VOLUME 3

BRIDGE LOAD RATING, PERMITTING AND POSTING MANUAL

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BRIDGE LOAD RATING, PERMITTING AND POSTING MANUAL

PURPOSE:

To establish procedures for load rating structures, establishing the safe load carrying capacity of structures for permitting overweight vehicles and posting structures that cannot safely carry legal loads.

AUTHORITY:

Sections 334.044 and 335.074, Florida Statutes

SCOPE:

The requirements related to this procedure affect all District Structures and Facilities personnel involved in load rating bridges, and all Department personnel involved in posting bridges. In addition, consultants performing load ratings for the Department may be required by contract to follow requirements of this procedure.

GENERAL:

This manual combines and supersedes the following procedures:

NUMBER	EFFECTIVE DATE	TITLE
850-010-002-b	November 17, 1988	Bridge Load Rating and Weight Limit Posting for State Owned Bridge Structures.
850-040-005-a	July 20, 1989	Preapproved Routing for Overweight Permits Between 150,000 Pounds and 172,000 Pounds.

TRAINING:

None required.

DISTRIBUTION:

One official copy of this manual will be held by each District Structures and Facilities Office, each District Structures Design Office, each District Traffic Engineer, the Structures Design Office, the State Road Use Permits Engineer, the Engineer of Structure Maintenance Operations, the Bridge Inspection and Evaluation Engineer, and Organization and Procedures. Additional official holders may be specified by the State Maintenance Office. The State Maintenance Office will maintain a master list to ensure additions and revisions are distributed to all official holders of the manual.

Each office may obtain additional copies of this manual, but it will be the individual office's responsibility to ensure that these additional manuals are updated.

Interested parties may obtain copies of this manual from the Maps and Publications Office, 605 Suwannee Street, Mail Station 12, Tallahassee, Florida 32399-0450; and it shall be their responsibility to obtain all future updates from the State Maintenance Office. This manual is supplied to Department personnel at no cost. Consultants and others outside the Department may purchase the manual.

REVISIONS AND UPDATES:

The Manual Review Committee will consist of all District Structures and Facilities Engineers, the Bridge Inspection and Evaluation Engineer and other representatives of the State Maintenance Office as appointed by the Engineer of Structure Maintenance Operations. The Bridge Inspection and Evaluation Engineer shall periodically convene the Manual Review Committee to review the manual and to consider any proposed revisions. The committee shall meet at least once annually.

Requests for revisions to this manual shall be submitted to the Bridge Inspection and Evaluation Engineer, Florida Department of Transportation, M.S. 52, 605 Suwannee Street, Tallahassee, Florida 32399-0450. Minor revisions to this manual may be issued by the State Maintenance Engineer after approval of the Manual Review Committee and consultation with any other affected parties; i.e., Federal Highway Administration and Organization and Procedures Office.

Major revisions, as determined by the Manual Review Committee, will be approved by the Secretary following the process established in the Department's Standard Operating System.

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SECTION I - GENERAL

A. **Integration With Bridge Management System Manuals.** The load rating process is a component of the inspection process and consists of determining the safe load carrying capacity of structures, determining if specific overweight vehicles can safely cross the structure and determining if a structure needs to be weight restricted and the level of posting required.

The bridge management system consists of the following existing or planned volumes:

- **Volume 1** - Bridge and Other Structures Inspection and Reporting Procedures Manual; (Topic No. 850-010-030) specifically defines standards for inspection and reporting practices.

- **Volume 2** - Bridge Management Inventory System Manual(BMIS); (Topic No. 850-010-010) defines the methods for coding bridge data into the computer database.

- **Volume 3** - Bridge Load Rating, Permitting and Posting Manual; (Topic No. 850-010-035) defines the method for load rating, and posting bridges and the analysis of routes for permitted vehicles.

- **Volume 4** - Bridge Maintenance Planning and Repair Methods Manual; (Topic No. 850-015-001) defines standard maintenance and repair details including repair equipment, material and manpower. (Future Volume).

- **Volume 5** - Bridge Underwater Operations Manual; (Topic No. 850-010-011) defines the procedures and safety requirements for diving operations to perform underwater bridge inspections. (Note: This manual is currently referred to as the Dive Manual.)

- **Volume 6** - Bridge Operations and Maintenance Manual; (Topic No. 850-010-031) defines the organization, responsibilities and functions involved in bridge inspection, maintenance and operations. (Future Volume.)

- **Volume 7** - Bridge and Other Structures Maintenance Operations System Manual; defines the Department's objectives and methods of bridge management. (Future Volume).

B. **Objectives.** The objectives of this manual are to codify the procedures and to detail the concepts for the load rating, posting and permitting process. Specific examples of load rating are not included. Load rating examples are available in a variety of references; the BARS Users manuals contain several good load rating examples. Currently, the "BARS Data Preparation Instructions", Volume 2, is available from the Maps and Publications Office. The other BARS Users' Manuals are out of print, but copies exist in each District Structures and Facilities Office.

C. **Definitions.**

1. Engineering Judgement - Decisions made by a registered Professional Engineer based on knowledge and experience of engineering factors for input into a recognized formula, computer program, or load test. Such judgement will not be used to override the final output of such formula, computer program, or load test, but should be used to evaluate the validity of the final output.

2. Governing Component - That component of a structure with the least live load carrying capacity.

3. Inventory Rating - The rating which represents the load level which can safely utilize an existing structure for an indefinite period of time.

4. Live Load Distribution Factor - The fraction of a rating truck wheel line load assumed to be carried by a structural component.

5. Load Rating - The process of determining the live load capacity of a structure based on its current condition through analysis or load test.

6. Operating Rating - The rating which represents the absolute maximum permissible load level to which the structure may be subjected.

7. Rating Factor - The ratio of the available Live Load Moment or Shear Capacity to the Moment or Shear produced by the load being investigated.

8. Redundant - A structure for which multiple load paths exist, where if one element fails, alternate load paths will allow the load to be redistributed.

D. Metrication. The United States is in the process of converting from the English system of units, to the System Internationale (SI) units. After the conversion is complete, all analysis, computer programs and specifications will be in SI units. During the transition period, a mixture will be used. Currently, legal loads are expressed in pounds and tons, our load rating programs use feet and pounds.

The public recognizes weight restrictions signs in tons. To prepare for the changes, this manual will use dual units with the English units in parenthesis. The English units will be the exact units and a "hard" conversion will be used. A hard conversion converts to the SI units using a number with appropriate accuracy as opposed to a soft conversion which uses an exact conversion. For example, the soft conversion of 20 tons would be 18,143.695 kg, and the hard conversion is 18,100 kg.

1 Ton = 907.185 Kg

SECTION II - PROCEDURES GOVERNING THE LOAD RATING PROCESS

A. **General.** The specifications governing this work is the latest edition (including interim specifications) of the "Manual for Condition Evaluation of Bridges", published by AASHTO. The District Maintenance Engineer and appropriate staff are responsible to ensure that every bridge structure within their jurisdiction is properly load rated. If the district staff is incapable of performing this function and the Engineer of Record has not load rated the bridge, then consulting engineers should be hired to perform this activity.

B. **Concepts.** The following concepts are to be applied to the load rating process:

1. Substructures generally do not control the load rating. However, after the superstructure has been load rated, the load rater should determine if the substructure can carry an equivalent or greater load than the superstructure. If not, the substructure will be load rated and the load rating adjusted. A complete analysis of the substructure is not required if in the engineering judgement of the load rater the substructure has equivalent or greater capacity than the superstructure.

2. Reinforced concrete bridge decks on redundant multi-girder bridges will not normally be rated unless damage, deterioration, or other reasons merit this analysis. All other bridge deck systems shall be rated.

3. Utilizing engineering judgement, all superstructure spans and components of the spans shall be load rated for both moment and shear until the governing component is established. For example, a two girder super-structure system with floor beams and stringers would require the rating of stringers, floor beams and girders to establish the governing component. If the engineer determines that certain components will not control the rating, then a full analysis of the non-controlling elements is not required.

4. The governing rating shall be the lesser of the shear capacity or moment capacity of the critical component.

5. Some composite prestressed concrete girder bridges were designed with the deck continuous over the supports in

order to eliminate transverse deck joints. The girders of these bridges were not made continuous over the support. Bridges meeting this description shall be load rated as simple spans.

6. Precast segmental box girder concrete bridges which are constructed from segments with dry joints (no epoxy in joints), shall be load rated with a limitation of zero concrete tensile stress perpendicular to the joints.

7. A thermal gradient shall be considered during the load rating of segmental bridges. This thermal gradient shall be applied in accordance with the "AASHTO Guide Specifications for the Design and Construction of Segmental Bridges".

8. The load factor method is the required method for load rating structures, unless circumstances dictate that other methods be used. The Federal Highway Administration (FHWA) mandated that Bridge Management Inventory Items H9(64) Operating Rating, and H10(66) Inventory Rating be reported in values calculated using the load factor method. All new load ratings and any reanalysis required due to change in condition are to be calculated using the load factor method. The FHWA has set a goal of having all structures on the National Highway System load rated by the load factor method by the time the Department submits the National Bridge Inventory data in 1995. The Department has agreed to try to have all structures that are functionally obsolete or structurally deficient on the National Highway System load rated by the load factor method when the Department submits the National Bridge Inventory data to the FHWA in 1995. Some short span flat slab reinforced concrete structures may have higher ratings with the working stress method than the load factor method. Other older structures may not meet load factor design specifications. Therefore, for structures where the working stress method yields higher load ratings, permitting and posting decisions will be made using the working stress method although the load rating results obtained using the load factor method will be entered for BMIS items H9(64) and H10(66). In this case, the State Road Use Permits Office should be informed in writing with a copy to the State Bridge Inspection and Evaluation Engineer. Where the load factor method is inapplicable to a structure the working stress method should be used, structures that do not meet load factor design specifications such

as riveted steel girders or steel trusses will often require working stress analysis. When a load test has been performed on a structure the load ratings determined by the load test should be entered in the BMIS file.

9. The formulas that govern the rating of prestressed concrete are stated in Figure II-1.

10. The Bridge Analysis and Rating System (BARS) is the preferred analysis program to load rate all bridge structures unless the BARS system is incapable of rating the bridge. The BARS and other bridge analysis input data shall be stored on the main frame computer disk pack for future analysis, including overload permit analysis. The BARS program is now available on a personal computer platform in addition to the mainframe. Input data for the PC version of BARS may be stored on disc or on the mainframe.

11. For most simple span bridge structures without skew the Department's software package, Structural Analysis for LOad Distribution (SALOD), is the preferred method for the determination of live load distribution. All structure types that can be accurately analyzed by the SALOD system shall utilize this software package. SALOD can be used for continuous spans by inputting the distance between points of dead load contraflexure as the span length.

    For most continuous span bridge structures, the Department's software package, Bridge Rating Using the Finite Element Method (BRUFEM) may be used for determination of live load distribution or the complete analysis of the structure.

