INDIAN ROADS CONGRESS

BRIDGE LOADINGS ROUND THE WORLD

NEW DELHI
1966

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BRIDGE LOADINGS

ROUND THE WORLD

The Indian Roads Congress issued a questionnaire to various countries in the world about the bridge loadings applied for design purposes.

The following countries very kindly sent the replies:

(1) America (U.S. Bureau of Public Roads)

(2) Austria

(3) Belgium—see pp. 128-129

(4) Canada (Toronto and Ontario)

(5) Finland

(6) Germany (Federal Republic)

(7) Great Britain

(8) India

(9) Italy

(10) Japan

(11) Malaysia

(12) New South Wales (Australia)

(13) New Zealand

(14) Norway

(15) Philippines

(16) Rhodesia

(17) Sweden

(18) Switzerland

(19) Turkey

The ensuing Tables have been prepared from the information received.

The Indian Roads Congress is very grateful to the above mentioned countries for the information supplied.

<table>
<tr><th>QUESTIONS</th><th>AMERICA
(U.S. Bureau of Public Roads)</th><th>AUSTRIA</th></tr>
<tr><td>1. LOADINGS
(i) Design train loading truck loading or any special loading for each category of roads.</td><td>Article 1.2.5*
(i) Truck loading and lane loading H10-44, H15-44, H20-44, H15-S12-44, H20-S16-44 and Military loading. (See Figs. 1, 2, 3 & 4 in Plate I).

For trunk highways or other highways which carry heavy truck traffic, minimum loading H15-S12-44.

For Inter-state highway system, Military loading (see Fig. 4 in Plate I) where-ever it causes moments or shear greater than those caused by H20-S16 truck or the standard lane loading.</td><td>
<table>
<tr><td>Bridge Classes</td><td colspan="4">See Fig. 6 in Plate I</td></tr>
<tr><td>Total weight</td><td>tonnes</td><td>25</td><td>16</td><td>16</td></tr>
<tr><td>(a) Truck</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Fore wheel</td><td>tonnes</td><td>4</td><td>2·5</td><td>2·5</td></tr>
<tr><td>Back wheel</td><td>tonnes</td><td>8·5</td><td>5·5</td><td>5·5</td></tr>
<tr><td>Equivalent weight</td><td>tonnes/m²</td><td>1·67</td><td>1·07</td><td>1·07</td></tr>
<tr><td>(b) Uniform load</td><td>tonnes/m²</td><td></td><td>0·50</td><td>0·40</td></tr>
<tr><td>(c) Caterpillar Car</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Total weight</td><td>tonnes</td><td>60</td><td>—</td><td></td></tr>
<tr><td>Caterpillar load</td><td>tonnes/m²</td><td>17·14</td><td>—</td><td></td></tr>
<tr><td>Equivalent weight</td><td>tonnes/m²</td><td>3·33</td><td>—</td><td></td></tr>
</table>
For spans more than 30 m, calculations may be made with the "Equivalent weight" (total weight, referred to the track area) instead of the different wheel loads.</td></tr>
<tr><td>(ii) Distance between successive trains or loads
(a)
(b)
(c)
(d)
(e)</td><td>(ii) No successive trains or loadings.</td><td></td></tr>
<tr><td>2. Lateral disposition of train loading or other types of loadings with respect to :
(a) Kerb

(b) Central line of the bridge</td><td>Article 1.2.6*
(a) Distance from kerb to centre line of wheel—2 ft (for slab design—1 ft). (see Figs. 1 and 3 in Plate I).

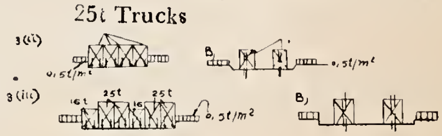
(b) No particular lateral disposition.</td><td>(a) The standard trucks, 2·5 m wide, are equal to the width of a lane; therefore the trucks have to be put close together, so that the live load for the considered structural part arises to a maximum.
It is not necessary to shift the wheels of the trucks to the kerb.

