.5	51	54	36	45	30
9	102	46	82.7	48.2	90.7	52.9	64	40	53.3	33.3
10	115	46	99.2	49.6	109	54.4	84	43.2	70	36
11	125	46	113	50.7	124	55.6	100	45.8	83.6	38.2
12	138	46	129	51.7	142	56.7	120	48	100	40
13	149	49.5	143	52.5	157	57.5	137	49.8	114	43.1
14	161	52.6	159	53.9	175	58.3	156	51.4	130	45.7
15	172	55.2	174	55.1	190	58.9	173	52.8	144	48
16	184	57.5	190	56.2	208	59.5	192	54	165	50
17	195	59.5	204	57.1	224	60.7	209	55.1	184	51.8
18	207	61.3	220	58	242	61.7	228	56	204	53.3
19	218	62.9	235	58.7	258	62.6	245	56.8	223	54.7
20	230	64.4	253	59.4	275	63.5	264	57.6	244	56
21	245	65.7	271	60	291	64.2	281	58.7	263	57.1
22	268	66.9	289	60.6	309	64.9	300	59.8	284	58.2
23	288	68	307	61.1	325	65.5	317	60.7	303	59.1
24	311	69	326	61.6	343	66.1	336	61.6	323	60
25	331	69.9	343	62	359	66.6	353	62.4	342	61.2
26	354	70.8	362	62.4	380	67.1	372	63.1	363	62.3
27	375	71.6	380	62.8	399	67.6	389	63.8	382	63.3
28	398	72.3	398	63.1	419	68	408	64.5	403	64.3
29	419	73	416	64.1	438	68.4	425	65	422	65.2
30	442	73.6	434	66.1	459	68.8	444	65.6	443	66
31	463	74.2	452	68	478	69.1	461	66.1	462	66.8
32	486	74.8	470	69.8	499	69.4	482	66.6	483	67.5
33	507	75.3	488	71.4	518	69.7	502	67.1	502	68.2
34	530	75.8	506	72.9	538	70	523	67.5	525	68.8
35	552	76.2	524	74.4	558	71.9	543	67.9	547	69.4
36	575	76.7	543	75.8	578	73.7	564	68.3	570	70
37	597	77.1	561	77.1	597	75.4	584	68.6	592	70.5
38	620	78.7	579	78.6	618	76.9	604	69	615	71.1
39	642	80.2	597	80	637	78.5	624	69.5	637	71.5
40	665	81.7	615	81.4	657	79.9	645	70.8	660	72
41	687	83	633	82.7	677	81.3	665	72	682	72.4
42	710	84.3	653	83.9	697	82.6	686	73.7	705	72.9
43	732	85.6	685	85.1	716	83.8	706	75.3	727	73.3
44	755	86.8	718	86.2	737	85	726	76.9	750	73.6
45	777	87.9	750	87.3	756	86.1	746	78.4	772	74.7
46	800	89	783	88.3	776	87.5	767	79.8	795	76.1
47	822	90	815	89.3	796	88.7	787	81.2	817	77.4
48	845	91	848	90.2	816	90	808	82.5	840	78.8
49	867	92	880	91.1	835	91.1	828	83.8	862	80

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Span (ft)	Veh 16	Veh 16	Veh 17	Veh 17	Veh 18	Veh 18	Veh 19	Veh 19	Veh 20	Veh 20
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
5	24.9	20.8	21.6	20.2	28.8	28.8	26.9	24	25.6	24.3
6	29	23.2	26	22.6	36	32	32.3	27.2	30.8	27
7	35.5	25.6	30.3	24.3	41.1	34.3	37.6	29.4	35.9	29
8	43.5	27.3	37.8	25.6	54	36	46.3	31.1	45.5	30.5
9	54.7	29.8	46	27.9	64	37.3	56.5	33.4	55.1	33.6
10	68.1	32.8	57.6	30.3	76.8	38.4	69.2	36.6	70	36.4
11	84.5	35.3	70.5	32.2	87.3	39.3	85.8	39.1	85.3	38.7
12	98.2	37.3	83.6	33.9	100	40	102	41.2	101	40.6
13	114	39.8	96.5	35.9	111	40.6	118	43	116	43.4
14	128	42.6	110	38.3	123	41.1	134	44.5	132	46.1
15	145	45.1	122	40.4	134	41.6	150	45.9	147	48.5
16	163	47.2	137	42.2	147	42	166	47	166	50.6
17	184	49.1	154	43.8	158	42.8	183	48.1	186	52.5
18	202	50.8	171	45.2	171	43.6	198	49	206	54.1
19	223	52.3	188	46.4	182	44.2	215	49.8	226	55.6
20	242	53.7	206	47.6	194	45.6	231	50.5	247	56.9
21	262	54.9	223	48.6	206	46.9	247	51.2	267	58.1
22	281	56.1	240	49.5	218	48	263	51.8	287	59.2
23	302	57.1	257	50.4	230	50.1	279	52.3	307	60.2
24	321	58	274	51.2	242	52	295	53	328	61.1
25	341	59	291	51.9	253	53.8	312	53.8	348	61.9
26	360	60.2	310	53	268	55.4	328	55.1	369	62.7
27	381	61.2	332	54.7	281	56.9	344	56.2	389	63.4
28	400	62.2	353	56.4	296	58.3	360	57.3	410	64.1
29	420	63	375	58.1	313	59.6	376	59.1	430	64.7
30	440	63.9	397	59.6	330	60.8	392	60.7	450	65.3
31	461	64.7	418	61	350	61.9	408	62.2	471	65.8
32	482	65.4	441	62.4	372	63	424	63.6	491	66.3
33	503	66.1	466	63.6	396	64	441	64.9	511	66.9
34	525	66.7	492	64.8	418	64.9	457	66.2	532	68
35	546	67.3	517	65.9	442	66.1	473	67.4	552	69
36	567	67.9	544	67	464	67.1	494	68.5	573	69.9
37	588	68.5	569	68	488	68.1	515	69.5	593	70.8
38	610	69	595	69	510	69.1	536	70.5	614	71.6
39	631	69.5	620	70.1	536	69.9	562	71.5	634	72.4
40	653	69.9	647	71.2	561	70.8	589	72.4	655	73.2
41	675	70.4	672	72.2	587	71.6	615	73.2	675	73.9
42	697	70.8	698	73.2	613	72.4	643	74.1	696	74.7
43	720	71.2	723	74.2	639	73.1	669	74.8	716	75.5
44	741	71.6	750	75.1	664	73.8	696	75.6	737	76.3
45	764	72.6	775	75.9	690	74.5	722	76.3	757	77
46	785	73.7	801	76.7	715	75.1	749	77	777	77.7
47	808	74.8	827	77.5	741	75.7	775	77.6	802	78.4
48	829	75.8	853	78.3	767	76.3	802	78.2	828	79
49	852	77	878	79	792	76.9	829	78.8	853	79.6

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Simple Span Load Effects Without Impact (spans 50-94 feet) - Standard Permit: Class C

Span (ft)	Veh 1 M (ft*k)	Veh 1 V (k)	Veh 2 M (ft*k)	Veh 2 V (k)	Veh 3 M (ft*k)	Veh 3 V (k)	Veh 4 M (ft*k)	Veh 4 V (k)	Veh 5 M (ft*k)	Veh 5 V (k)
50	750	84	844	90	912	91.2	906	84.3	871	78.3
51	765	84.7	872	90.6	939	91.6	930	84.5	893	78.5
52	789	85.4	900	91.2	967	92.1	954	84.8	915	78.7
53	817	86	928	91.7	994	92.5	978	85.1	936	78.9
54	844	86.7	957	92.2	1,020	92.9	1,000	85.3	958	79
55	873	87.3	985	92.7	1,050	93.3	1,030	85.5	980	79.2
56	900	87.9	1,010	93.2	1,080	93.6	1,050	85.8	1,000	79.4
57	928	88.4	1,040	93.7	1,100	94	1,070	86	1,020	79.5
58	956	89	1,070	94.1	1,130	94.3	1,100	86.2	1,050	79.7
59	984	89.5	1,100	94.6	1,160	94.7	1,120	86.4	1,070	79.8
60	1,010	90	1,130	95	1,190	95	1,150	86.6	1,090	79.9
61	1,040	90.5	1,160	95.4	1,210	95.3	1,170	86.8	1,110	80.1
62	1,070	91	1,190	95.8	1,240	95.6	1,190	86.9	1,130	80.2
63	1,100	91.4	1,210	96.2	1,270	95.9	1,220	87.1	1,150	80.3
64	1,130	91.9	1,240	96.6	1,300	96.2	1,240	87.3	1,180	80.4
65	1,150	92.3	1,270	96.9	1,330	96.5	1,270	87.4	1,200	80.6
66	1,180	92.7	1,300	97.3	1,350	96.7	1,290	87.6	1,220	80.7
67	1,210	93.1	1,330	97.6	1,380	97	1,320	87.8	1,240	80.8
68	1,240	93.5	1,360	97.9	1,410	97.2	1,340	87.9	1,260	80.9
69	1,270	93.9	1,390	98.3	1,440	97.5	1,360	88.1	1,290	81
70	1,300	94.3	1,420	98.6	1,470	97.7	1,390	88.2	1,310	81.1
71	1,330	94.6	1,450	98.9	1,490	97.9	1,410	88.3	1,330	81.2
72	1,350	95	1,480	99.2	1,520	98.2	1,440	88.5	1,350	81.3
73	1,380	95.3	1,500	99.5	1,550	98.4	1,460	88.6	1,370	81.4
74	1,410	95.7	1,530	99.7	1,580	98.6	1,490	88.7	1,390	81.5
75	1,440	96	1,560	100	1,610	98.8	1,510	88.9	1,420	81.5
76	1,470	96.3	1,590	100	1,630	99	1,530	89	1,440	81.6
77	1,500	96.6	1,620	101	1,660	99.2	1,560	89.1	1,460	81.7
78	1,530	96.9	1,650	101	1,690	99.4	1,580	89.2	1,480	81.8
79	1,560	97.2	1,680	101	1,720	99.6	1,610	89.3	1,500	81.9
80	1,580	97.5	1,710	101	1,750	99.8	1,630	89.4	1,530	82
81	1,610	97.8	1,740	101	1,770	99.9	1,660	89.5	1,550	82
82	1,640	98	1,770	102	1,800	100	1,680	89.6	1,570	82.1
83	1,670	98.3	1,800	102	1,830	100	1,700	89.7	1,590	82.2
84	1,700	98.6	1,830	102	1,860	100	1,730	89.8	1,610	82.2
85	1,730	98.8	1,860	102	1,890	101	1,750	89.9	1,640	82.3
86	1,760	99.1	1,880	103	1,910	101	1,780	90	1,660	82.4
87	1,790	99.3	1,910	103	1,940	101	1,800	90.1	1,680	82.4
88	1,820	99.5	1,940	103	1,970	101	1,830	90.2	1,700	82.5
89	1,850	99.8	1,970	103	2,000	101	1,850	90.3	1,720	82.6
90	1,870	100	2,000	103	2,030	101	1,880	90.4	1,750	82.6
91	1,900	100	2,030	104	2,050	101	1,900	90.5	1,770	82.7
92	1,930	100	2,060	104	2,080	102	1,920	90.5	1,790	82.7
93	1,960	101	2,090	104	2,110	102	1,950	90.6	1,810	82.8
94	1,990	101	2,120	104	2,140	102	1,970	90.7	1,830	82.9