12. Bridge superstructures constructed with composite prestressed deck panels which are in good condition (no spalling), should have live load distribution factors established which are 10% larger (greater applied load) than the distribution factors predicted by the SALOD system. Deck panel systems which are in poor condition (exhibiting either transverse or longitudinal spalling), shall have the live load distribution factors established as if the deck slabs act as simple spans between girders.

13. The inventory rating is normally calculated for the MS-18 (HS-20) truck.

14. The operating rating must be calculated for the MS-18 (HS-20) design truck and seven legal trucks as described in Figures II-2 to II-9.

15. First order load rating calculations as described above, shall consist of computations made from design plans, shop drawings, as-built plans, or field measurements.

    Second order computations shall consist of first order computations adjusted for actual material properties as determined from field sampling and tests of the materials. Second order calculations may require the use of 3-D models such as the model used in the BRUFEM software. Second order load ratings should be performed before attempting load tests (third order).

    Third order load ratings shall be determined from full scale instrumented load tests designed to ascertain the ultimate load capacity of the structure or 2.16 times MS-18 (HS-20) loading, whichever is less.

16. When consultants perform load ratings, they will follow the requirements of this manual. The district load rating staff will review the consultant's load ratings and perform spot checks to confirm accuracy of the consultant's work. Consultant load ratings will be signed and sealed by a professional engineer. The consultant shall have quality control procedures in place to assure the accuracy and completeness of the load ratings.

GENERALIZED FORMULAS FOR RATING PRESTRESSED CONCRETE BRIDGE FOR MOMENT NOTING THE CRACKING LOAD LIMITATION

Non-Composite

Inventory

Elastic $M_{L+I} \leq \left[6\sqrt{f'_c} + \frac{F_F}{A_C} + \frac{F_F e_c}{S^+_b} - \frac{M_D}{S^-_b}\right] S^+_b$

Load Factor $M_{L+I} \leq \frac{1}{1.667}\left[\frac{Mu}{1.3} - M_D\right]$

Operating

Load Factor $M_{L+I} \leq .75M_u - M_D$

Elastic * $M_{L+I} \leq \left[B\sqrt{f'_c} + \frac{F_F}{A_c} + \frac{F_F e_c}{S^+_b} - \frac{M_D}{S^-_b}\right] S^+_b$

** $M_{L+I} \leq \left[(0.9)(0.85)(f'_s) - \frac{M_D}{Z}\right] Z$

Composite

Inventory

Elastic $M_{L+I} \leq \left[6\sqrt{f'_c} + \frac{F_F}{A_c} + \frac{F_F e_c}{S^+_b} - \frac{M_D}{S^+_b} - \frac{M_D}{S^-_b}\right] S^+_{bc}$

Load Factor $M_{L+I} \leq \frac{1}{1.667}\left[\frac{Mu}{1.3} - M_D - M_{SD}\right]$

Operating

Load Factor $M_{L+I} \leq 0.75Mu - M_D - M_{SD}$

Elastic * $M_{L+I} \leq \left[B\sqrt{f'_c} + \frac{F_F}{A_c} + \frac{F_F e_c}{S^+_b} - \frac{M_D}{S^+_b} - \frac{M_{SD}}{S^+_{bc}}\right] S^+_{bc}$

** $M_{L+I} \leq \left[(0.9)(0.85)(f'_s) - \frac{M_D}{Z} - \frac{M_{SD}}{Z_c}\right] Z_c$

Legend

Mu - Ultimate Moment Capacity	e_c - prestressing eccentricity
M_{L+I} - Live load and impact moment	S - Elastic section modulus
M_D - Dead load moment	Z - Plastic section modulus
M_{SD} - Secondary dead load moment	F_F - Prestressing force
f'_c - concrete compressive strength	f'_s - prestressing steel ultimate strength

* Present Practice: B = Modulus of Rupture Factor = 8.25 no longer used.

** Present Practice: (Default - Common Block Data) - The BARS system utilizing the common block does not perform this check. This check is not recommended; however, it can be activated by coding X in cc 16 on card 8.

FIGURE II-1

SINGLE UNIT - 2 AXLE (SU2)

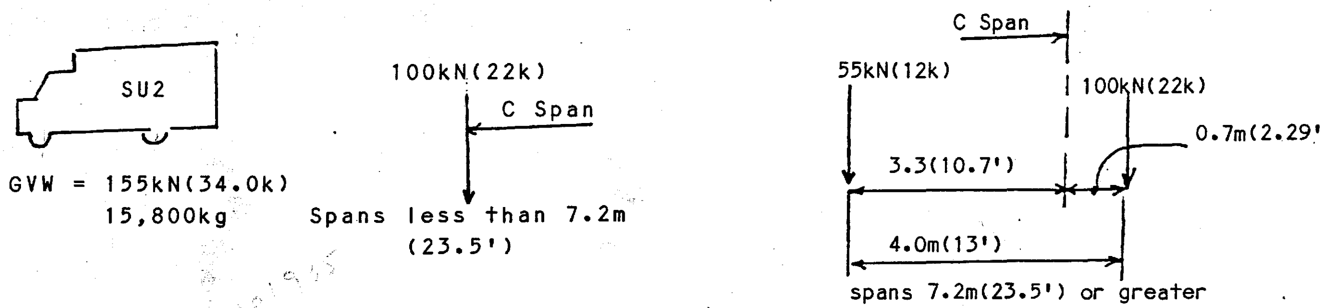


FIGURE II-2

SINGLE UNIT - 3 AXLE (SU3)

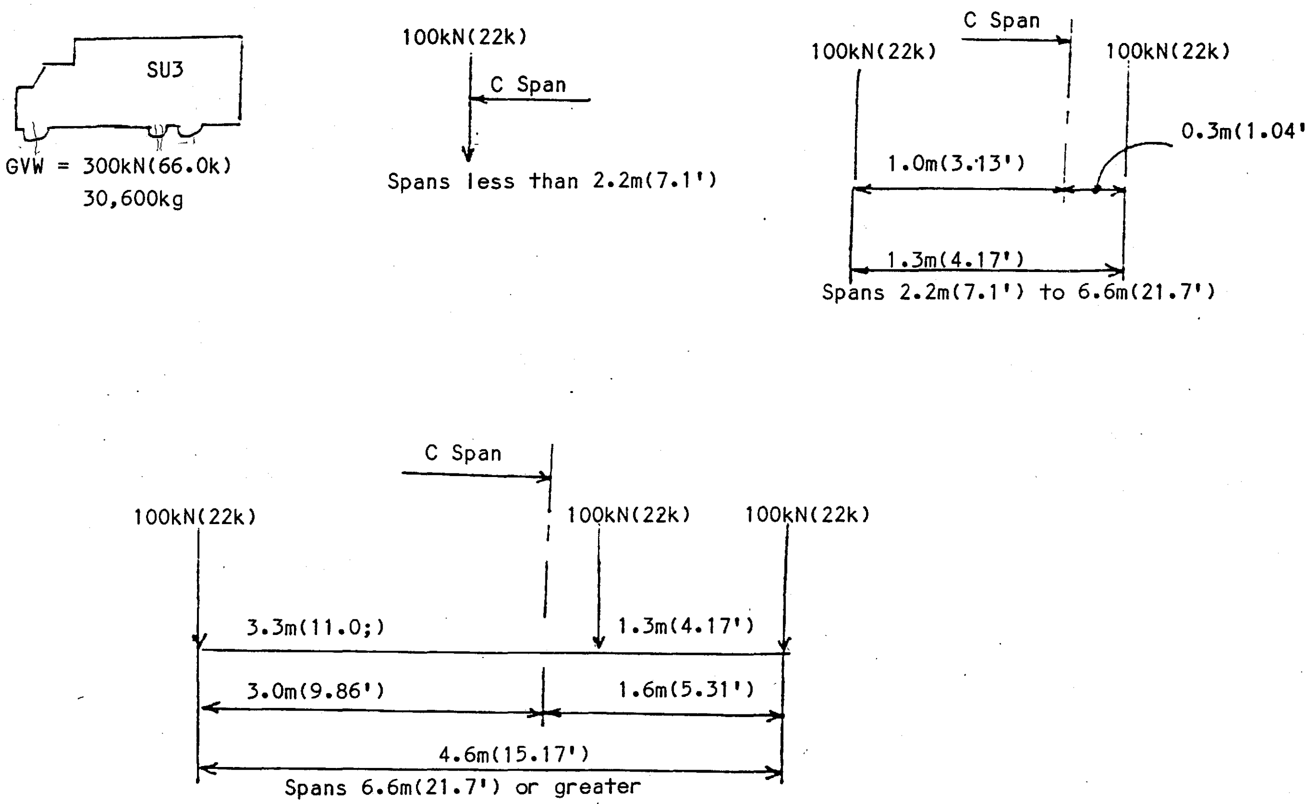


FIGURE II-3
MAXIMUM FLORIDA LEGAL LOAD CASES AND AASHTO DESIGN LOAD CASES AND THEIR PLACEMENTS ON VARIOUS SIMPLE SPANS TO YIELD MAXIMUM MOMENT

SINGLE UNIT - 4 AXLE (SU4)

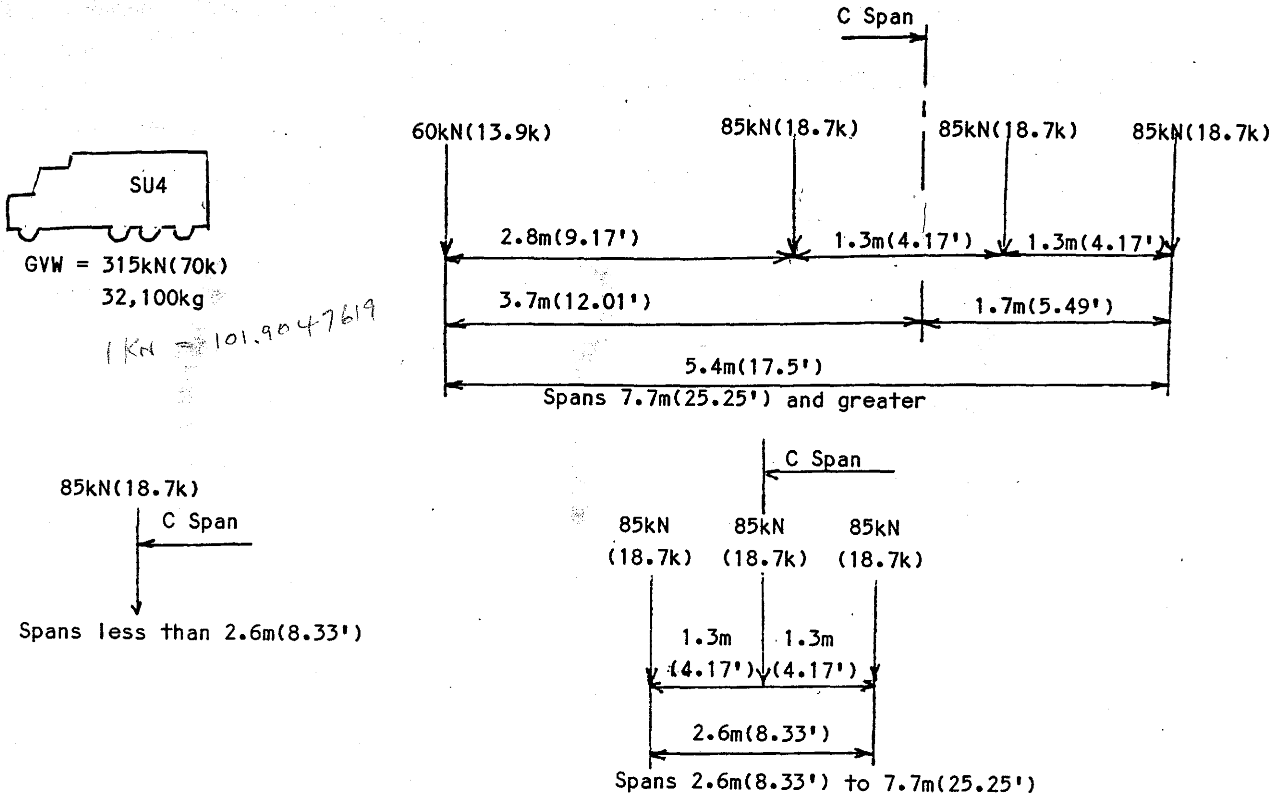


FIGURE II-4

COMBINATION - 3 AXLE (C3)