(b) The caterpillar, as the only load on the roadway, has a maximum deviation of 0·5 m on both sides from the centre line of the roadway.</td></tr>
<tr><td>3. No. of train loadings taken for design of each span of bridges and culverts with the following number of traffic lanes :

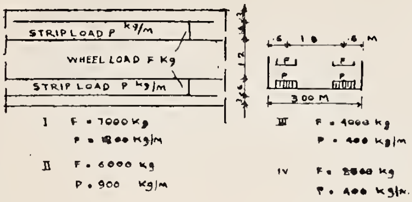
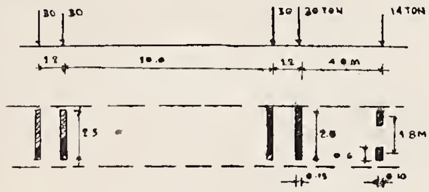
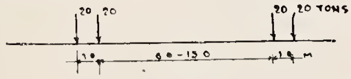
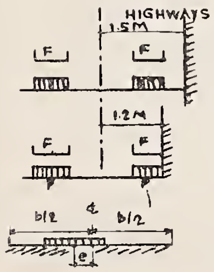
(i) Two lanes

(ii) Two lanes each way on a divided highway

(iii) Three lanes each way on a divided highway</td><td>Articles 1.2.7, 1.2.8, 1.2.9*

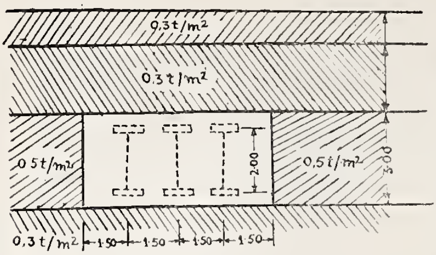
(i) 100 per cent of either 2-lane loading or one standard H or H.S. truck per each lane.
(ii) 75 per cent of either 4 lane loading or one standard H or H.S. truck per each lane.
(iii) 75 per cent of either 6 lane loading or one standard H or H.S. truck per each lane.
Note : In case of a 3-lane bridge, 90 per cent of the full live load.</td><td>Bridge Class I : The calculation has to be executed for :
(A) on 2 adjoining lanes, 1 truck of 25 t each. On every other of the following lanes, 1 truck of 16 t. The rest of roadway and footpath to be covered with uniformly distributed load of 0·5 t per metre.
(B) For a caterpillar of 60 tonnes only, also see 2(b) above.
Bridge Class II : On 2 adjoining lanes, one 16 t truck each. The rest of the roadway and footpath to be covered with uniformly distributed load of 0.4 t per sq. metre.
60 t CATERPILLAR
3 (ii) 25t Trucks
3 (iii)
</td></tr>
</table>

*Articles referred to relate to the A.A.S. H.O. Standard Specifications for Highway Bridges (1961).

CANADA	FINLAND
TORONTO Truck loading is based on the H20-S16-44 or the heavier H25-S20 loading in the A.A.S.H.O. Standard Specifications for Highway Bridges (1961). **ONTARIO** All H20-S16-44 Article 1.2.4 to 1.2.9*	**LANE LOAD**  **HEAVY TRUCK LOAD I**  **HEAVY TRUCK LOAD II** 
TORONTO (a) For trucks, wheel is placed 2 ft away. (b) No relationship for trucks. **ONTARIO** Article 1.2.6.*	 With Impact Without Impact For Heavy Truck Load e≤0.1 b
TORONTO (i) 2 train loads. (ii) (a) 2 train loads. (b) 3 train loads with 10 per cent reduction. (c) 4 train loads with 25 per cent reduction whichever gives the most critical stress. (iii) As in (i) above except that (c) becomes 4 lanes or more with 25 per cent reduction. **ONTARIO** Article 1.2.9*	(i) 100 per cent (ii) Two lanes 100 per cent, remaining lanes 50 per cent.

*Articles referred to relate to the A.A.S.H.O. Standard Specifications for Highway Bridges (1961).