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Span (ft)	Veh 6 M (ft*k)	Veh 6 V (k)	Veh 7 M (ft*k)	Veh 7 V (k)	Veh 8 M (ft*k)	Veh 8 V (k)	Veh 9 M (ft*k)	Veh 9 V (k)	Veh 10 M (ft*k)	Veh 10 V (k)
50	888	78	877	78.6	920	83.5	888	81	924	86
51	911	78.2	900	78.9	946	83.9	914	81.5	954	86.7
52	933	78.5	923	79.1	972	84.3	941	82	984	87.4
53	955	78.7	946	79.4	999	84.7	967	82.4	1,010	88
54	978	78.9	969	79.7	1,030	85.1	993	82.9	1,040	88.7
55	1,000	79.1	992	79.9	1,050	85.5	1,020	83.3	1,070	89.3
56	1,020	79.3	1,020	80.1	1,080	85.9	1,050	83.7	1,110	89.9
57	1,050	79.5	1,040	80.4	1,100	86.2	1,070	84.1	1,130	90.4
58	1,070	79.7	1,060	80.6	1,130	86.5	1,100	84.4	1,170	91
59	1,090	79.8	1,090	80.8	1,160	86.9	1,130	84.8	1,200	91.5
60	1,110	80	1,110	81	1,180	87.2	1,150	85.1	1,230	92
61	1,140	80.2	1,130	81.2	1,210	87.5	1,180	85.5	1,260	92.5
62	1,160	80.3	1,150	81.4	1,240	87.8	1,200	85.8	1,290	93
63	1,180	80.5	1,180	81.6	1,260	88.1	1,230	86.1	1,320	93.4
64	1,200	80.6	1,200	81.7	1,290	88.3	1,260	86.4	1,350	93.9
65	1,220	80.8	1,220	81.9	1,320	88.6	1,280	86.7	1,380	94.3
66	1,250	80.9	1,250	82.1	1,340	88.9	1,310	87	1,410	94.7
67	1,270	81	1,270	82.2	1,370	89.1	1,340	87.3	1,440	95.1
68	1,290	81.2	1,290	82.4	1,390	89.3	1,360	87.5	1,470	95.5
69	1,310	81.3	1,320	82.6	1,420	89.6	1,390	87.8	1,500	95.9
70	1,340	81.4	1,340	82.7	1,450	89.8	1,410	88.1	1,530	96.3
71	1,360	81.5	1,360	82.8	1,470	90	1,440	88.3	1,560	96.6
72	1,380	81.7	1,390	83	1,500	90.3	1,470	88.6	1,590	97
73	1,400	81.8	1,410	83.1	1,530	90.5	1,490	88.8	1,620	97.3
74	1,430	81.9	1,430	83.3	1,550	90.7	1,520	89	1,650	97.7
75	1,450	82	1,460	83.4	1,580	90.9	1,550	89.2	1,680	98
76	1,470	82.1	1,480	83.5	1,610	91.1	1,570	89.4	1,710	98.3
77	1,490	82.2	1,500	83.6	1,630	91.2	1,600	89.7	1,740	98.6
78	1,520	82.3	1,530	83.8	1,660	91.4	1,630	89.9	1,770	98.9
79	1,540	82.4	1,550	83.9	1,680	91.6	1,650	90.1	1,800	99.2
80	1,560	82.5	1,570	84	1,710	91.8	1,680	90.3	1,830	99.5
81	1,580	82.6	1,600	84.1	1,740	92	1,710	90.4	1,860	99.8
82	1,610	82.7	1,620	84.2	1,760	92.1	1,730	90.6	1,890	100
83	1,630	82.8	1,640	84.3	1,790	92.3	1,760	90.8	1,920	100
84	1,650	82.9	1,670	84.4	1,820	92.4	1,780	91	1,950	101
85	1,670	82.9	1,690	84.5	1,840	92.6	1,810	91.2	1,980	101
86	1,700	83	1,710	84.6	1,870	92.7	1,840	91.3	2,010	101
87	1,720	83.1	1,730	84.7	1,900	92.9	1,860	91.5	2,040	101
88	1,740	83.2	1,760	84.8	1,920	93	1,890	91.7	2,070	102
89	1,760	83.3	1,780	84.9	1,950	93.2	1,920	91.8	2,100	102
90	1,790	83.3	1,800	85	1,980	93.3	1,940	92	2,140	102
91	1,810	83.4	1,830	85.1	2,000	93.5	1,970	92.1	2,170	102
92	1,830	83.5	1,850	85.2	2,030	93.6	2,000	92.3	2,200	102
93	1,850	83.5	1,870	85.3	2,050	93.7	2,020	92.4	2,230	103
94	1,880	83.6	1,900	85.3	2,080	93.8	2,050	92.5	2,260	103

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Span (ft)	Veh 11 M (ft*k)	Veh 11 V (k)	Veh 12 M (ft*k)	Veh 12 V (k)	Veh 13 M (ft*k)	Veh 13 V (k)	Veh 14 M (ft*k)	Veh 14 V (k)	Veh 15 M (ft*k)	Veh 15 V (k)
50	891	92.9	913	92	856	92.3	849	85	885	81.6
51	921	93.8	946	92.8	878	93.3	869	86.1	907	83.1
52	955	94.7	979	93.6	914	94.4	889	87.2	930	84.6
53	989	95.5	1,010	94.4	949	95.4	909	88.3	952	86
54	1,020	96.3	1,040	95.1	985	96.3	930	89.5	975	87.4
55	1,060	97	1,080	95.8	1,020	97.3	950	90.7	997	88.7
56	1,090	97.8	1,110	96.5	1,060	98.2	971	91.8	1,020	90
57	1,130	98.5	1,140	97.2	1,090	99	996	92.9	1,040	91.2
58	1,160	99.1	1,180	97.8	1,130	99.9	1,020	93.9	1,070	92.4
59	1,200	99.8	1,210	98.4	1,160	101	1,050	94.9	1,090	93.6
60	1,230	100	1,240	99	1,200	101	1,090	95.9	1,110	94.7
61	1,260	101	1,270	99.6	1,230	102	1,130	96.9	1,130	95.7
62	1,300	102	1,310	100	1,270	103	1,160	97.8	1,160	96.9
63	1,330	102	1,340	101	1,310	104	1,200	98.7	1,190	98.1
64	1,370	103	1,370	101	1,340	104	1,240	99.5	1,220	99.2
65	1,400	103	1,410	102	1,380	105	1,280	100	1,260	100
66	1,440	104	1,440	102	1,410	106	1,310	101	1,290	101
67	1,470	104	1,470	103	1,450	106	1,350	102	1,330	102
68	1,500	105	1,510	103	1,490	107	1,390	103	1,360	103
69	1,540	105	1,540	104	1,520	107	1,430	103	1,400	104
70	1,570	106	1,570	104	1,560	108	1,460	104	1,440	105
71	1,610	106	1,610	104	1,590	109	1,500	105	1,480	106
72	1,640	107	1,640	105	1,630	109	1,540	106	1,520	107
73	1,680	107	1,670	105	1,670	110	1,580	106	1,560	108
74	1,710	108	1,700	106	1,700	110	1,610	107	1,610	109
75	1,740	108	1,740	106	1,740	111	1,650	107	1,650	110
76	1,780	108	1,770	106	1,770	111	1,690	108	1,690	110
77	1,810	109	1,800	107	1,810	112	1,730	109	1,730	111
78	1,850	109	1,840	107	1,850	112	1,770	109	1,770	112
79	1,880	109	1,870	108	1,880	112	1,800	110	1,810	113
80	1,920	110	1,900	108	1,920	113	1,840	110	1,860	113
81	1,950	110	1,940	108	1,950	113	1,880	111	1,900	114
82	1,990	111	1,970	109	1,990	114	1,920	111	1,940	115
83	2,020	111	2,000	109	2,030	114	1,950	112	1,980	115
84	2,050	111	2,040	109	2,060	115	1,990	112	2,020	116
85	2,090	111	2,070	109	2,100	115	2,030	113	2,070	117
86	2,120	112	2,100	110	2,140	115	2,070	113	2,110	117
87	2,160	112	2,140	110	2,170	116	2,110	114	2,150	118
88	2,190	112	2,170	110	2,210	116	2,140	114	2,190	119
89	2,230	113	2,200	111	2,250	116	2,180	115	2,230	119
90	2,260	113	2,240	111	2,280	117	2,220	115	2,280	120
91	2,300	113	2,270	111	2,320	117	2,260	116	2,320	120
92	2,330	114	2,300	111	2,350	117	2,290	116	2,360	121
93	2,360	114	2,340	112	2,390	118	2,330	116	2,400	121
94	2,400	114	2,370	112	2,430	118	2,370	117	2,440	122