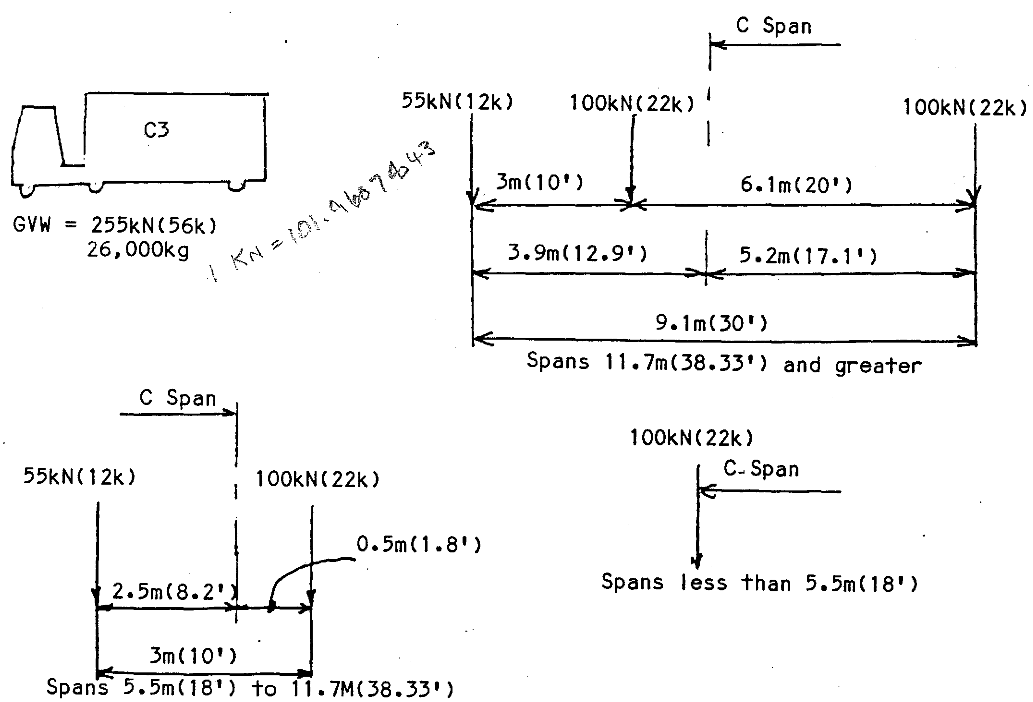


FIGURE II-5

COMBINATION - 4 AXLE (C4)

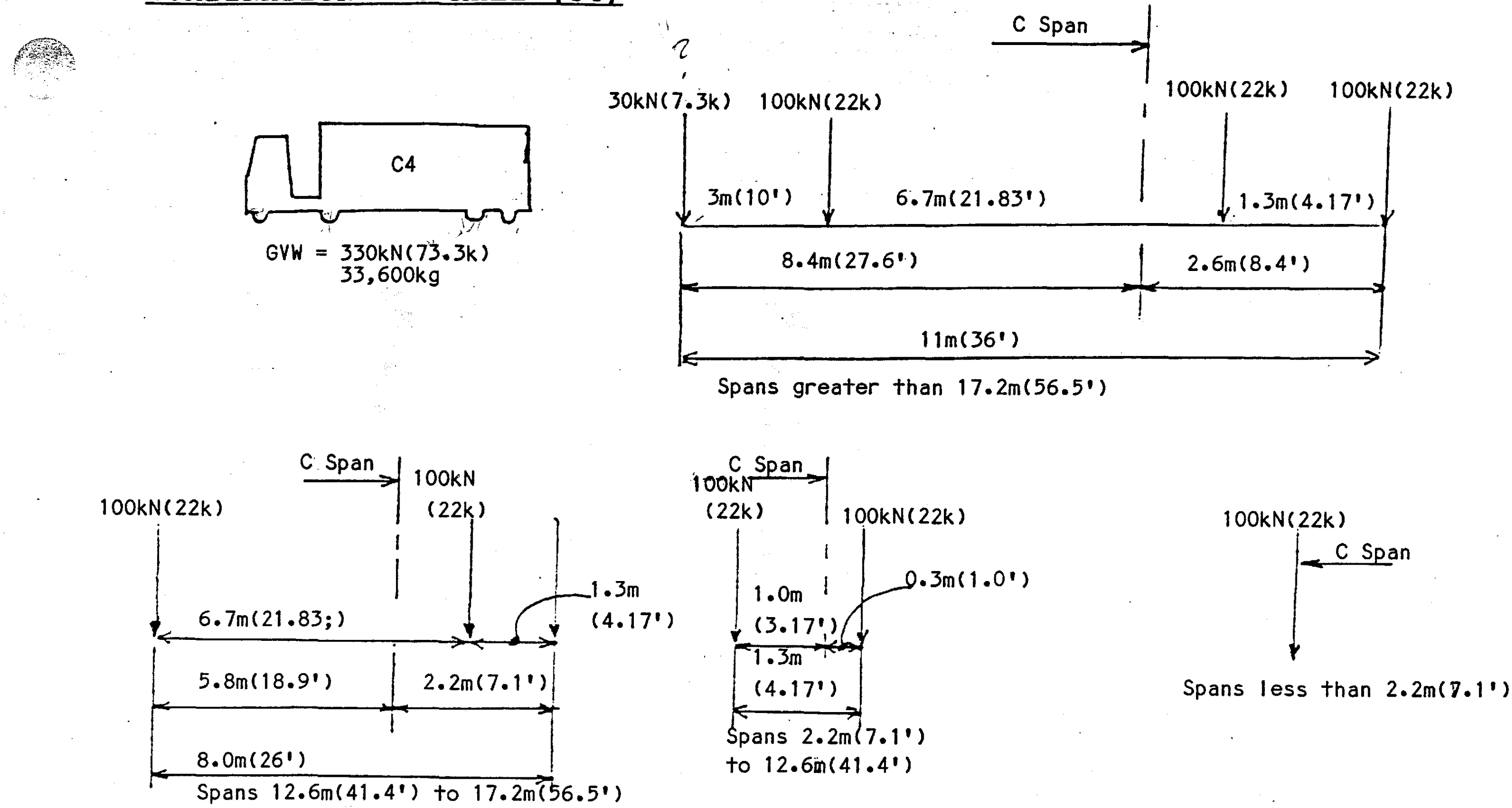


FIGURE II-6

COMBINATION - 5 AXLE (C5)

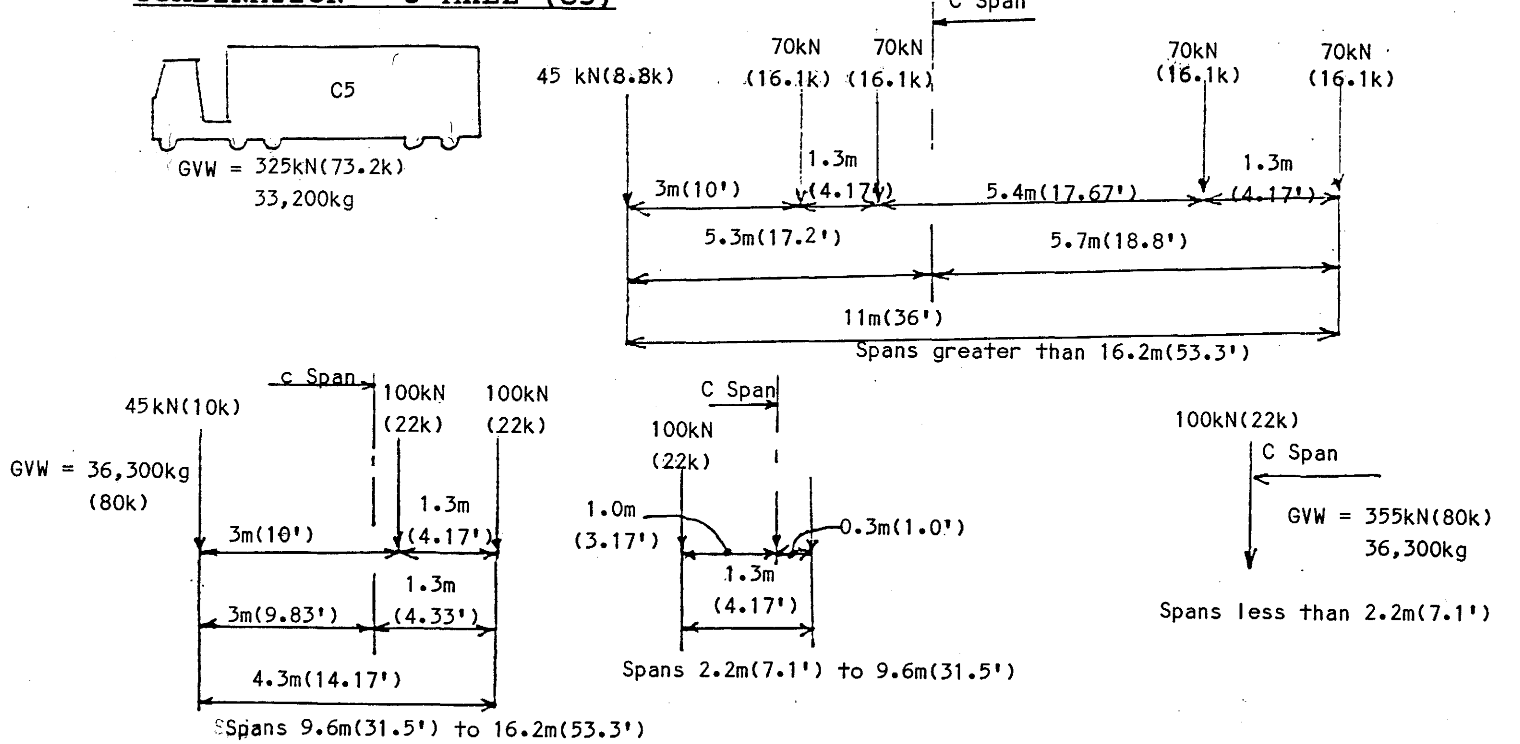


FIGURE II-7

SINGLE UNIT TRUCKS PULLING A TRAILER OR TRACTOR PULLING TANDEM TRAILERS (ST5)