FEDERAL REPUBLIC OF GERMANY



(i) For Federal Autobahns, Federal Highways and Rural Highways of 1st order, Bridge Class 60=6×10 t

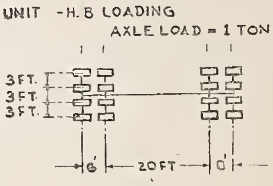
For Rural Highways of 2nd order and District Roads, Bridge Class 30=6×5 t

For Minor Roads, Bridge Class 16 & 6, see Fig. 7 in Plate II.

GREAT BRITAIN

Bridges carrying public roads are designed for HA loading (British Standard 153-Part 3-Section A—see Fig. 8 in Plate II consisting of a uniformly distributed load plus a single knife edge load. The U.D. load varies with the span but between 20 and 75 ft it is constant at 2200 lb per linear foot of 10 ft wide lane. The knife edge load is placed parallel to the supports of the member under consideration and has a value of 27,000 lb for a 10 ft wide lane.

Bridges carrying important roads are checked for 45 units of HB loading to British Standard 153.



Federal Republic of Germany

(a) For main carriageway, the load should be so placed as to cause worst effects. Laterally it can be placed upto the kerb.

(b) Outside the carriageway, uniformly distributed load of 0·3 t per m² for bridges of class 60 and 30.

Great Britain

(a) Any part of the bridge deck between kerbs, including the hard shoulder, if any, is deemed to be subject to HA or HB loading.

Federal Republic of Germany

(i) & (ii) The portion of train loading according relieving effect will not be considered.

Great Britain

(i) Two lanes of HA loading or one lane of HB loading together with one lane of 1/3 HA loading.

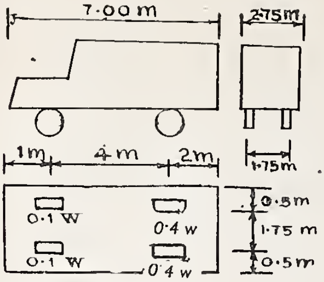
(ii) Two lanes of HA loading and two lanes of 1/3 HA loading or one lane of HB loading and the adjacent lane with 1/3 HA loading. The two lanes in the other carriageway each with HA loading.

(iii) Two lanes of HA loading and four lanes of 1/3 HA loading or one lane of HB loading and the two adjacent lanes with 1/3HA loading. In the other carriagway, two lanes with HA loading and the other lane with 1/3 HA loading.

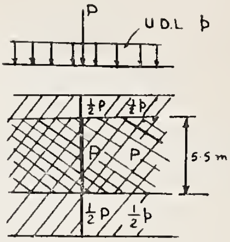
INDIA	ITALY
Clauses 201* and 207* (i) Class "AA" tracked vehicle and Class "AA" wheeled vehicle. Class "A" train of vehicles. Class "B" train of vehicles. (See Figs. 9, 10 & 11 in Plate III) (a) For every 2-lane width of bridge Class "AA" one tracked or wheeled vehicle or two lanes of Class "A" loading whichever creates worst effects, to be used for road bridges in municipal limits, industrial and other specified areas and on specified highways. (b) Class "A" to be used for all roads on which permanent bridges and culverts are constructed. (c) Class "B" for temporary bridges, etc. (ii) See Figs. 9, 10 & 11 in Plate III For Class "AA" tracked vehicles—300 ft min. For Class "A" train of vehicles—65 ft min. For Class "B" train of vehicles—65 ft min.	For the purpose of loading, highways are divided into the following two categories. : (I) Highways for civil and military use, and (II) Highways for civil use only (local and minor roads). Loading system. Type 1. a continuous train of 12 t truck ,, 2. a single 18 t steam roller ,, 3. a crowd load of 400 kg per sq. m. ,, 4. a continuous train of military loads of 61.5 t ,, 5. a continuous train of military loads of 32 t ,, 6. a single military load of 74.5 t (See Fig. 13 in Plate—IV) Loading system to be adopted in the design of highway bridges. Category (I)—One military type-the heaviest of types 4, 5 or 6 flanked by one or more trains of truck (Type 1) with crowd loading of 400 kg/m^2 (Type 3) on the footpaths. Category (II)—The most unfavourable of the following conditions : (a) one or more lanes loaded with continuous trains of trucks (Type 1) with crowd loading on the footpaths (Type 3) (b) one or more steam rollers (Type 2) side by side with crowd loading on footpaths (Type 3).
Clause 207* (See Figs. 9 to 11, Plate III) (a) Class "AA" clear distance between kerb and outer edge of wheel or track=1ft for single lane bridge with 12 ft carriageway; 2 ft for multi-lane bridge with less than 18 ft carriageway; 4 ft for 18 ft or above carriageway: In case of Class "A"—clear distance 6 in. between kerb and wheel having 20 in. width for all carriageway widths. Class "B" 6 in. for wheel having 15 in. width. (b) Not given.	No details given.
Clauses 113* and 208.2* (i) One train of Class "AA" tracked or wheeled vehicles or two lanes of Class "A" train of vehicles for National Highways and State Highways. (ii) 80 per cent of two trains of Class "AA" tracked or wheeled vehicles or of four lanes of Class "A" train of vehicles. (iii) This type of bridge construction is not permitted.	No details given.