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Simple Span Load Effects Without Impact (spans 50-94 feet) - Standard Permit: Class C

Span (ft)	Veh 16		Veh 17		Veh 18		Veh 19		Veh 20	
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
50	873	78.4	905	79.7	818	77.4	856	79.4	879	80.2
51	896	79.7	931	80.4	844	78	884	80	905	80.8
52	917	81	959	81	869	78.5	912	80.5	930	81.3
53	940	82.3	988	81.6	895	78.9	941	81	956	81.9
54	961	83.9	1,020	82.2	921	79.4	970	81.5	982	82.4
55	984	85.3	1,040	82.8	947	79.9	998	82	1,010	82.9
56	1,010	86.7	1,070	83.3	972	80.6	1,030	82.4	1,030	83.3
57	1,030	88.1	1,100	83.9	998	81.7	1,060	82.9	1,060	83.8
58	1,050	89.4	1,130	84.4	1,020	82.8	1,080	83.3	1,080	84.2
59	1,070	90.7	1,160	84.9	1,050	83.8	1,110	83.7	1,110	84.7
60	1,090	91.9	1,190	85.4	1,080	84.8	1,140	84.1	1,130	85.1
61	1,120	93.1	1,210	85.8	1,100	85.8	1,170	84.5	1,160	85.5
62	1,140	94.3	1,240	86.3	1,130	86.7	1,200	84.8	1,190	85.9
63	1,170	95.4	1,270	86.7	1,150	87.6	1,230	85.4	1,210	86.2
64	1,200	96.5	1,300	87.1	1,180	88.5	1,260	86.1	1,240	86.6
65	1,230	97.6	1,330	87.5	1,200	89.4	1,280	86.7	1,270	86.9
66	1,260	98.7	1,360	87.9	1,230	90.2	1,310	87.4	1,300	87.3
67	1,300	99.8	1,390	88.3	1,260	91	1,340	88	1,320	87.6
68	1,330	101	1,410	88.7	1,280	91.8	1,370	89	1,350	87.9
69	1,360	102	1,440	89	1,310	92.9	1,400	89.8	1,380	88.7
70	1,400	103	1,470	89.4	1,330	93.9	1,430	90.7	1,400	89.8
71	1,440	104	1,500	89.7	1,360	95	1,460	91.6	1,430	90.8
72	1,470	105	1,530	90.1	1,390	96	1,480	92.4	1,460	91.8
73	1,510	106	1,560	90.4	1,420	97.3	1,510	93.2	1,490	92.8
74	1,550	107	1,580	90.7	1,460	98.6	1,540	93.9	1,510	94
75	1,600	108	1,610	91	1,490	99.8	1,570	94.7	1,540	95.2
76	1,640	109	1,640	91.9	1,530	101	1,600	95.4	1,570	96.4
77	1,680	109	1,670	92.9	1,570	102	1,630	96.1	1,590	97.5
78	1,720	110	1,700	94	1,610	103	1,660	96.8	1,620	98.6
79	1,770	111	1,730	95	1,640	105	1,690	97.5	1,650	99.7
80	1,810	112	1,750	95.9	1,680	106	1,710	98.2	1,680	101
81	1,850	112	1,780	96.9	1,720	107	1,740	99	1,700	102
82	1,890	113	1,810	97.8	1,760	108	1,770	99.9	1,730	103
83	1,940	114	1,840	98.7	1,800	109	1,800	101	1,760	104
84	1,980	115	1,870	99.6	1,830	110	1,830	102	1,790	105
85	2,020	115	1,900	100	1,870	111	1,860	102	1,810	106
86	2,060	116	1,930	101	1,910	112	1,890	103	1,840	107
87	2,100	117	1,950	102	1,950	113	1,910	104	1,870	108
88	2,150	117	1,980	103	1,990	114	1,940	106	1,890	108
89	2,190	118	2,010	104	2,020	115	1,970	106	1,920	109
90	2,230	119	2,040	105	2,060	116	2,000	107	1,950	110
91	2,270	119	2,070	105	2,100	117	2,030	108	1,980	111
92	2,320	120	2,100	106	2,140	118	2,060	109	2,020	112
93	2,360	120	2,130	107	2,190	118	2,090	110	2,060	113
94	2,400	121	2,170	107	2,240	119	2,120	111	2,100	114

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Simple Span Load Effects Without Impact (spans 95-139 feet) - Standard Permit: Class C

Span (ft)	Veh 1 M (ft*k)	Veh 1 V (k)	Veh 2 M (ft*k)	Veh 2 V (k)	Veh 3 M (ft*k)	Veh 3 V (k)	Veh 4 M (ft*k)	Veh 4 V (k)	Veh 5 M (ft*k)	Veh 5 V (k)
95	2,020	101	2,150	104	2,170	102	2,000	90.8	1,850	82.9
96	2,050	101	2,180	104	2,200	102	2,020	90.9	1,880	83
97	2,080	101	2,210	105	2,220	102	2,050	90.9	1,900	83
98	2,110	102	2,240	105	2,250	102	2,070	91	1,920	83.1
99	2,140	102	2,270	105	2,280	102	2,090	91.1	1,940	83.1
100	2,170	102	2,300	105	2,310	103	2,120	91.1	1,960	83.2
101	2,200	102	2,330	105	2,340	103	2,140	91.2	1,990	83.2
102	2,230	102	2,360	105	2,360	103	2,170	91.3	2,010	83.3
103	2,260	103	2,390	105	2,390	103	2,190	91.3	2,030	83.3
104	2,280	103	2,420	106	2,420	103	2,220	91.4	2,050	83.3
105	2,310	103	2,440	106	2,450	103	2,240	91.5	2,070	83.4
106	2,340	103	2,470	106	2,480	103	2,270	91.5	2,100	83.4
107	2,370	103	2,500	106	2,510	103	2,290	91.6	2,120	83.5
108	2,400	103	2,530	106	2,530	103	2,310	91.6	2,140	83.5
109	2,430	103	2,560	106	2,560	104	2,340	91.7	2,160	83.6
110	2,460	104	2,590	106	2,590	104	2,360	91.8	2,180	83.6
111	2,490	104	2,620	106	2,620	104	2,390	91.8	2,210	83.6
112	2,520	104	2,650	107	2,650	104	2,410	91.9	2,230	83.7
113	2,550	104	2,680	107	2,680	104	2,440	91.9	2,250	83.7
114	2,580	104	2,710	107	2,700	104	2,460	92	2,270	83.8
115	2,610	104	2,740	107	2,730	104	2,480	92	2,290	83.8
116	2,640	104	2,770	107	2,760	104	2,510	92.1	2,320	83.8
117	2,670	105	2,800	107	2,790	104	2,530	92.1	2,340	83.9
118	2,700	105	2,830	107	2,820	104	2,560	92.2	2,360	83.9
119	2,730	105	2,860	107	2,850	104	2,580	92.2	2,380	83.9
120	2,760	105	2,890	108	2,870	105	2,610	92.3	2,400	84
121	2,790	105	2,920	108	2,900	105	2,630	92.3	2,430	84
122	2,820	105	2,950	108	2,930	105	2,660	92.4	2,450	84
123	2,840	105	2,980	108	2,960	105	2,680	92.4	2,470	84.1
124	2,870	105	3,010	108	2,990	105	2,700	92.5	2,490	84.1
125	2,900	106	3,040	108	3,020	105	2,730	92.5	2,510	84.1
126	2,930	106	3,070	108	3,040	105	2,750	92.6	2,540	84.2
127	2,960	106	3,100	108	3,070	105	2,780	92.6	2,560	84.2
128	2,990	106	3,130	108	3,100	105	2,800	92.6	2,580	84.2
129	3,020	106	3,160	108	3,130	105	2,830	92.7	2,600	84.2
130	3,050	106	3,190	108	3,160	105	2,850	92.7	2,620	84.3
131	3,080	106	3,220	109	3,190	105	2,880	92.8	2,650	84.3
132	3,110	106	3,250	109	3,210	105	2,900	92.8	2,670	84.3
133	3,140	106	3,280	109	3,240	105	2,920	92.8	2,690	84.4
134	3,170	107	3,300	109	3,270	105	2,950	92.9	2,710	84.4
135	3,200	107	3,330	109	3,300	106	2,970	92.9	2,730	84.4
136	3,230	107	3,360	109	3,330	106	3,000	93	2,750	84.4
137	3,260	107	3,390	109	3,360	106	3,020	93	2,780	84.5
138	3,290	107	3,420	109	3,380	106	3,050	93	2,800	84.5
139	3,320	107	3,450	109	3,410	106	3,070	93.1	2,820	84.5

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Simple Span Load Effects Without Impact (spans 95-139 feet) - Standard Permit: Class C