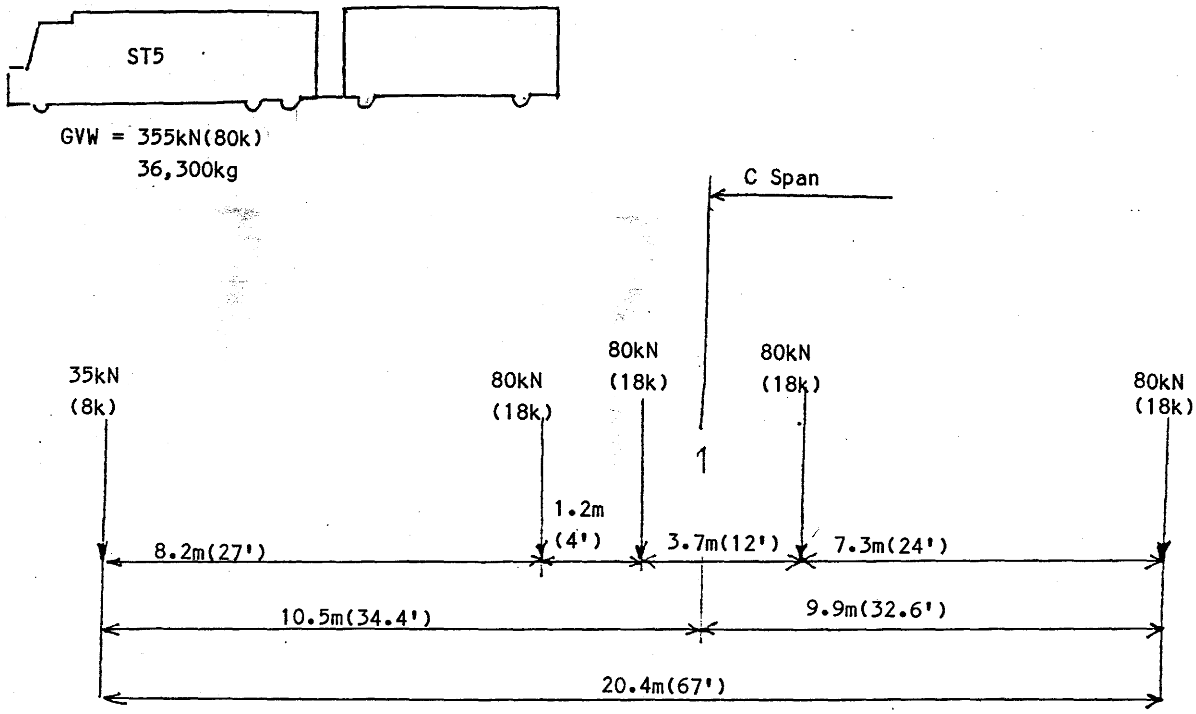


FIGURE II-8

MS LOADING (HS)

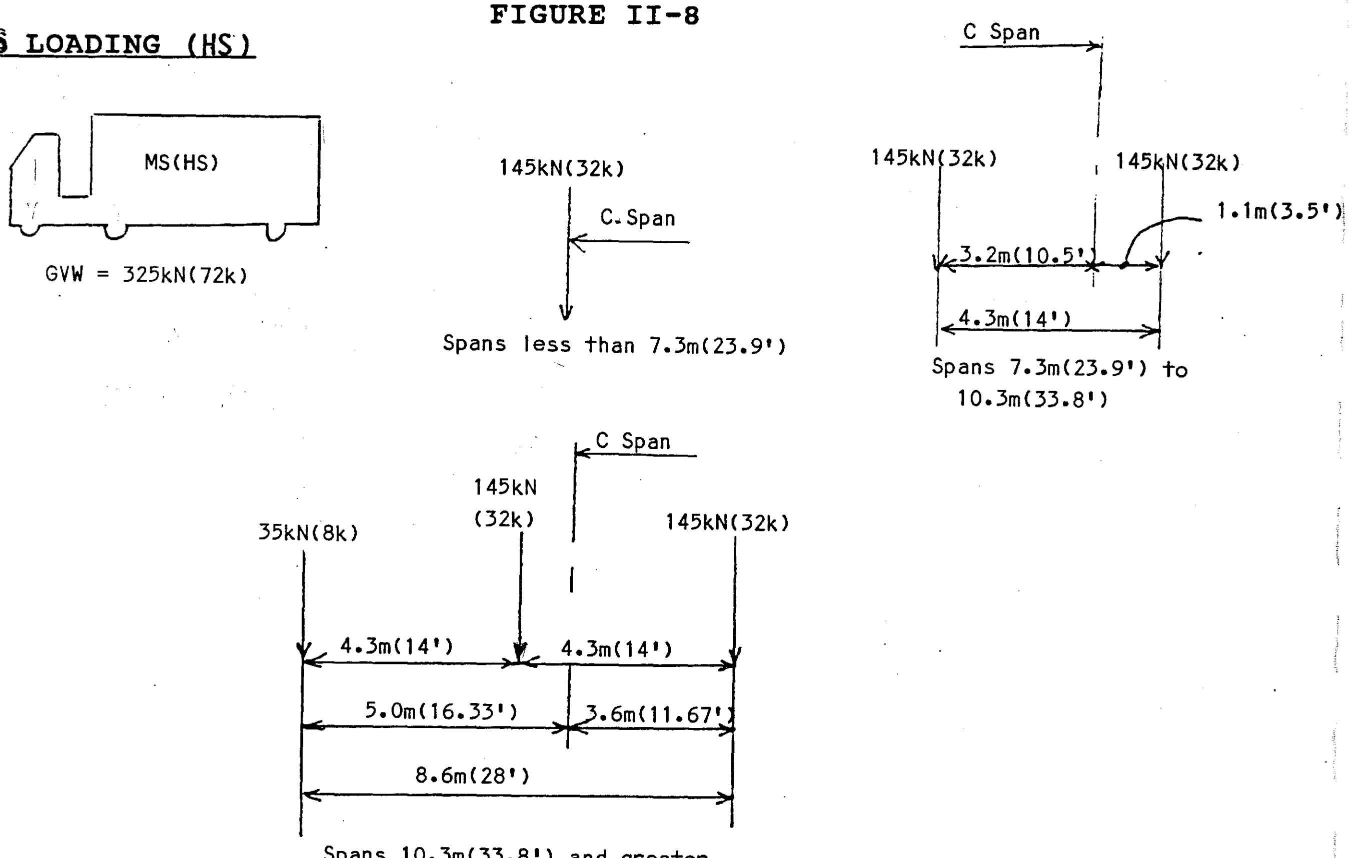


FIGURE II-9

C. **Procedure for Posting of Weight Restrictions on Department Maintained Structures.** If load rating calculations indicate that the applied Florida legal loads will induce stresses in excess of the operating rating stresses, then the bridge must be weight posted. If traffic is diverted off the bridge and the bridge repaired or strengthened so that the Florida legal loads induce stresses less than the operating rating stresses, then weight posting will not be required. A load test may be performed to determine if the actual stress levels induced by Florida legal loads are in excess of the operating rating stresses.

When weight restrictions on Department maintained structures are required, the following procedure shall be followed:

1. To initiate weight limit restrictions, the recommendations shall be developed by the District Structures and Facilities Engineer and endorsed by the District Maintenance Engineer.

2. The request for weight limit restrictions, and calculations, computer output or load test results and sign configuration are to be submitted to the Engineer of Structure Maintenance Operations for processing through the State Maintenance Engineer to the Secretary for approval. The recommendations should be accompanied by: an explanation of the cause of the low rating; what repairs are planned; when the repairs will be performed; will the repairs be performed by state forces or by contract; cost of repairs; if and when the bridge is scheduled for rehabilitation or replacement; and what effect posting the bridge will have on local traffic and emergency vehicles.

3. Upon approval of the weight limit restrictions, the District Traffic Operations Engineer and the State Permits Office shall be sent a copy of these restrictions. The Traffic Operations Office shall notify the appropriate local governments that a weight limit regulation has been approved.

4. A request for removal of weight limit restrictions shall be initiated by the District Structures and Facilities Engineer with the District Maintenance Engineer's approval. This request should indicate that the structure has been restored to legal load capacity. This request must be sent to the Engineer of Structure Maintenance Operations for processing. Removal of weight limit restrictions must have the approval of the

Secretary of the Department of Transportation, prior to removal of posting signs.

5. If the bridge is permanently taken out of service, then the District Structures and Facilities Engineer must notify the Engineer of Structure Maintenance Operations in writing of this occurrence so that the State Maintenance Office removes the bridge from the list of posted bridges and the State Permits Office notified that the bridge has been permanently removed from service.

6. Weight limit restrictions should not be processed until the capacity of the structure has been established by using the Department's SALOD or BRUFEM software. Structural types not compatible with these systems will be exempt from this requirement.

7. Weight limits to be shown on the posting signs at a bridge site, shall represent the gross vehicular weight (GVW) in tons for a maximum of three truck types. However, no more than one or two truck symbols may be needed. A graphic depiction of the general weight limit sign is shown on the Roadway and Traffic Design Standard Index No. 17357. The three truck types are as follows:

   a. Single unit trucks. **(SU)**

   b. Combination trucks with a single trailer. **(C)**

   c. Combination trucks with two trailers or a single unit truck with one trailer. **(ST5)**

   The single unit truck case will be the lowest operating rating for two axle (SU2), three axle (SU3) and four axle (SU4) trucks. This single unit truck will be represented on the weight limit sign by a two axle single unit truck silhouette. The operating rating GVW may exceed the legal limit GVW of one or more truck types. In this case, these specific truck types would be excluded when establishing the lowest permissible operating rating. For example if the operating rating for the SU2 truck was 16,300 kg (18 tons) then the SU2 truck would not be considered for posting since the legal limit for the SU2 truck is 15,400 kg (15 tons).

   The combination truck with one trailer will be the lowest permissible operating rating for three axle

(C3), four axle (C4) and five axle (C5) trucks. This combination truck will be represented on the weight limit sign by a three axle combination truck silhouette (one trailer). The operating rating GVW may exceed the legal limit GVW of one or more truck types. In this case, these specific truck types would be excluded when establishing the lowest permissible operating rating. For example if the operating rating for the C3 truck was 26,300 kg (29 tons), then the C3 truck would not be considered for posting since the legal limit for the C3 truck is 25,400 kg (28 tons).

The combination truck with two trailers or a straight truck with one trailer will be governed by the operating rating for the single unit truck with one trailer (ST5). This combination truck will be represented on the weight limit sign by a silhouette of a two axle single unit truck pulling a two axle trailer.

8. The following are the requirements for weight limit signs:

   a. The location and construction of weight limit posting signs shall be in accordance with the Roadway and Traffic Design Standard Index No. 17357. This standard index has been prepared to meet or exceed the requirement established in Section 2B-41 of the Manual on Uniform Traffic Control Devices.

   b. After approval of the weight limit restrictions by the Secretary of the Department of Transportation, the District Maintenance Engineer shall solicit the recommendations of the District Traffic Operations Engineer for sign location and design.

   c. After receiving the District Traffic Operations Engineer's recommendations, the District Maintenance Engineer shall order the signs from the sign shop and direct the sign crew to immediately install them upon receipt.

9. Bona Fide Emergencies: In case of bona fide emergencies, the District Maintenance Engineer shall take the necessary steps to protect the public safety. Corrective action may be initiated while seeking approval of weight limit posting. Such action may consist of posting the structure for no trucks or only

trucks below a specified gross weight, while analysis and or repairs are performed and the official request is prepared and sent to the Engineer of Structure Maintenance Operations.

10. The bridge file should contain all pertinent information concerning posting and removal of posting actions.

D. **Procedure for Posting of Weight Restrictions on Local Government Structures.** Local government agencies are responsible for load posting of their structures. The Department, or its consultant, may load rate local government structures. When local government structures require weight restrictions the following procedure shall be followed:

1. The Department, or its consultant, will develop recommendations for weight restrictions and notify the Department's local government bridge inspection project manager.

2. The project manager will send the recommendations for weight restrictions to the local government agency. The agency will be required to perform the necessary actions to post the structure. The agency may elect to use their own forces or hire a consultant engineer to perform additional testing and analysis as described in Section III of this manual.

3. The local government agency should respond to the weight restrictions recommendations by posting the structure as recommended or commencing further testing and analysis. The Department should be notified of the agency's action within 30 days of receipt of the weight restriction recommendations. If further testing or analysis is to be performed this should be accomplished and the results should be reported to the Department within 90 days of first notification.

4. The Department should be kept informed of all posting actions accomplished by the local government agency. This should include copies of all calculations and testing results.

5. Weight limit signs shall conform to the requirements stated in this manual. Exceptions to these requirements may be approved by the project manager on a case by case basis.

E. Procedure for Load Testing of Bridges.

1. General. Analysis methods by their very nature represent engineering approximations of the stresses in a structure. Assumptions are made at every step of the analysis process. For example, a steel girder without shear connectors is assumed to act non-compositely with the concrete deck. Experiments have shown that a girder without shear connectors will have a portion of the composite action of a girder with shear connectors. Stiffness provided to the deck by concrete barriers aids in distributing live load. The cumulative effects of these assumptions may lead the actual safe load carrying capacity to be significantly larger than that calculated by analysis. These conservative assumptions are generally good in that they provide a safe conservative design and simplify the analysis.

   For some critical structures, it may be desirable to establish a higher safe load carrying capacity. The following types of structures are candidates for load testing:

   - Bridges that restrict the flow of overweight vehicles.
   - Bridges that are posted for weight restrictions.
   - Bridges that do not lend themselves to conventional analysis.
   - Bridges for which plans are not available.

2. Load Test Candidate List. Periodically, the Bridge Inspection and Evaluation Engineer will develop a list of candidate bridges for load testing. Following is the process for the development of the load test candidate list.

   b. This list will be sent to the District Structures and Facilities Engineer for use in developing a list of bridges for load testing. The District Structures and Facilities Engineer will review the list and add additional bridges that meet the criteria for candidates for load testing.

   c. The District Structures and Facilities Engineer should assign a priority order to this list and submit the list to the Bridge Inspection and

Evaluation Engineer who will compile a statewide list of bridges to be load tested.

d. The Bridge Inspection and Evaluation Engineer will send the statewide list to the Structures Research Center.

e. The Structures Research Center will schedule the load tests with the Districts using the established priority ranking modified to reduce travel time from site-to-site.

f. The Structures Research Center will send the load test report to the District Structures and Facilities Engineer with copies to the State Permits Office and the Bridge Inspection and Evaluation Engineer.

g. The District Structures and Facilities Engineer will enter the ratings from the load test reports into the Bridge Management Inventory System Data File and Section D (Load Rating) of the Bridge Record.

3. Load Test Reports. The load test report should at a minimum contain the following information, determined during the load test or assumed during the analysis of data gathered during the load test:

a. Date load test performed.

b. Brief description of bridge and condition.

c. Controlling span and length.

d. Rating controlled by shear, positive moment, or negative moment.

e. Controlling element.

f. Impact factor.

g. Live load distribution factor.

h. If structure is a box girder structure thermal gradient assumed.

i. Truck used for load test.

j. General assumptions made.

k. Load test static or dynamic.

l. Available live load moment.

m. Ratings for HS vehicle and all Florida legal trucks.

n. Signature and registration number of professional engineer performing load test. (If load test is performed by consultant, the load test report should be sealed.)

SECTION III - HIERARCHY OF ANALYSIS AND TESTING

A. General. The level of analysis chosen is a trade off between sophistication of analysis and required work effort. The simpler methods are chosen as a first choice due to the need to analyze many structures with limited resources. When this analysis yields satisfactory results, there is no need to perform a more sophisticated analysis. Satisfactory results would be the establishment of a safe load carrying capacity that does not require posting the structures and does not unduly restrict the flow of permitted overweight trucks. A more sophisticated analysis is justified to avoid posting the bridge or to ease restrictions on the flow of permitted overweight trucks.

The ratings calculated through analysis are a factor in the selection of rehabilitation, replacement or widening of a structure. Thus, a more sophisticated analysis yielding higher ratings could result in a decision to widen a structure rather than replacing a structure. Some of the newer more complex structures (segmentals, cable stayed), were designed using sophisticated analysis methods. Therefore, a sophisticated level of analysis will be required to rate these structures.

B. Routine Analysis With Line Model Programs. This model assumes the structure acts as separate lines, in a girder-slab structure, each girder is basically assumed to act independently with limited distribution between the girders. The advantages of this model are that it is relatively easy to apply and that the computer generated output is easy to check long hand. The BARS program is a line model program.

C. Analysis With Ribbed Plate Model Programs. This model looks at the structure globally and treats a girder-slab structure as a system using finite element methods. The SALOD program approximates this by comparing the structure to stored finite element structures. The BRUFEM program is a sophisticated program that creates a finite element model of the structure to analyze and rate the structure.

D. Limited Material Test to Augment Analysis. When analysis is performed, certain minimum material properties are assumed based on design criteria or assumed properties based on year of construction. Actual material properties may be significantly better due to suppliers exceeding minimum standards, concrete increasing in strength with age, or for older structures material being higher grade than assumed.

Therefore, testing material may result in higher property values thus increasing the rating of the structure.

E. **Full Scale Load Test.** The load test procedure is a process where a structure is instrumented and then subjected to a known test load which is progressively increased. This determines the safe load carrying capacity by measuring the actual load the structure can carry without distress. Since even the most sophisticated analysis contains assumptions, this method is the most accurate. However, the process is expensive and time consuming and therefore should be selected judiciously. For a structure to be load tested it must be on the load test candidate list.

F. **Bridge Analysis Software (Utilization and Rationale for Use).**

1. BARS. The Bridge Analysis and Rating System is a computer program, capable of analyzing and rating the most common types of bridge superstructure. The BARS program is a line model type of program and therefore, does not create a sophisticated model of the structure. The program is relatively easy to use and once a file is created, the bridge can be easily checked for additional types of vehicles. The BARS program should generally be the first choice for rating a bridge if applicable. For instructions in using the BARS program, refer to the BARS manuals.

2. BRUFEM. The Bridge Rating of Girder-Slab Bridges Using Automated Finite Element Method, is a computer program which allows the user to input the bridge type, geometry, materials, and vehicle loadings on a bridge which is to be analyzed. The program creates a finite element model of the bridge, processes the model and then rates the bridge. Since BRUFEM uses a more sophisticated analysis than BARS, the BRUFEM ratings will generally be higher than those produced by BARS. BRUFEM should be used for those bridge types that BARS can not analyze. If the ratings produced by the BARS program require posting of the bridge or restrict the flow of permitted vehicles, then the BRUFEM program may be used to attempt to increase the ratings to avoid weight restrictions and load testing.

3. SALOD. The Structural Analysis for LOad Distribution program, determines a lateral live load distribution factor for each girder of a particular bridge system. The program also computes effective widths for flat

slab bridges. The program compares the input bridge geometry with influence surfaces stored in the appropriate bridge type database and then interpolates or extrapolates from these influence surfaces to generate an influence surface suitable for the actual bridge. From this influence surface SALOD determines the lateral live load distribution factor for the input live load. This distribution factor is then used as input for the BARS program.

4. Other Programs. Other programs may also be used when the standard programs are not applicable. The DESCUS program is useful for analyzing curved steel girder bridges.

5. The coding manual for the BARS program may be obtained from the Maps and Publications Office. Other manuals may be obtained from the Structures Design Office, Computer Section.

SECTION IV - WORKING RESPONSIBILITIES

A. **District Structures and Facilities Office.** The responsibilities of the District Structures and Facilities Office are:

1. Perform load ratings.

2. Administer consultant contracts performing load ratings.

3. Store computer files of load ratings in PANVALET.

4. Enter results of load ratings into the Bridge Management Inventory System Data File and Section D (Load Rating) of the Bridge Record.

5. Select bridges for load testing.

6. Inform the Road Use Permits Office of reductions or increases in the safe load carrying capacity of structures immediately.

7. Review analysis performed by the Road Use Permits Office on overloads greater than 78,000 kg (172,000 lbs.), gross vehicular weight.

8. Initiate requests for load postings and removal of load postings.

9. Maintain bridge design plans and shop drawing inventory.

10. Review bridge inspection reports to determine when reanalysis is required.

B. **State Maintenance Office.** The responsibilities of the State Maintenance Office are:

1. Quality assurance.

2. Establish procedures.

3. Training.

4. Assist Districts and Road Use Permits Office when requested.

5. Periodically, backup load ratings computer files.

6. Act on computer program malfunctions.

7. Develop better analysis programs.

8. Inform districts of new procedures and concerns.

9. Review load posting and load posting removal requests.

C. **Road Use Permits Office.** The responsibilities of the Road Use Permits Office are:

1. Issuance of overweight and overdimensional permits.

2. Develop a statewide map which identifies approved routes for a certain overweight vehicle.

3. Distribute this map to trucking firms that have obtained overweight permits from the Department in the last 12 months, the District Maintenance Engineers and Office of Motor Carrier Compliance and the District Structures and Facilities Engineer.

4. Keeping the statewide map current based on data submitted by the districts.

5. Receive requests for preapproved routing from trucking firms.

6. Approve preapproved routing.

7. Perform the analysis for overloads greater than 78,000 kg (172,000 lbs.) and then submit the analysis to the District Structures and Facilities Engineer for review.