Span (ft)	Veh 6 M (ft*k)	Veh 6 V (k)	Veh 7 M (ft*k)	Veh 7 V (k)	Veh 8 M (ft*k)	Veh 8 V (k)	Veh 9 M (ft*k)	Veh 9 V (k)	Veh 10 M (ft*k)	Veh 10 V (k)
95	1,900	83.7	1,920	85.4	2,110	94	2,070	92.7	2,290	103
96	1,920	83.8	1,940	85.5	2,130	94.1	2,100	92.8	2,320	103
97	1,940	83.8	1,970	85.6	2,160	94.2	2,130	92.9	2,350	103
98	1,970	83.9	1,990	85.6	2,190	94.3	2,150	93.1	2,380	104
99	1,990	83.9	2,010	85.7	2,210	94.4	2,180	93.2	2,410	104
100	2,010	84	2,040	85.8	2,240	94.5	2,210	93.3	2,440	104
101	2,030	84.1	2,060	85.9	2,270	94.7	2,230	93.4	2,470	104
102	2,060	84.1	2,080	85.9	2,290	94.8	2,260	93.6	2,500	104
103	2,080	84.2	2,110	86	2,320	94.9	2,290	93.7	2,530	105
104	2,100	84.2	2,130	86.1	2,340	95	2,310	93.8	2,560	105
105	2,120	84.3	2,150	86.1	2,370	95.1	2,340	93.9	2,590	105
106	2,150	84.3	2,180	86.2	2,400	95.2	2,360	94	2,620	105
107	2,170	84.4	2,200	86.3	2,420	95.3	2,390	94.1	2,650	105
108	2,190	84.4	2,220	86.3	2,450	95.4	2,420	94.2	2,680	105
109	2,210	84.5	2,250	86.4	2,480	95.5	2,440	94.3	2,710	105
110	2,240	84.5	2,270	86.4	2,500	95.6	2,470	94.4	2,740	106
111	2,260	84.6	2,290	86.5	2,530	95.6	2,500	94.5	2,770	106
112	2,280	84.6	2,320	86.6	2,560	95.7	2,520	94.6	2,800	106
113	2,300	84.7	2,340	86.6	2,580	95.8	2,550	94.7	2,830	106
114	2,330	84.7	2,360	86.7	2,610	95.9	2,580	94.8	2,860	106
115	2,350	84.8	2,390	86.7	2,640	96	2,600	94.9	2,900	106
116	2,370	84.8	2,410	86.8	2,660	96.1	2,630	95	2,930	106
117	2,390	84.9	2,430	86.8	2,690	96.2	2,650	95.1	2,960	107
118	2,420	84.9	2,450	86.9	2,710	96.2	2,680	95.2	2,990	107
119	2,440	85	2,480	86.9	2,740	96.3	2,710	95.3	3,020	107
120	2,460	85	2,500	87	2,770	96.4	2,730	95.4	3,050	107
121	2,480	85	2,520	87	2,790	96.5	2,760	95.5	3,080	107
122	2,510	85.1	2,550	87.1	2,820	96.5	2,790	95.5	3,110	107
123	2,530	85.1	2,570	87.1	2,850	96.6	2,810	95.6	3,140	107
124	2,550	85.2	2,590	87.2	2,870	96.7	2,840	95.7	3,170	107
125	2,570	85.2	2,620	87.2	2,900	96.8	2,870	95.8	3,200	108
126	2,600	85.2	2,640	87.3	2,930	96.8	2,890	95.9	3,230	108
127	2,620	85.3	2,660	87.3	2,950	96.9	2,920	95.9	3,260	108
128	2,640	85.3	2,690	87.4	2,980	97	2,940	96	3,290	108
129	2,660	85.3	2,710	87.4	3,000	97	2,970	96.1	3,320	108
130	2,690	85.4	2,730	87.5	3,030	97.1	3,000	96.2	3,350	108
131	2,710	85.4	2,760	87.5	3,060	97.2	3,020	96.2	3,380	108
132	2,730	85.5	2,780	87.5	3,080	97.2	3,050	96.3	3,410	108
133	2,750	85.5	2,800	87.6	3,110	97.3	3,080	96.4	3,440	108
134	2,780	85.5	2,830	87.6	3,140	97.4	3,100	96.4	3,470	109
135	2,800	85.6	2,850	87.7	3,160	97.4	3,130	96.5	3,500	109
136	2,820	85.6	2,870	87.7	3,190	97.5	3,160	96.6	3,530	109
137	2,840	85.6	2,900	87.7	3,220	97.5	3,180	96.6	3,560	109
138	2,870	85.7	2,920	87.8	3,240	97.6	3,210	96.7	3,600	109
139	2,890	85.7	2,940	87.8	3,270	97.6	3,240	96.8	3,630	109

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Simple Span Load Effects Without Impact (spans 95-139 feet) - Standard Permit: Class C

Span (ft)	Veh 11	Veh 11	Veh 12	Veh 12	Veh 13	Veh 13	Veh 14	Veh 14	Veh 15	Veh 15
	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)	M (ft*k)	V (k)
95	2,430	114	2,400	112	2,460	118	2,410	117	2,490	122
96	2,470	115	2,440	112	2,500	119	2,450	118	2,530	123
97	2,500	115	2,470	112	2,540	119	2,480	118	2,570	123
98	2,540	115	2,500	113	2,570	119	2,520	118	2,610	124
99	2,570	115	2,540	113	2,610	120	2,560	119	2,650	124
100	2,610	115	2,570	113	2,650	120	2,600	119	2,700	125
101	2,640	116	2,600	113	2,680	120	2,640	119	2,740	125
102	2,670	116	2,640	114	2,720	120	2,670	120	2,780	126
103	2,710	116	2,670	114	2,750	121	2,710	120	2,820	126
104	2,740	116	2,700	114	2,790	121	2,750	120	2,860	126
105	2,780	117	2,740	114	2,830	121	2,790	121	2,910	127
106	2,810	117	2,770	114	2,860	121	2,830	121	2,950	127
107	2,850	117	2,800	115	2,900	122	2,860	121	2,990	128
108	2,880	117	2,840	115	2,940	122	2,900	122	3,030	128
109	2,920	117	2,870	115	2,970	122	2,940	122	3,070	128
110	2,950	118	2,900	115	3,010	122	2,980	122	3,120	129
111	2,980	118	2,940	115	3,050	123	3,020	122	3,160	129
112	3,020	118	2,970	115	3,080	123	3,050	123	3,200	130
113	3,050	118	3,000	116	3,120	123	3,090	123	3,240	130
114	3,090	118	3,040	116	3,160	123	3,130	123	3,280	130
115	3,120	118	3,070	116	3,190	123	3,170	124	3,330	131
116	3,160	119	3,100	116	3,230	124	3,210	124	3,370	131
117	3,190	119	3,140	116	3,270	124	3,240	124	3,410	131
118	3,230	119	3,170	116	3,300	124	3,280	124	3,450	132
119	3,260	119	3,200	117	3,340	124	3,320	125	3,500	132
120	3,290	119	3,240	117	3,380	124	3,360	125	3,540	132
121	3,330	119	3,270	117	3,410	125	3,400	125	3,580	133
122	3,360	120	3,300	117	3,450	125	3,440	125	3,620	133
123	3,400	120	3,340	117	3,490	125	3,470	125	3,660	133
124	3,430	120	3,370	117	3,520	125	3,510	126	3,710	133
125	3,470	120	3,400	117	3,560	125	3,550	126	3,750	134
126	3,500	120	3,440	118	3,600	125	3,590	126	3,790	134
127	3,540	120	3,470	118	3,630	126	3,630	126	3,830	134
128	3,570	120	3,510	118	3,670	126	3,660	127	3,880	135
129	3,600	121	3,540	118	3,710	126	3,700	127	3,920	135
130	3,640	121	3,570	118	3,740	126	3,740	127	3,960	135
131	3,670	121	3,610	118	3,780	126	3,780	127	4,000	135
132	3,710	121	3,640	118	3,810	126	3,820	127	4,040	136
133	3,740	121	3,670	118	3,850	127	3,850	128	4,090	136
134	3,780	121	3,710	119	3,890	127	3,890	128	4,130	136
135	3,810	121	3,740	119	3,920	127	3,930	128	4,170	136
136	3,850	121	3,770	119	3,960	127	3,970	128	4,210	137
137	3,880	122	3,810	119	4,000	127	4,010	128	4,260	137
138	3,910	122	3,840	119	4,030	127	4,050	129	4,300	137
139	3,950	122	3,870	119	4,070	128	4,080	129	4,340	137

MICHIGAN DEPARTMENT OF TRANSPORTATION
BRIDGE ANALYSIS GUIDE

Simple Span Load Effects Without Impact (spans 95-139 feet) - Standard Permit: Class C