SECTION V - APPROVAL OF OVERLOADS

A. During Construction. The approval of overloads on new structures during construction is the responsibility of the District Structures Design Office. Overloads for existing bridges that are being reconstructed should be approved by the District Construction Engineer after consulting with the District Structures and Facilities Engineer and District Structures Engineer. The Road Use Permits Office will not approve overloads on a structure until responsibility for that structure has been transferred from Construction to Maintenance.

B. After Completion of Construction.

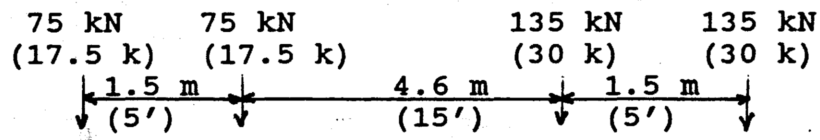
1. House Moving. Permits for buildings are issued by the District Maintenance Engineer in the area where the move originated. If the move crosses district lines, all applicable District Maintenance Engineers should be consulted.

2. Divisible Loads. Easily divisible overloads should be broken down into legal loads instead of issuing a permit.

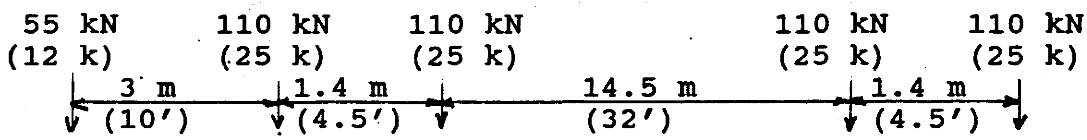
C. Non-Divisible Loads. Non-divisible overloads not greater than 78,000 kg (172,000 lbs.) gross vehicular weight, can be approved or denied by the Road Use Permits Engineer as long as the policies, techniques and procedures developed by the Structure Maintenance Section are followed.

Non-divisible overweight loads with a gross vehicular weight in excess of 78,000 kg (172,000 lbs.), shall be approved by the District Structures and Facilities Engineer before the permit is granted or denied by the Road Use Permits Office. The State Maintenance Office will act as a consultant to both the District and the Road Use Permits Office to facilitate this process. Overload analysis for permit loads in this weight range, shall typically be short hauls and will be analyzed as specific trip requests. The Road Use Permits Office will perform the analysis using the BARS and the Bridge Analysis Data System. The results of this analysis will be approved by the District within five working days. Upon receipt of the district's comments, the Road Use Permits Engineer will approve or deny the permit.

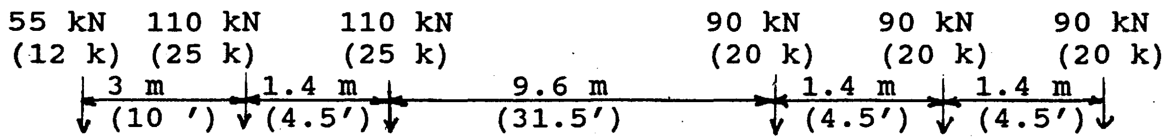
PERMIT VEHICLES



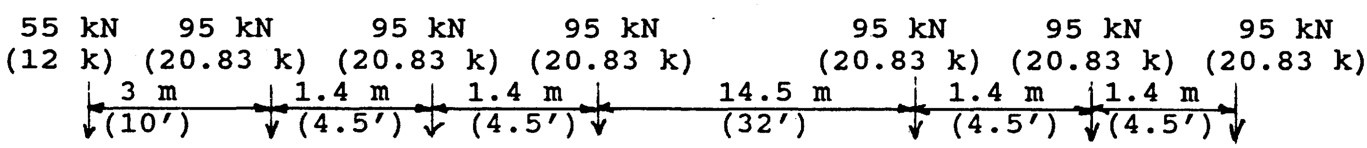
420 kN 42,800 kg (95,000 pound) Truck Crane



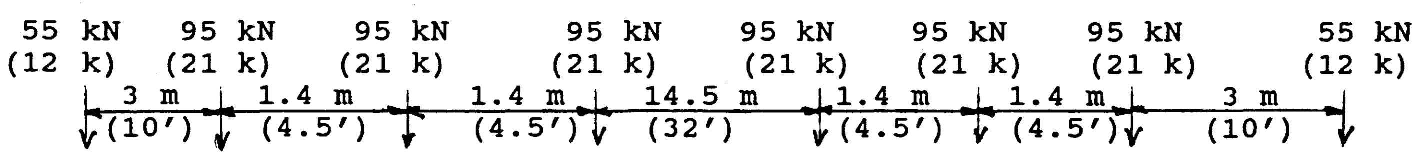
495 kN 50,500 kg (112,000 pound) 5 Axle Truck



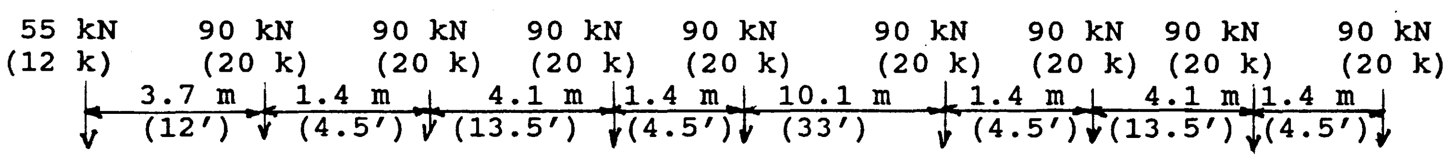
545 kN 55,600 kg (122,000 pound) 6 Axle Truck



625 kN 63,700 kg (137,000 pound) 7 Axle Truck



680 kN 69,300 kg (150,000 pound) 8 Axle Truck



775 kN 79,000 kg (172,000 pound) 9 Axle Truck

FIGURE V-1

SECTION VI - COLLECTION OF EXISTING DATA

The first step is the collection of relevant existing data required to perform the load rating.

A. **Existing Plans.** Existing plans are used to determine loads, bridge geometry, section and material properties. Design plans are created by the designer and used as a contract document for bidding the job. Certain structures (generally flat slab bridges and culverts) are built from standard drawings. These standard drawings have been changed and revised over time. The specific standard drawings used for construction are generally identified in the roadway plans for the project under which the bridge was built. Construction record plans are contract design plans which have been modified to reflect changes made during construction. Shop drawings are also useful sources of information about the bridge. Plans may not exist for some bridges. In these cases field measurements will be required.

B. **Inspection Reports.** Inspection reports must be reviewed prior to load rating to determine if there is deterioration or other damage present that may change the carrying capacity of the structure and whether or not the bridge plans are accurate.

C. **Other Records.** Other appropriate bridge history records, such as repair or rehabilitation plans, should be reviewed to determine their impact on the load carrying capacity of the structure.

SECTION VII - LOAD RATING CONCEPTS

A. Analysis Methods. There are several analysis methods.

1. Working Stress Method. This method compares the stresses caused by the actual loads on the structure with an allowable stress which is the ultimate material stress divided by a factor of safety.

2. Load Factor Method. This method compares the stresses caused by the actual loads increased by factors reflecting the level of uncertainty with the ultimate material stress. This method is also known as the Ultimate Strength Method.

3. Load and Resistance Factor Method. This method compares the stresses caused by the actual loads increased by factors with the ultimate material stresses reduced by a factor of safety. These factors are determined by probabilistic determination of reliability.

B. Conversions of Rating Vehicles. For simple span bridges, it may be convenient to convert a rating from HS to H or H to HS or HS to another truck type.

STEP 1 Compute Rating Factor (RF)

$$RF = \frac{\text{MS Truck Rating in Kilograms}}{\text{32600 kg}} \qquad \frac{\text{HS Truck Rating in Tons}}{\text{36 (HS Truck Weight in Tons)}}$$

STEP 2 Convert Rating Factor to Truck of Interest

$$RF\ (\text{Truck Type X}) = \frac{100}{\text{Truck Type X as \% of MS18 (HS20) for particular span length}} \times RF$$

The percentage factor for certain truck types may be found by multiplying 100 times the factors in Table VII-2.

STEP 3 Find Rating of Truck Type of Interest

Rating (Truck Type X) = RF (Truck Type X) x (Gross Weight of Truck Type X in Tons)

EXAMPLE - Say we have a rating of 45400 kg (50 tons) for an MS18 (HS20) truck with a simple span of 44 m (145 feet) and we wanted the equivalent rating for a C4 truck.

STEP 1 RF = $\frac{45400}{32600}$ $\frac{(50)}{(36)}$ = 1.39

STEP 2 RF C4 = $\frac{1.39}{}$ $\frac{(1.00)}{0.97}$ = 1.43

STEP 3 Rating C4 = 1.43 X 33,300 (36.7) = 47,600 kg (52.5 Tons)

It should be noted that Tables VII-1 and VII-2 are based on moment and assume equal lateral live load distribution factors (LLDF) for each truck type.

The different LLDF's may be considered by multiplying the final rating by the Ratio:

$$\frac{\text{MS18 X LLDF}}{\text{Truck of Interest X LLDF}}$$

If shear controls the rating or the span length exceeds 61m (200 ft.), the following general equation may be used:

$$\text{RF (Truck Type X)} = \text{RF(MS18)} \times \frac{\text{M of (MS18)}}{\text{M of (Truck Type X)}}$$

or

$$\text{RF (Truck Type X)} = \text{RF(MS18)} \times \frac{\text{V of (MS18)}}{\text{V of (Truck Type X)}}$$

Note the above formula can be used for continuous spans, Tables VII-1 and VII-2 apply only to simple spans.

TABLE VII-1
TRUCK AXLE AND WEIGHT CONFIGURATIONS

TRUCK TYPE	AXLE LOAD and GVW	Axle spacings
SU 2	55 kN (12k); 100 kN (22k)	4 m (1.3')
SU 3	100 kN (22k); 100 kN (22k); 100 kN (22k)	3.3 m (11'); 1.3 m (4.2')
SU 4	60 kN (13.9k); 85 kN (18.7k); 85 kN (18.7k); 85 kN (18.7K)	2.8 m (9.2'); 1.3 m (4.2'); 1.3 m (4.2')
C 3	55 kN (12k); 100 kN (22k); 100 kN (22k)	3 m (10'); 6.1 m (20')
C 4	30 kN (7.3k); 100 kN (22k); 100 kN (22k); 100 kN (22k)	3 m (10'); 6.7 m (21.8'); 1.3m (4.2')
C 5*	40 kN (10k); 70 kN (16.1k); 70 kN (16.1k); 70 kN (16.1k); 70 kN (16.1k)	3 m (10'); 1.3 m (4.2'); 5.4 m (17.7'); 1.3 m (4.2')
Standard Tractor Trailer	35 kN (8k); 80 kN (19.8k); 80 kN (19.8k); 80 kN (19.8k); 80 kN (19.8k)	4.3 m (14'); 1.2 m (4'); 9.8 m (32'); 1.2 m (4')
Tandem Trailer Case 1	35 kN (8k); 80 kN (18k); 80 kN (18k); 80 kN (18k); 80 kN (18k)	4.6 m (15'); 7.3 m (24'); 1.8 m (6'); 7.3 m (24')
Tandem Trailer Case 2 ST5	35 kN (8k); 80 kN (18k); 80 kN (18k); 80 kN (18k); 80 kN (18k)	8.2 m (27'); 1.2 m (4'); 3.7 m (12'); 7.3 m (24')
Standard 68000 kg (150000 lb.) Truck	55 kN (12k); 100 kN (23k); 100 kN (23k); 100 kN (23k); 100 kN (23k); 100 kN (23k); 100 kN (23k)	4.3 m (14'); 1.3 m (4.2'); 1.3 m (4.2'); 9.1 m (30'); 1.2 m (4'); 1.2 m (4')

* Span lengths up to 13.7 m (45') are governed by axle loading cases of 35 kN, 65 kN, 65 kN, 100 kN and 100 kN (8 k, 14 k, 14 k, 22 k and 22 k)

TABLE VII-2
MAXIMUM MOMENT COMPARISON OF TRUCK LOAD CASES TO HS20 DESIGN LOAD FOR SIMPLE SPAN

STT ST5

SPAN LENGTH	SU2	SU3	SU4	C3	C4	C5	STD TRCTR TRLR	TANDEM TRLR CASE 1	TANDEM TRLR CASE 2	STD 68000 kg TRUCK
15	0.69	1.02	1.10	0.69	1.02	1.02	0.93	0.72	0.85	1.39
25	0.68	1.20	1.32	0.76	1.11	1.11	1.01	0.84	0.95	1.64
35	0.62	1.14	1.23	0.67	0.94	0.96	0.89	0.73	0.92	1.42
45	0.57	1.07	1.15	0.67	0.87	0.94	0.82	0.66	0.86	1.32
55	0.55	1.04	1.11	0.70	0.88	0.98	0.78	0.67	0.84	1.27
65	0.53	1.01	1.08	0.71	0.90	1.00	0.76	0.71	0.83	1.24
75	0.52	1.00	1.06	0.72	0.92	1.02	0.81	0.76	0.86	1.28
85	0.52	0.99	1.05	0.73	0.93	1.03	0.85	0.80	0.89	1.43
95	0.51	0.98	1.04	0.74	0.94	1.04	0.88	0.84	0.92	1.51
105	0.51	0.97	1.03	0.74	0.96	1.06	0.93	0.90	0.96	1.62
115	0.50	0.97	1.03	0.74	0.96	1.06	0.93	0.90	0.96	1.62
125	0.50	0.96	1.02	0.75	0.96	1.06	0.94	0.91	0.97	1.66
135	0.50	0.96	1.02	0.75	0.97	1.07	0.96	0.93	0.98	1.70
145	0.50	0.95	1.01	0.75	0.97	1.07	0.97	0.94	0.99	1.72
155	0.47	0.91	0.97	0.72	0.93	1.03	0.94	0.92	0.96	1.68
165	0.45	0.88	0.93	0.70	0.90	0.99	0.91	0.89	0.93	1.63
175	0.44	0.84	0.89	0.67	0.87	0.96	0.88	0.87	0.90	1.59
185	0.42	0.81	0.86	0.65	0.84	0.92	0.85	0.84	0.87	1.65
195	0.40	0.79	0.82	0.63	0.81	0.89	0.83	0.82	0.85	1.50
200	0.40	0.76	0.81	0.62	0.80	0.88	0.82	0.81	0.83	1.48

C. **Estimation of Remaining Fatigue Life.** The estimation of remaining life for a structure is more of an art than a science. There are two major processes which impact the life expectancy of a bridge, corrosion and fatigue.

Fatigue is generally limited to steel structures and is a function of stress range, number of cycles and the nature of any fatigue prone details. Fatigue is also a factor for reinforced concrete and prestressed concrete structures. However, there has been insufficient research performed in this area to determine relevant design criteria or a methodology to estimate remaining life expectancy.

In design, the stress range created by an HS20 design truck at a number of cycles is set by the class of road and the average daily truck traffic used for the design. In practice, the stress ranges experienced by the bridge vary depending on the vehicle, and the actual stress ranges experienced by the structure are generally less than the design stress range. The relationship between stress range and design life is not linear but logarithmic, for example, for an AASHTO Category E detail a stress range of 103.5 MPa (15 ksi) would have a design life of 300,000 cycles while a stress range of 69.5 MPa (10 ksi) would have a design life of 1,000,000 cycles. This relationship becomes even more complicated when the stress range is variable, as it is in the real world. It is virtually impossible to know the exact load history of a bridge. Therefore, some approximate methods have been developed to estimate the remaining fatigue life of a structure.

Methods for determining the remaining fatigue life are given in the AASHTO Guide Specifications and in the paper "Fatigue Rating of Highway Bridges" by T. Huang, et al presented at the 1988 International Bridge Conference. Methods such as these should be used judiciously and the results obtained should be evaluated with sound engineering judgement.

D. **Interpretations of AASHTO Specifications With Respect to Load Ratings.**

1. <u>Reduction in live loads due to more than two lanes of live load</u>. "AASHTO Standard Specifications for Highway Bridges" Section 3.12, reduces live load when more than two lanes are loaded. The correct interpretation of this section's intent is to check two lanes at 100%, three lanes at 90%, and 4 or more lanes at 75%, and use the most severe condition for design and analysis.

2. <u>Distribution of Secondary Dead Loads to Hollow Core Slab Units</u>. When the hollow core slab units are in good condition (acting together), secondary dead loads should be distributed equally to all slab units. When the joints between the slab units are cracking and the slab units are acting independently then

engineering judgement must be used. Generally, the conservative assumption would be that the railing weight would be carried by the exterior slab unit only.

3. Rating Structures Subject to Sidewalk Live Load and Traffic Live Loads. The AASHTO "Manual for Condition Evaluation of Bridges", does not give extensive guidance on sidewalk live load for bridge rating beyond stating the engineer may use his engineering judgement and apply a smaller unit load than called for in the AASHTO specifications based on the location of the bridge and anticipated maximum load. The following guidelines should be used to rate structures subject to traffic and sidewalk live load.

   a. Working Stress - "AASHTO Standard Specifications for Highway Bridges", Section 3.23.2.3.1.3, allows a 25% overstress for this condition. Therefore, the structure should be checked for two conditions:

      1) DL+(LL+I)+SWLL <1.25 x allowable stress.
      2) DL+LL+I < allowable stress
      Where; DL = Dead Load
      LL+I = Live Load+Impact (from traffic)
      SWLL = Sidewalk Live Load

      These equations should be used for both inventory and operating ratings.

   b. Load Factor - "AASHTO Standard Specifications for Highway Bridges" Section 3.23.2.3.1.3, states that 1.25 be used as the beta factor instead of 1.67. Therefore, the inventory rating should be determined from the worst case of the two following equations:

      1) Mult = 1.3 (DL+1.67(LL+I))
      2) Mult = 1.3 (DL+1.25(LL+I)+SWLL)

      For operating ratings there is no real guidance in the AASHTO specifications. The following two equations should be checked with the worst case being used for the operating rating:

      1) Mult = 1.3(DL+(LL+I))
      2) Mult = 1.3(DL+0.75(LL+I)+SWLL)

      This is a reasonable approach based on the very minor probability of having maximum sidewalk live load and traffic live load at the same time. In addition, where pedestrian traffic is minimal, the sidewalk live load can be treated as zero for load rating purposes.

4. Structures With No Barrier Between Roadway and Sidewalk. "AASHTO Standard Specifications for Highway Bridges" Section 3.24.2.2, calls for a wheel load to be placed 300 mm (1 foot) away from the rail when there is no barrier between the sidewalk and the roadway. A curb 200 mm (8 inches) or higher may be considered a barrier. A 50% overstress is allowed for this condition. For load factor a beta factor of 1.00 should be used.

   a. Working Stress - Use the worst case of the following two equations:

      1) DL+(LL+I) < allowable stress no wheel load on sidewalk.
      2) DL+(LL+I)) < 1.5 x allowable stress wheel load on sidewalk.

   b. Load Factor - Inventory Rating:

      1) Mult = 1.3 (DL+1.67(LL+I)) no wheel load on sidewalk.
      2) Mult = 1.3 (DL+(LL+I)) wheel load on sidewalk.

      Operating Rating
      1) Mult = 1.3(DL+(LL+I))
      2) Mult = 1.0(DL+(LL+I))

5. Transverse Location of Rating Vehicle on Bridge.

   a. Wheel line edge distance - The AASHTO specifications require the placement of the design or rating vehicle 300 mm (1 foot) away from the curb line for the design or rating of the slab, and 600 mm (2 feet) for the design or rating of the girders. For a concrete box girder the slab portion should be rated with a wheel line 300 mm (1 foot) from the curb line and the flanges and bottom slab shall be rated with a wheel line placed no closer than 600 mm (2 feet) from the curb line.

   b. Restrictions of rating vehicles to traveled lanes - The AASHTO "Manual for Condition Evaluation of Bridges" requires the placement of vehicles to be in accordance with the AASHTO design specifications, but allows the engineer to use judgement in restricting the placement of vehicles according to the actual traffic patterns. However it provides no guidelines. The following guidelines will be used for this:

1) Ramp structures striped for less lanes than the width of the structure could carry may be load rated for the actual number of lanes being carried.

2) Bridges that would require posting if the full width of the structure was subject to live loads may be load rated by restricting the live load to the traveled lanes. However, the structure should be checked at service load versus the yield stress with the live load in the shoulder.

3) At the request of the Road Use Permits Office a structure may be load rated with the live loads restricted to the travel lanes for a structure that restricts the flow of overweight permitted vehicles.

Whenever the load rating is calculated with the live loads restricted to the travel lanes, this should be documented on the load rating summary sheet.

c. <u>Multiple Lanes Loaded</u> - When live load is placed in more than one lane and the analysis is for any design load or Florida legal loads then all lanes should be loaded with the same type of vehicle. When the structure is being load rated for an overweight permit vehicle only one lane shall be loaded with the permit vehicle and other lanes shall be loaded with MS18 (HS20) vehicles. If more than two lanes are loaded remember to apply the lane reduction percentage.

Effective:
REV. DATE:

SECTION VIII - UTILIZATION OF CONSULTING ENGINEERS FOR BRIDGE RATING

A. **General.** Consultants may be used for load rating state owned bridges when in-house resources are lacking. Consultants are used to load rate local agency bridges as part of the local government bridge inspection contracts. If conditions are found during the consultant's inspection that would change the load rating of the structure, the Department's project manager may direct the consultant to determine a new load rating for the structure based on the results of the inspection.

B. **Controls.** Consultants shall load rate structures in accordance with this manual and the AASHTO "Manual for Condition Evaluation of Bridges".