Span (ft)	Veh 16 M (ft*k)	Veh 16 V (k)	Veh 17 M (ft*k)	Veh 17 V (k)	Veh 18 M (ft*k)	Veh 18 V (k)	Veh 19 M (ft*k)	Veh 19 V (k)	Veh 20 M (ft*k)	Veh 20 V (k)
95	2,440	121	2,200	108	2,290	120	2,140	112	2,150	114
96	2,490	122	2,240	109	2,340	121	2,170	113	2,200	115
97	2,530	122	2,280	109	2,390	122	2,200	114	2,240	116
98	2,570	123	2,320	110	2,440	123	2,230	114	2,290	117
99	2,620	123	2,370	111	2,490	123	2,260	115	2,340	117
100	2,660	124	2,410	111	2,540	124	2,290	116	2,380	118
101	2,700	124	2,460	112	2,590	125	2,320	117	2,430	119
102	2,740	125	2,500	113	2,640	126	2,350	118	2,480	120
103	2,790	125	2,550	113	2,680	126	2,390	118	2,520	120
104	2,830	126	2,590	114	2,730	127	2,430	119	2,570	121
105	2,870	126	2,640	114	2,780	128	2,470	120	2,620	122
106	2,910	127	2,680	115	2,830	128	2,500	120	2,660	122
107	2,960	127	2,730	115	2,880	129	2,540	121	2,710	123
108	3,000	128	2,770	116	2,930	130	2,580	122	2,760	124
109	3,040	128	2,820	116	2,980	130	2,630	122	2,800	124
110	3,080	128	2,860	117	3,030	131	2,670	123	2,850	125
111	3,130	129	2,910	117	3,080	132	2,710	124	2,900	125
112	3,170	129	2,950	118	3,130	132	2,760	124	2,940	126
113	3,210	130	3,000	118	3,180	133	2,810	125	2,990	127
114	3,260	130	3,040	119	3,230	133	2,860	126	3,040	127
115	3,300	130	3,090	119	3,280	134	2,910	126	3,090	128
116	3,340	131	3,130	120	3,330	135	2,960	127	3,130	128
117	3,380	131	3,180	120	3,380	135	3,010	127	3,180	129
118	3,430	131	3,220	121	3,430	136	3,060	128	3,230	129
119	3,470	132	3,270	121	3,470	136	3,110	128	3,270	130
120	3,510	132	3,320	122	3,520	137	3,160	129	3,320	130
121	3,560	133	3,360	122	3,570	137	3,210	130	3,370	131
122	3,600	133	3,410	122	3,620	138	3,260	130	3,410	131
123	3,640	133	3,450	123	3,670	138	3,310	131	3,460	132
124	3,680	133	3,500	123	3,720	139	3,360	131	3,510	132
125	3,730	134	3,540	124	3,770	139	3,410	132	3,560	133
126	3,770	134	3,590	124	3,820	140	3,450	132	3,600	133
127	3,810	134	3,630	124	3,870	140	3,500	133	3,650	134
128	3,860	135	3,680	125	3,920	141	3,550	133	3,700	134
129	3,900	135	3,720	125	3,970	141	3,600	133	3,740	135
130	3,940	135	3,770	126	4,020	142	3,650	134	3,790	135
131	3,980	136	3,810	126	4,070	142	3,700	134	3,840	135
132	4,030	136	3,860	126	4,120	143	3,750	135	3,890	136
133	4,070	136	3,910	127	4,170	143	3,800	135	3,930	136
134	4,110	136	3,950	127	4,220	143	3,850	136	3,980	137
135	4,160	137	4,000	128	4,270	144	3,900	136	4,030	137
136	4,200	137	4,040	128	4,320	144	3,950	137	4,080	138
137	4,240	137	4,090	128	4,370	145	4,000	137	4,120	138
138	4,280	138	4,130	129	4,420	145	4,050	137	4,170	138
139	4,330	138	4,180	129	4,470	145	4,100	138	4,220	139

MICHIGAN DEPARTMENT OF TRANSPORTATION
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Simple Span Load Effects Without Impact (spans 140-300 feet) - Standard Permit: Class C

Span (ft)	Veh 1 M (ft*k)	Veh 1 V (k)	Veh 2 M (ft*k)	Veh 2 V (k)	Veh 3 M (ft*k)	Veh 3 V (k)	Veh 4 M (ft*k)	Veh 4 V (k)	Veh 5 M (ft*k)	Veh 5 V (k)
140	3,350	107	3,480	109	3,440	106	3,100	93.1	2,840	84.5
141	3,380	107	3,510	109	3,470	106	3,120	93.1	2,860	84.6
142	3,410	107	3,540	109	3,500	106	3,140	93.2	2,890	84.6
143	3,440	107	3,570	110	3,530	106	3,170	93.2	2,910	84.6
144	3,470	108	3,600	110	3,550	106	3,190	93.2	2,930	84.6
145	3,500	108	3,630	110	3,580	106	3,220	93.3	2,950	84.7
146	3,530	108	3,660	110	3,610	106	3,240	93.3	2,970	84.7
147	3,560	108	3,690	110	3,640	106	3,270	93.3	3,000	84.7
148	3,590	108	3,720	110	3,670	106	3,290	93.4	3,020	84.7
149	3,620	108	3,750	110	3,700	106	3,320	93.4	3,040	84.8
150	3,640	108	3,780	110	3,720	106	3,340	93.4	3,060	84.8
155	3,790	108	3,930	110	3,870	107	3,460	93.6	3,170	84.9
160	3,940	109	4,080	111	4,010	107	3,580	93.7	3,280	85
165	4,090	109	4,230	111	4,150	107	3,710	93.8	3,390	85.1
170	4,240	109	4,380	111	4,290	107	3,830	94	3,500	85.2
175	4,390	110	4,530	111	4,430	107	3,950	94.1	3,610	85.2
180	4,540	110	4,680	112	4,580	108	4,070	94.2	3,720	85.3
185	4,690	110	4,830	112	4,720	108	4,200	94.3	3,830	85.4
190	4,840	111	4,970	112	4,860	108	4,320	94.4	3,940	85.5
195	4,980	111	5,120	112	5,000	108	4,440	94.5	4,050	85.5
200	5,130	111	5,270	113	5,140	108	4,560	94.6	4,160	85.6
205	5,280	111	5,420	113	5,290	108	4,690	94.7	4,270	85.6
210	5,430	111	5,570	113	5,430	109	4,810	94.7	4,380	85.7
215	5,580	112	5,720	113	5,570	109	4,930	94.8	4,490	85.7
220	5,730	112	5,870	113	5,710	109	5,050	94.9	4,600	85.8
225	5,880	112	6,020	113	5,860	109	5,170	95	4,710	85.8
230	6,030	112	6,170	113	6,000	109	5,300	95	4,820	85.9
235	6,180	112	6,320	114	6,140	109	5,420	95.1	4,930	85.9
240	6,330	113	6,470	114	6,280	109	5,540	95.1	5,040	86
245	6,480	113	6,620	114	6,420	109	5,660	95.2	5,150	86
250	6,630	113	6,770	114	6,570	109	5,790	95.3	5,260	86.1
255	6,780	113	6,920	114	6,710	110	5,910	95.3	5,370	86.1
260	6,930	113	7,070	114	6,850	110	6,030	95.4	5,480	86.1
265	7,080	113	7,220	114	6,990	110	6,150	95.4	5,590	86.2
270	7,220	113	7,370	114	7,140	110	6,280	95.5	5,700	86.2
275	7,370	113	7,520	115	7,280	110	6,400	95.5	5,810	86.2
280	7,520	114	7,670	115	7,420	110	6,520	95.6	5,920	86.3
285	7,670	114	7,820	115	7,560	110	6,640	95.6	6,030	86.3
290	7,820	114	7,970	115	7,700	110	6,770	95.6	6,140	86.3
295	7,970	114	8,120	115	7,850	110	6,890	95.7	6,250	86.4
300	8,120	114	8,270	115	7,990	110	7,010	95.7	6,360	86.4

MICHIGAN DEPARTMENT OF TRANSPORTATION
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Simple Span Load Effects Without Impact (spans 140-300 feet) - Standard Permit: Class C

Span (ft)	Veh 6 M (ft*k)	Veh 6 V (k)	Veh 7 M (ft*k)	Veh 7 V (k)	Veh 8 M (ft*k)	Veh 8 V (k)	Veh 9 M (ft*k)	Veh 9 V (k)	Veh 10 M (ft*k)	Veh 10 V (k)
140	2,910	85.7	2,970	87.9	3,290	97.7	3,260	96.8	3,660	109
141	2,930	85.7	2,990	87.9	3,320	97.8	3,290	96.9	3,690	109
142	2,960	85.8	3,010	87.9	3,350	97.8	3,310	97	3,720	109
143	2,980	85.8	3,040	88	3,370	97.9	3,340	97	3,750	109
144	3,000	85.8	3,060	88	3,400	97.9	3,370	97.1	3,780	110
145	3,020	85.9	3,080	88	3,430	98	3,390	97.1	3,810	110
146	3,050	85.9	3,110	88.1	3,450	98	3,420	97.2	3,840	110
147	3,070	85.9	3,130	88.1	3,480	98.1	3,450	97.2	3,870	110
148	3,090	85.9	3,150	88.1	3,510	98.1	3,470	97.3	3,900	110
149	3,110	86	3,180	88.2	3,530	98.2	3,500	97.4	3,930	110
150	3,140	86	3,200	88.2	3,560	98.2	3,530	97.4	3,960	110
155	3,250	86.1	3,310	88.4	3,690	98.5	3,660	97.7	4,110	110
160	3,360	86.3	3,430	88.5	3,820	98.7	3,790	97.9	4,270	111
165	3,470	86.4	3,550	88.6	3,950	98.9	3,920	98.2	4,420	111
170	3,590	86.5	3,660	88.8	4,090	99.1	4,050	98.4	4,570	111
175	3,700	86.6	3,780	88.9	4,220	99.3	4,190	98.6	4,720	112
180	3,810	86.7	3,900	89	4,350	99.5	4,320	98.8	4,870	112
185	3,920	86.8	4,010	89.1	4,480	99.6	4,450	99	5,030	112
190	4,040	86.8	4,130	89.2	4,610	99.8	4,580	99.1	5,180	113
195	4,150	86.9	4,240	89.3	4,750	99.9	4,710	99.3	5,330	113
200	4,260	87	4,360	89.4	4,880	100	4,850	99.5	5,480	113
205	4,370	87.1	4,480	89.5	5,010	100	4,980	99.6	5,640	113
210	4,490	87.1	4,590	89.6	5,140	100	5,110	99.8	5,790	113
215	4,600	87.2	4,710	89.6	5,270	100	5,240	99.9	5,940	114
220	4,710	87.3	4,830	89.7	5,410	101	5,370	100	6,090	114
225	4,820	87.3	4,940	89.8	5,540	101	5,510	100	6,250	114
230	4,940	87.4	5,060	89.9	5,670	101	5,640	100	6,400	114
235	5,050	87.4	5,170	89.9	5,800	101	5,770	100	6,550	114
240	5,160	87.5	5,290	90	5,930	101	5,900	100	6,700	115
245	5,270	87.6	5,410	90.1	6,070	101	6,030	101	6,860	115
250	5,390	87.6	5,520	90.1	6,200	101	6,170	101	7,010	115
255	5,500	87.6	5,640	90.2	6,330	101	6,300	101	7,160	115
260	5,610	87.7	5,760	90.2	6,460	101	6,430	101	7,310	115
265	5,720	87.7	5,870	90.3	6,590	101	6,560	101	7,470	115
270	5,840	87.8	5,990	90.3	6,730	102	6,690	101	7,620	115
275	5,950	87.8	6,100	90.4	6,860	102	6,830	101	7,770	115
280	6,060	87.9	6,220	90.4	6,990	102	6,960	101	7,920	116
285	6,170	87.9	6,340	90.5	7,120	102	7,090	101	8,080	116
290	6,290	87.9	6,450	90.5	7,250	102	7,220	101	8,230	116
295	6,400	88	6,570	90.6	7,390	102	7,350	101	8,380	116
300	6,510	88	6,690	90.6	7,520	102	7,480	102	8,530	116

MICHIGAN DEPARTMENT OF TRANSPORTATION
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Simple Span Load Effects Without Impact (spans 140-300 feet) - Standard Permit: Class C

Span (ft)	Veh 11 M (ft*k)	Veh 11 V (k)	Veh 12 M (ft*k)	Veh 12 V (k)	Veh 13 M (ft*k)	Veh 13 V (k)	Veh 14 M (ft*k)	Veh 14 V (k)	Veh 15 M (ft*k)	Veh 15 V (k)
140	3,980	122	3,910	119	4,110	128	4,120	129	4,380	138
141	4,020	122	3,940	119	4,140	128	4,160	129	4,420	138
142	4,050	122	3,970	119	4,180	128	4,200	129	4,470	138
143	4,090	122	4,010	120	4,220	128	4,240	129	4,510	138
144	4,120	122	4,040	120	4,250	128	4,270	130	4,550	139
145	4,160	122	4,070	120	4,290	128	4,310	130	4,590	139
146	4,190	123	4,110	120	4,330	128	4,350	130	4,640	139
147	4,220	123	4,140	120	4,360	129	4,390	130	4,680	139
148	4,260	123	4,170	120	4,400	129	4,430	130	4,720	139
149	4,290	123	4,210	120	4,440	129	4,470	130	4,760	140
150	4,330	123	4,240	120	4,470	129	4,500	131	4,810	140
155	4,500	123	4,410	121	4,660	130	4,700	131	5,020	141
160	4,670	124	4,580	121	4,840	130	4,890	132	5,230	142
165	4,850	124	4,740	121	5,020	131	5,080	133	5,440	143
170	5,020	125	4,910	122	5,210	131	5,270	133	5,650	143
175	5,190	125	5,080	122	5,390	132	5,460	134	5,860	144
180	5,360	125	5,250	123	5,580	132	5,650	134	6,080	145
185	5,530	126	5,410	123	5,760	132	5,840	135	6,290	146
190	5,710	126	5,580	123	5,940	133	6,030	135	6,500	146
195	5,880	126	5,750	123	6,130	133	6,230	136	6,710	147
200	6,050	127	5,920	124	6,310	134	6,420	136	6,920	147
205	6,220	127	6,080	124	6,490	134	6,610	137	7,130	148
210	6,400	127	6,250	124	6,680	134	6,800	137	7,350	148
215	6,570	128	6,420	124	6,860	135	6,990	138	7,560	149
220	6,740	128	6,590	125	7,040	135	7,180	138	7,770	149
225	6,910	128	6,760	125	7,230	135	7,370	138	7,980	150
230	7,090	128	6,920	125	7,410	135	7,570	139	8,190	150
235	7,260	128	7,090	125	7,600	136	7,760	139	8,410	151
240	7,430	129	7,260	126	7,780	136	7,950	139	8,620	151
245	7,600	129	7,430	126	7,960	136	8,140	139	8,830	152
250	7,780	129	7,590	126	8,150	136	8,330	140	9,040	152
255	7,950	129	7,760	126	8,330	137	8,520	140	9,260	152
260	8,120	129	7,930	126	8,520	137	8,720	140	9,470	153
265	8,290	129	8,100	126	8,700	137	8,910	141	9,680	153
270	8,470	130	8,260	126	8,880	137	9,100	141	9,890	153
275	8,640	130	8,430	127	9,070	137	9,290	141	10,100	154
280	8,810	130	8,600	127	9,250	137	9,480	141	10,300	154
285	8,980	130	8,770	127	9,430	138	9,670	141	10,500	154
290	9,160	130	8,940	127	9,620	138	9,870	142	10,700	154
295	9,330	130	9,100	127	9,800	138	10,100	142	11,000	155
300	9,500	130	9,270	127	9,990	138	10,300	142	11,200	155

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Simple Span Load Effects Without Impact (spans 140-300 feet) - Standard Permit: Class C

Span (ft)	Veh 16 M (ft*k)	Veh 16 V (k)	Veh 17 M (ft*k)	Veh 17 V (k)	Veh 18 M (ft*k)	Veh 18 V (k)	Veh 19 M (ft*k)	Veh 19 V (k)	Veh 20 M (ft*k)	Veh 20 V (k)
140	4,370	138	4,220	129	4,520	146	4,150	138	4,260	139
141	4,410	138	4,270	130	4,570	146	4,200	139	4,310	139
142	4,460	139	4,310	130	4,620	147	4,250	139	4,360	140
143	4,500	139	4,360	131	4,660	147	4,300	139	4,410	140
144	4,540	139	4,400	131	4,710	147	4,350	140	4,450	141
145	4,580	139	4,450	131	4,760	148	4,400	140	4,500	141
146	4,630	139	4,500	132	4,810	148	4,450	140	4,550	141
147	4,670	140	4,540	132	4,860	148	4,500	141	4,600	142
148	4,710	140	4,590	132	4,910	149	4,550	141	4,640	142
149	4,760	140	4,630	133	4,960	149	4,600	142	4,690	142
150	4,800	140	4,680	133	5,010	149	4,640	142	4,740	143
155	5,010	141	4,900	135	5,260	151	4,890	144	4,970	144
160	5,230	142	5,130	136	5,510	153	5,140	145	5,210	146
165	5,440	143	5,360	138	5,760	154	5,390	147	5,450	147
170	5,660	144	5,590	139	6,010	155	5,640	148	5,690	148
175	5,880	145	5,810	140	6,260	157	5,890	149	5,920	150
180	6,090	146	6,040	141	6,500	158	6,140	150	6,160	151
185	6,310	147	6,270	142	6,750	159	6,390	152	6,400	152
190	6,520	147	6,500	144	7,000	160	6,640	153	6,640	153
195	6,740	148	6,730	145	7,250	161	6,890	154	6,880	154
200	6,950	149	6,950	145	7,500	162	7,140	155	7,110	155
205	7,170	149	7,180	146	7,750	163	7,390	156	7,350	156
210	7,380	150	7,410	147	8,000	164	7,640	157	7,590	156
215	7,600	150	7,640	147	8,250	165	7,890	157	7,830	157
220	7,810	151	7,860	148	8,500	166	8,140	158	8,070	158
225	8,030	151	8,090	149	8,750	166	8,390	159	8,310	159
230	8,250	152	8,320	150	9,000	167	8,640	160	8,540	160
235	8,460	152	8,550	150	9,240	168	8,890	161	8,780	160
240	8,680	153	8,780	151	9,490	168	9,140	161	9,020	161
245	8,890	153	9,010	152	9,740	169	9,390	162	9,260	161
250	9,110	153	9,230	152	9,990	170	9,640	163	9,500	162
255	9,330	154	9,460	153	10,200	170	9,890	163	9,740	163
260	9,540	154	9,690	153	10,500	171	10,100	164	9,980	163
265	9,760	155	9,920	154	10,700	171	10,400	164	10,200	164
270	9,970	155	10,100	155	11,000	172	10,600	165	10,500	164
275	10,200	155	10,400	155	11,200	172	10,900	166	10,700	165
280	10,400	156	10,600	156	11,500	173	11,100	166	10,900	165
285	10,600	156	10,800	156	11,700	173	11,400	167	11,200	166
290	10,800	156	11,100	156	12,000	174	11,600	168	11,400	166
295	11,100	156	11,300	157	12,200	174	11,900	168	11,600	167
300	11,300	157	11,500	157	12,500	175	12,100	169	11,900	167

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Structural Steel Historic Properties (MBE 6B.5.2.1-1 and 2)

Material	Period Built	MDOT Specification	ASTM Specification	Ultimate Stress f_u (ksi)	Yield Stress f_y (ksi)
Str Stl	1873-1889		Wrought Iron	46	26
Str Stl	< 1905	1890	Soft Steel	52-62	26
Str Stl	1905-1923	1901	A-7, OH	52-62	1/2 tensile
Str Stl	1924-1932	1924	A-7	55-65	30
Str Stl	1933-1962	1933 T	A-7	60-72	33
Str Stl	1957-1962	1954	A-373	58-75	32
Str Stl	1963-	1960	A-36	60-80	36
Str Stl	1946-1962	1941 T	A-242 3/4 inches thick	70	50
Str Stl	1946-1962	1941 T	A-242 3/4-1.5 inches thick	67	46
Str Stl	1946-1962	1941 T	A-242 1.5-4 inches thick	63	42
Str Stl	1963-	1960	A-441 3/4 inches thick	70	50
Str Stl	1963-	1960	A-441 3/4-1.5 inches thick	67	46
Str Stl	1963-	1960	A-441 1.5-4 inches thick	63	42
Str Stl	1929-1954	1954	A-94 Sil. \leq 1 1/8 inches	80-95	45
Str Stl	1965-1979	1968	A-588 \leq 4 inches	70	50
Str Stl	> 1980	1979	A-572 Grade 50 \leq 2 inches	65	50
Str Stl	1996	1996 (M)	AASHTO M270 Gr. 250	65	50
Str Stl	1996	1996 (M)	AASHTO M270 Gr. 345	65	50
Pipe		1951	A-53 Grade B	60	35
Pipe		1951	A-53 Grade A	48	30

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Structural Steel Historic Properties - Allowable Stress Method Only