C. **Consultant Qualifications.** For the load rating of routine structures the consultant must have experience in the design or load rating of bridges. For the load rating of complex structures, the consultant's engineer performing the load rating must have experience in designing that type of structure. Examples of complex structures are segmental concrete bridges, post tensioned bridges, curved steel box girder bridges, curved steel girder bridges, and trusses. If the consultant changes the individual or individuals performing the load rating of a complex structure, the new individual must be approved by the Department's project manager.

SECTION IX - SUMMARY OF RATINGS

After the structure has been load rated FDOT Form 850-010-06 "Load Capacity Information Form" shall be completed and placed in Section D of the Bridge Record File. For sample blank forms see Figures IX-1 and IX-2. For sample completed forms see Figures IX-3 and IX-4. This form may be obtained from the State Maintenance Office or is available in the Department's Forms Library through Office Vision.

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

D: LOAD CAPACITY INFORMATION

FORM 850-010-06
MAINTENANCE - 06/93
Page 1 of 2

1. **BRIDGE DATA:**

Bridge Number ______________ Date ______________
STR Type Main [BMIS Item B1(43)] ______________ STR Type APR [BMIS Item B2(44)] ______________

2. **POSTING DATE:**

Posted _____ If yes, Existing Restrictions ______________
BMIS Item H8(41) ______________

Posting Needed _____ If Yes, Proposed Restrictions ______________
BMIS Item H11(70) ______________
BMIS Item H7(31) ______________

3. **ANALYSIS DATA:**

A. Method of Analysis:
______ Load Factor
______ Working Stress

B. Analysis System:
______ BARS
______ SALOD
______ BRUFEM
______ Load Test
______ Other ______________

C. Analysis Based On:
______ Design Drawings
______ As-Built Record Plans
______ Shop Drawings
______ Field Measurement
______ Catalogs
______ Sample Testing
______ Other ______________

D. Data Stored:
______ District Office
______ Central Office
______ Microfilm
______ Bridge Owner
______ Materials Test Lab
______ Other ______________

E. Controlling Member Analyzed:

Material:
______ Steel
______ Concrete
_____ Cast in Place
_____ Precast
_____ Prestressed
_____ Post Tensioned
______ Timber
______ Other ______________

Function:
______ Slab
______ Stringer
______ Floor Beam
______ Girder
______ Culvert
______ Truss

Substructure:
______ Bent Construction
_____ Piling
_____ Cap
______ Pier Construction
_____ Piling
_____ Footing
_____ Column
_____ Cap

Span:
______ Simple
______ Continuous
______ Frame

Slab:
______ Non-Composite
______ Composite

Shape:
______ Rolled
______ Built-up Welded
______ Built-up Riveted
______ Box Shape
______ AASHTO Girders
______ Other ______________

4. Load Rating Summary Table:

LOAD RATING SUMMARY FOR OPERATING RATING (GROSS TONS)

VEHICLE TYPE	TONS	OPR RATING	OPR FACTOR	SPAN NO.	SPAN LENGTH	CONTR. MEMBER	M OR V	LLDF
SU2	17							
SU3	33							
SU4	35							
C3	28							
C4	36.6							
C5	40.0							
ST5	40.0							
HS20	36							

HS 20 Inventory Rating ______ Rating Factor ______

5. **Comments:**

____
____
____

Computations:
Performed By ______________ Date ______________
Checked By ______________ Date ______________
Reviewed By ______________ Date ______________

7. **Responsible Engineer:** ______________
P.E. # ______________ Date ______________

FIGURE IX-2

INSTRUCTIONS FOR COMPLETING LOAD CAPACITY INFORMATION FORM

SECTION 1 - For Structure Type, enter the appropriate codes from the BMIS manual.

SECTION 2 - For BMIS items, enter appropriate codes from the BMIS manual.

SECTION 3A-D - Check all appropriate items, more than one item may be checked in each category.

SECTION 3E - Enter the number for all appropriate items corresponding to the number placed in the controlling member column of the load rating summary table.

SECTION 4 - Operating Rating: Place the lowest operating rating (in tons) for each vehicle type.

Operating Factor: Enter the ratio of the operating rating to the weight of the vehicle, for each vehicle type.

Span Length: Enter the span length bearing to bearing.

Controlling Member: This is the member that governs the rating for this vehicle type. Enter a number "1" to "N", if the controlling member is the same for all load types "1", should be entered for all vehicle types. If different members control for different vehicle types, then enter "1" for Type SU2 and all vehicle types controlled by the same member, and "2" for the first vehicle type controlled by a different member etc.

M or V: Enter "M" if Moment controls the load rating or "V", if Shear controls the load rating.

LLDF: Enter the live load distribution factor.

SECTION 5 - Enter any additional comments, example; Rating controlled by negative Moment.

SECTION 6 AND 7 - Complete as indicated.

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

D: LOAD CAPACITY INFORMATION

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MAINTENANCE - 06/93
Page 1 of 2

1. **BRIDGE DATA:**

Bridge Number 999999 — Date DECEMBER 25, 1994

STR Type Main [BMIS Item B1(43)] 111 — STR Type APR [BMIS Item B2(44)] 104

2. **POSTING DATE:**

Posted NO If yes, Existing Restrictions ______
BMIS Item H8(41) A

Posting Needed NO If Yes, Proposed Restrictions ______
BMIS Item H11(70) 5
BMIS Item H7(31) 2

3. **ANALYSIS DATA:**

A. Method of Analysis:
X Load Factor
___ Working Stress

B. Analysis System:
X BARS
___ SALOD
___ BRUFEM
___ Load Test
X Other HAND CALCS.

C. Analysis Based On:
X Design Drawings
___ As-Built Record Plans
___ Shop Drawings
___ Field Measurement
___ Catalogs
___ Sample Testing
___ Other ______

D. Data Stored:
X District Office
___ Central Office
___ Microfilm
___ Bridge Owner
___ Materials Test Lab
___ Other ______

E. Controlling Member Analyzed:

Material:
___ Steel
1,2 Concrete
  1,2 Cast in Place
  ___ Precast
  ___ Prestressed
  ___ Post Tensioned
___ Timber
___ Other ______

Function:
___ Slab
___ Stringer
1 Floor Beam
2 Girder
___ Culvert
___ Truss

Substructure:
___ Bent Construction
  ___ Piling
  ___ Cap
___ Pier Construction
  ___ Piling
  ___ Footing
  ___ Column
  ___ Cap

Span:
1,2 Simple
___ Continuous
___ Frame

Slab:
___ Non-Composite
1,2 Composite

Shape:
___ Rolled
___ Built-up Welded
___ Built-up Riveted
___ Box Shape
___ AASHTO Girders
1,2 Other T-BEAM

4. **Load Rating Summary Table:**

LOAD RATING SUMMARY FOR OPERATING RATING (GROSS TONS)

VEHICLE TYPE	TONS	OPR RATING	OPR FACTOR	SPAN NO.	SPAN LENGTH	CONTR. MEMBER	M OR V	LLDF
SU2	17	18.7	1.10	6	24	1	M	1.21
SU3	33	34.7	1.05	8	35	2	M	1.09
SU4	35	37.8	1.08	8	35	2	M	1.09
C3	28	30.0	1.07	6	24	1	M	1.21
C4	36.6	39.5	1.08	8	35	2	M	1.09
C5	40.0	42.8	1.07	8	35	2	M	1.09
ST5	40.0	43.2	1.08	8	35	2	M	1.09
HS20	36	38,5	1.07	6	24.0	1	M	1.21

HS 20 Inventory Rating 23.1 — Rating Factor 0.64

5. **Comments:**

MEMBER 1 IS A FLOOR BEAM IN SPAN 6 WITH A SPAN OF 24 FEET
MEMBER 2 IS A T-BEAM GIRDER IN SPAN 8 WITH A SPAN OF 35 FEET

Computations:

Performed By T. TERZHAGI — Date DECEMBER 23, 1994
Checked By G. TIMOSHENKO — Date DECEMBER 24, 1994
Reviewed By P. POPOV — Date DECEMBER 25, 1994

7. **Responsible Engineer:** ______

P.E. # 77777 — Date DECEMBER 25, 1994

FIGURE IX-4

INSTRUCTIONS FOR COMPLETING LOAD CAPACITY INFORMATION FORM

SECTION 1 - For Structure Type, enter the appropriate codes from the BMIS manual.

SECTION 2 - For BMIS items, enter appropriate codes from the BMIS manual.

SECTION 3A-D - Check all appropriate items, more than one item may be checked in each category.

SECTION 3E - Enter the number for all appropriate items corresponding to the number placed in the controlling member column of the load rating summary table.

SECTION 4 - Operating Rating: Place the lowest operating rating (in tons) for each vehicle type.

Operating Factor: Enter the ratio of the operating rating to the weight of the vehicle, for each vehicle type.

Span Length: Enter the span length bearing to bearing.

Controlling Member: This is the member that governs the rating for this vehicle type. Enter a number "1" to "N", if the controlling member is the same for all load types "1", should be entered for all vehicle types. If different members control for different vehicle types, then enter "1" for Type SU2 and all vehicle types controlled by the same member, and "2" for the first vehicle type controlled by a different member etc.

M or V: Enter "M" if Moment controls the load rating or "V", if Shear controls the lo rating.

LLDF: Enter the live load distribution factor.

SECTION 5 - Enter any additional comments, example; Rating controlled by negative Moment.

SECTION 6 AND 7 - Complete as indicated.

SECTION X - QUALITY CONTROL

Quality control is important in the load rating process.

A. Computer Programs. The load rater should perform long hand checks of a portion of the computer analysis to satisfy the load rater that the computer program is accurate. It is of utmost importance that the load rater understand when computer results are reasonable. Blind faith in any computer program should be avoided.

B. Checking. An independent check of the analysis shall be performed. When computer programs are used, the checker should verify all input data, verify that the summary of load capacity information accurately reflects the analysis, and be satisfied with the accuracy and suitability of the computer program.

C. Review. The analysis must be performed under the supervision of a Professional Engineer. If neither the load rater or the checker are Professional Engineers, then the Professional Engineer in charge must review the work for accuracy and completeness.

D. Reanalysis. When the condition of a structure changes, a reanalysis of the structure may be required. Conditions that may require reanalysis are; structural deterioration, damage due to vessel or vehicular hits or specification changes. Every bridge inspection report and accident report should be reviewed by a person knowledgeable in load rating concepts to determine if reanalysis is required. The best method of assuring this, is for all bridge inspection reports to be reviewed by the load rating section.

E. Load Rating File. Computer input and output files, hand calculations, field measurements, catalogs and other pertinent information, used in performing the load rating, shall be stored in the load rating file. This will provide easy access for reviewing or revising the load rating.

F. Bridge Management Inventory System (BMIS) Data. The accuracy of this data is vital to the operation of the Road Use Permits Office. Therefore, the load rating section will obtain an output of the BMIS report after the inspection report has been reviewed. If no reanalysis is required, the load rating section will verify the BMIS data in Section H and BMIS Item I2(67) and Item D7(48). After reanalysis, the load rating section will provide the BMIS engineer with the proper values and backcheck the BMIS data after the BMIS engineer has updated the BMIS data file.

SECTION XI - TRANSMITTALS