Material	Period Built	MDOT Spec.	ASTM Specification	Inventory Gross Sec. 0.55 fy (ksi)	Inventory Net Sec. 0.50 fu (ksi)	Operating Gross Sec. 0.75 fy (ksi)	Operating Net Sec. 0.67 fu (ksi)
Str Stl	1873-1889		Wrought Iron	14.5	23	19.5	30.8
Str Stl	< 1905	1890	Soft Steel	14.5	26-31	19.5	34.8-41.5
Str Stl	1905-1923	1901	A-7, OH	16.5	26-31	22.5	34.8-41.5
Str Stl	1924-1932	1924	A-7	16.5	27.5-32.5	22.5	36.8-43.5
Str Stl	1933-1962	1933 T	A-7	18	30-36	24.5	40.2-48.2
Str Stl	1957-1962	1954	A-373	18	29-37.5	24.5	38.9-50.2
Str Stl	1963-	1960	A-36	20	30-40	27	40.2-53.6
Str Stl	1946-1962	1941 T	A-242 3/4 inches thick	27.5	35	37.5	46.9
Str Stl	1946-1962	1941 T	A-242 3/4-1.5 inches thick	25	33.5	34.5	44.9
Str Stl	1946-1962	1941 T	A-242 1.5-4 inches thick	23	31.5	31.5	42.2
Str Stl	1963-	1960	A-441 3/4 inches thick	27.5	35	37.5	46.9
Str Stl	1963-	1960	A-441 3/4-1.5 inches thick	25	33.5	34.5	44.9
Str Stl	1963-	1960	A-441 1.5-4 inches thick	23	31.5	31.5	42.2
Str Stl	1929-1954	1954	A-94 Sil. <= 1 1/8 inches	24.5	40-47.5	33.5	53.6-63.6
Str Stl	1965-1979	1968	A-588 <= 4 inches	27.5	35	37.5	46.9
Str Stl	> 1980	1979	A-572 Grade 50 <= 2 inches	27.5	32.5	37.5	43.5
Str Stl	1996	1996 (M)	AASHTO M270 Gr. 250	27.5	32.5	37.5	43.5
Str Stl	1996	1996 (M)	AASHTO M270 Gr. 345	27.5	32.5	37.5	43.5
Pipe		1951	A-53 Grade B	19.5	30	26	40.2
Pipe		1951	A-53 Grade A	16.5	24	22.5	32.2

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Reinforcing Steel - Historic Properties (MBE 6B.5.2.3-1)

Period Built	Year of MDOT Spec.	ASTM Specification	Ultimate Stress Min. f _u (ksi)	Yield Stress Min. f _y (ksi)
< 1954	Unknown	A-15 Structural	55-75	33
1955-1967	1954	A-15 Structural	70-90	36
1968-1976	1968	A-615 Grade 40	70	40
> 1977	1976-1990	A-615 Grade 60	90	60
1996	1996 (Metric)	A-615M Grade 400	90	60

Reinforcing Steel Historic Properties - Allowable Stress Method Only

Period Built	Year of MDOT Spec.	ASTM Specification	Inventory Rating (ksi)	Operating Rating (ksi)
< 1954	Unknown	A-15 Structural	18	25
1955-1967	1954	A-15 Structural	20	28
1968-1976	1968	A-615 Grade 40	20	28
> 1977	1976-1990	A-615 Grade 60	24	36
1996	1996 (M)	A-615M Grade 400	24	36

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Prestressing Steel Historic Properties

Period Built	Year of MDOT Spec	ASTM Specification	Dia. (in)	Area (in ²)	Ultimate Strength Min f_{ps} (k)	Ultimate Stress Min f'_s (ksi)	Yield Stress f^*_y (ksi)	Inventory Allowable Stress Prior to Transfer and Loss (ksi)*	Operating Allowable Stress $0.90f^*_y$ (ksi)
1954-1961	1957	A-416 (Grade 250)	3/8	0.080	20.00	250	212.5	175	191.25
1954-1961	1957	A-416 (Grade 250)	7/16	0.108	27.00	250	212.5	175	191.25
1954-1961	1957	A-416 (Grade 250)	1/2	0.144	36.00	250	212.5	175	191.25
1962-	1965	A-416 (Grade 270)	3/8	0.085	22.95	270	229.5	189	206.55
1962-	1965	A-416 (Grade 270)	7/16	0.115	31.05	270	229.5	189	206.55
1962-	1965	A-416 (Grade 270)	1/2	0.153	41.31	270	229.5	189	206.55
1970-	1970	A-416 (Grade 250) stress-relieved	1/2	0.153	38.25	250	212.5	175	191.25
1970-	1970	A-416 (Grade 270) stress-relieved	1/2	0.153	41.31	270	229.5	189	206.55
1976-	1976	A-416 (Grade 270)	1/2	0.153	41.31	270	229.5	189	206.55
1990-1996	1990	A-416 (Grade 270) Supplement I low-relaxation	1/2	0.153	41.31	270	243	202.5	218.7
1996-	1996 (M)	A-416M (Grade 1860 MPa) low relaxation (Grade 270 ksi)	1/2 12.7 mm	0.153 98.71 mm ²	41.31	270	243	202.5	218.7
1997-	1996 (M)	A-416M (Grade 1860 MPa) low-relaxation (Grade 270 ksi)	0.6 15.2 4mm	0.217 140 mm ²	58.59	270	243	202.5	218.7

* Inventory Rating (< 1990) stress prior to transfer = 0.70f's. Inventory Rating (> 1990) stress prior to transfer = 0.75f's.

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Reinforced Concrete Historic Properties

Period Built	Grade	f_c (ksi) (Values for Design)	f_c (ksi)(Specification)	*n Es/Ec
< 1921		2.0	2.5	15
1922-1935	A	2.5	3.0	12
1936-1943	A	2.5	3.0	12
1944-1972	A	3.0	3.5	10
1944-1972	AA	3.5	4.0	10
1944-1972	B	2.5	3.0	12
1973-1975	40S	3.5	4.0	10
1976-1990	45D	4.0	4.5	8
1976-1990	35S	3.0	3.5	10
> 1996	D	4.0 (28 MPa)	4.5 (31 MPa)	8
> 1996	S2	3.0 (21 MPa)	3.5 (24 MPa)	10

Reinforced Concrete Historic Properties - Allowable Stress Method Only

Period Built	Grade	*Inventory Rating (f_c) (ksi)	*Operating Rating (f_c) (ksi)
< 1921		0.8	1.2
1922-1935	A	1.0	1.5
1936-1943	A	1.0	1.5
1944-1972	A	1.2	1.9
1944-1972	AA	1.2	1.9
1944-1972	B	1.0	1.9
1973-1975	40S	1.3	2.1
1976-1990	45D	1.6	2.4
1976-1990	35S	1.2	1.9
> 1996	D	1.6	2.4
> 1996	S2	1.2	1.9

* Per AASHTO MBE 6B.5.2.4.1-1

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Prestressed Concrete Historic Properties

Period Built	f'_c (ksi) (Deck Design)	f'_c (ksi) (Beam Design)	n (E_{beam}/E_{deck})	n^{**} (E_s/E_c)
< 1973	3.0	5.0	1.3	7
1973-1975	3.5	5.0	1.2	7
1973-1975	3.5	6.0	1.3	6
1976-1990	4.0	5.0	1.1	7
1976-1990	4.0	6.0	1.2	6
> 1990	4.0	*	*	*

* The Standard Specifications for Construction require a minimum f'_c of 5.0 ksi. However, prestressed concrete compressive strengths generally range from 5.0 ksi to 7.0 ksi during this time period. Consult the existing bridge plans for actual design strengths.

** $E_s=28,000$ ksi for prestressing strands

AASHTO LRFD Specifications (5.4.2.4): $E_c = 120,000 K_1 w_c^{2.0} f'_c^{0.33}$ (where f'_c is in ksi)

AASHTO Standard Specifications: $E_c \text{ beam} = 33 w_c^{1.5} f'_c^{0.5}$ (where $w_c=145$ pcf and f'_c is in psi)

Prestressed Concrete Historic Properties - Allowable Stress Method Only

Period Built	f'_c (ksi) (Beam Design)	Inventory f_c (psi)	Operating f_c (psi)
< 1973	5.0	2.0	2.75
1973-1975	5.0	2.0	2.75
1973-1975	6.0	2.4	3.3
1976-1990	5.0	2.0	2.75
1976-1990	6.0	2.4	3.3
> 1990	*	(0.4 f'_c)	(0.55 f'_c)

* The Standard Specifications for Construction require a minimum f'_c of 5.0 ksi. However, prestressed concrete compressive strengths generally range from 5.0 ksi to 7.0 ksi during this time period. Consult the existing bridge plans for actual design strengths.

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Dapped Concrete Beam Ends (BA-2018-3)

Dapped concrete beam ends are created by notching either the lower corner of the beam web, allowing the nib of the beam to rest on a beam or other support (see Figure 1), or by notching the upper corner of the beam web, providing a bearing support for a shallower section (see Figure 2). Although superstructure designs with dapped beam ends are uncommon on highway bridges, these superstructure types have been used in Michigan. The importance of closely inspecting the beam end, bearing seat and surrounding area cannot be overstated. The inherent design of the beam end leads to concentrated shear stresses at the reduced section and the joint creates a shelf where road salt and other debris can accumulate. In addition to the formation of shear cracks, inspectors should closely monitor dapped beam ends for flexure cracking, tension cracking, delamination, spalling and corrosion of steel reinforcement. Dapped beam ends must also be load rated to verify the capacity for legal loads.

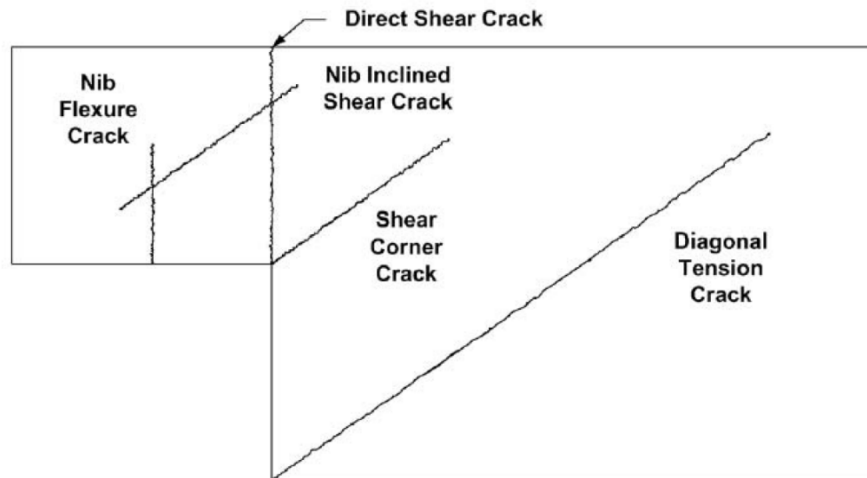


Figure D-1: Crack Locations for Dapped End Double Tee Beams, Report No. FHWA NHI 12-049 (p. 9.8.6)

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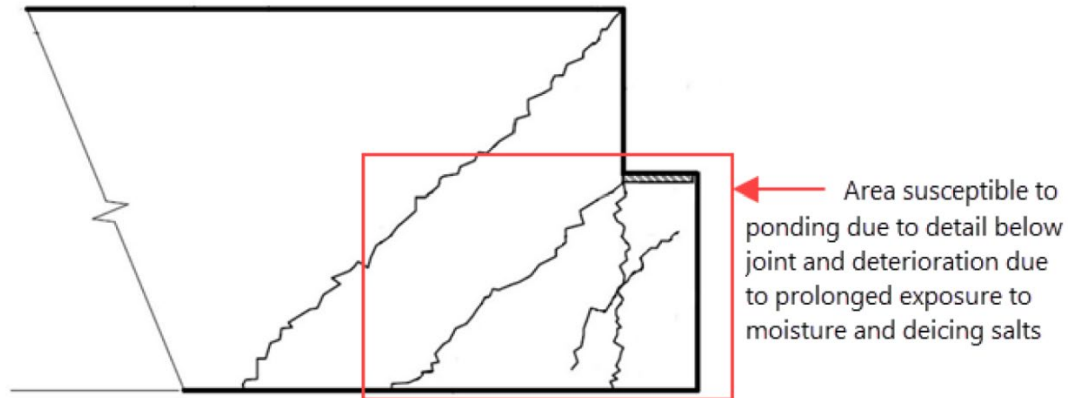


Figure D-2: Crack Locations for Inverted Dapped End Beams

Inspecting Dapped Concrete Beam Ends

Bridge owners and inspectors are encouraged to schedule periodic detailed, hands-on inspections to detect new cracks as they develop and document any cracking that had previously formed. Cracking in both prestressed and conventionally reinforced beams should be monitored with increased inspection frequencies. Measuring crack widths in several locations will aid in determining changes during future inspections. Special attention should be paid to the bearing area of inverted dapped beam ends, where ponding of water due to the joint above and prolonged exposure to moisture and deicing salts could cause accelerated deterioration of concrete and reinforcing steel in these locations.

Leaking joints and/or the application of deicing materials may cause the steel reinforcement within this area to corrode at an advanced rate compared to other portions of the structure. Efflorescence and rust staining on the underside surface should also be documented. Rust staining should initiate a response from the bridge owner or inspector to sound the concrete in an effort to verify the extent of debonding. Pneumatic scaling within the surrounding area to measure the remaining section thickness of steel reinforcement is not recommended.

Load Rating Dapped Concrete Beam Ends

The PCI Design Handbook lists the following potential failure modes that should be investigated when analyzing dapped concrete beam ends. Research indicates that these failure modes are applicable to both prestressed and reinforced concrete beam ends. The five failure modes are illustrated in Figure 3.

1. Flexure (cantilever bending) and axial tension in the extended end.
2. Direct shear at the junction of the dap and the main body of the component.
3. Diagonal tension emanating from the reentrant corner.

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4. Diagonal tension in the extended end.
5. Diagonal tension in the undapped portion.

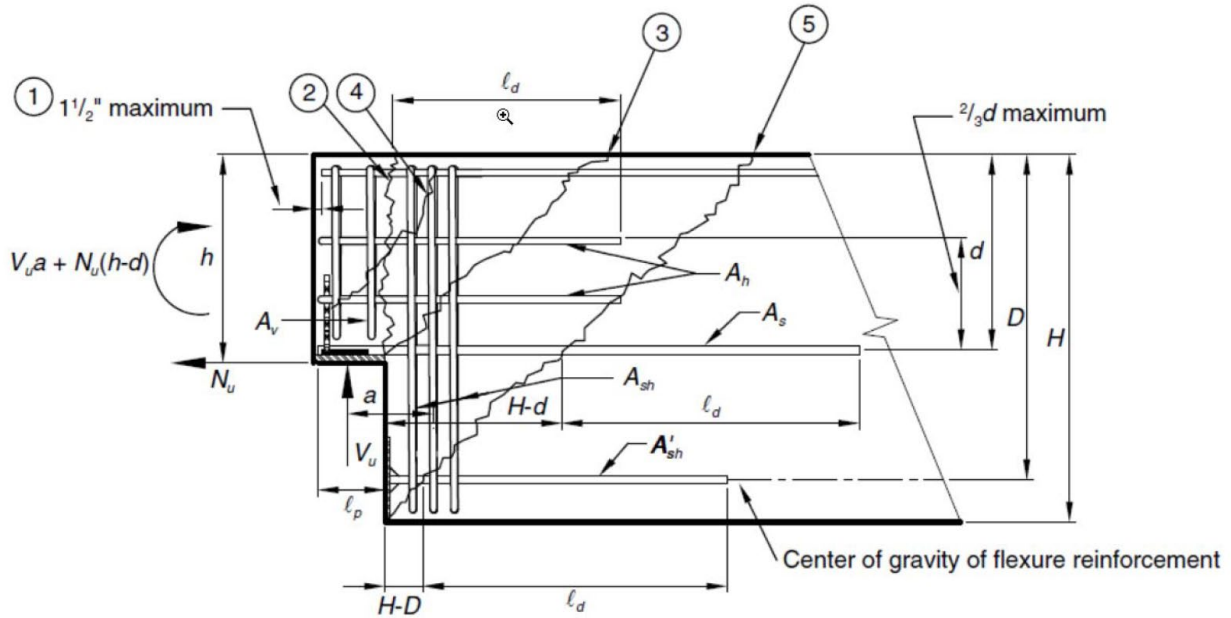


Figure D-3: Potential failure modes and required reinforcement in dapped-end connections, PCI Design Handbook, 7th Edition (p. 5-80)

It is important to remember that section loss of the reinforcing steel within this location will impact the load carrying capacity of the entire structure. If further inspection or analysis is necessary, it is highly recommended to document these needs on a Request for Action (RFA) report in MiBridge.

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MDOT Load Rating Policy and Modeling Preferences

MDOT makes the following assumptions/modeling approaches when conducting load ratings.

LRFR Analysis

Do not run overload vehicles as single lane loaded in LRFR.

The pedestrian load input under sidewalk in the structure typical section does not apply the load to the model in BrR. The pedestrian load will have to be added under “Member Loads,” “Pedestrian Load” under each beam.

Prestressed Concrete Structures

Model all multi-span prestressed concrete structures as simply supported.

For box beams with skewed stirrups at ends, stirrups should be entered as dimensioned along the same face of the beam. For fanned stirrups, this reflects the tighter spacing at one end of the beam and the wider spacing at the other end.

The weights of concrete diaphragms shall be calculated and input into the framing plan section of the model.

The weights of the joint grout between side-by-side box beams shall be calculated and input as a member defined load.

For a new structure, uncheck “Ignore Design and Legal Load Shear” in the LRFR control options.

In LRFR, there are additional limit states that need to be checked for new designs and existing structures showing distress at the beam ends or high flexural demand locations. “Ignore design and legal load shear” and “Ignore permit load shear” should be unchecked in BrR for HL-93 design, legal and permit loads. “Consider legal load tensile concrete stress” should be checked in BrR for legal loads. “Consider permit load tensile steel stress” should be checked in BrR for permit loads.

Use of 1979 Interim Code Shear Specifications is limited to beams with large shear stirrup spacings for the entire length of the span, no shear cracks or issues noted during recent inspections, and to only be used when necessary to avoid posting or dropping overload class. A note about using the 1979 shear specs shall be added to the assumptions and summary forms.

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Steel Structures

For pin and hangers, use the P&H Spreadsheet from MDOT to determine its capacity and include it in the load rating calculations. This can also be accomplished in BrR by creating a Point of Interest at the pin and hanger and manually overriding the shear capacity.

Plastic analysis can be used for A373 steel although the MBE states only for steels at or above 33 ksi. Plastic analysis cannot be used for riveted plate girders or other members with holes in the tension flange without an analysis to ensure there are no issues with fracturing.

MDOT will not post a bridge based on LFR steel serviceability if the structure does not show signs of permanent deflection or deformation. Serviceability can be ignored to avoid dropping the overload class, but not to raise it. A note shall be added to assumptions and summary form if this option is used.

Live Load Distribution

Use lever rule on fascia beams as applicable. This should be done on a case-by-case basis.

AASHTO 1994 Design Guide Specs can be used to improve rating.

Deck Thickness

Use full depth of deck per plans. Do not omit the AASHTO 1.5-inch sacrificial wearing surface from the structural thickness.

Haunches

In all cases except for deck replacements, include haunch weight as a member dead load but do not include the haunch depth in the structural capacity unless the haunch is specifically dimensioned on the plans. Assume 2-inch haunch for weight.

Culverts

Use 2.0 feet for LFD and LRFD live load surcharge heights.