*Clauses referred to relate to the Indian Roads Congress Standard Specifications & Code of Practice for Road Bridges-Sections I & II (1964).

JAPAN



T—LOADING



L—LOADING

T—loading for design of floor system :

Class of bridge	Load	Weight W(t)
1st	T-20	20
2nd	T-14	14

One vehicle longitudinally and as many as possible transversely.

Note : For spans exceeding 150 m, specifications are otherwise considered.

Loading for the Design of Main Girders

Class of bridge	Load	Main-lane loading (width of 5·5 m)			Other lanes
		Live load P.(kg/m.)	U.D.L. P. (kg./m²)		
			$l \leqslant 80$m	$150 > l > 80$m	
1st	L-20	5000	350	$430 - l \geqslant 300$	½ of main loading
2nd	L-14	70 per cent of L-20			

MALAYSIA

B.S. 153-Part 3A: 1954 (see Fig. 8 in Plate II.)

Type HA (British) loading represents approximately effect of 3 vehicles, each 22 tons in weight, closely spaced, in each of two carriageway lanes, followed by 10-ton and 5-ton vehicles. For short span members, the effects of two 9-ton wheels 3 ft apart have been considered (*i.e.*, approximately two 11¼-ton wheels with 25 per cent overstress).

(a) Nil.

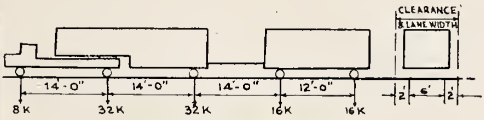
(b) Nil.

B.S. 153-Part 3A—1954—Clause 4-A (a), (b) and (c).

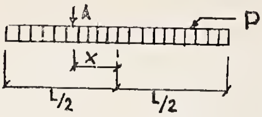
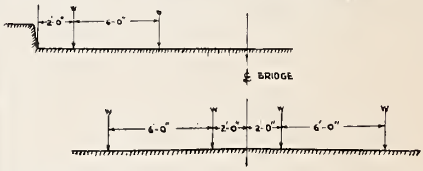
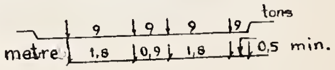
(i) Occupied by full type HA loading.

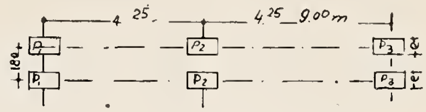
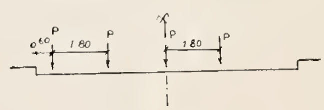
(ii) Occupied by full type HA loading.

(iii) Two lanes occupied by full type HA loading and one lane occupied by one-third the full lane loading.

NEW SOUTH WALES	NEW ZEALAND
Clauses 2·5* and 2·7* (i) Truck loading and lane loading H10-44, H15-44, H 20-44 and H15-S12-44 and H20-S16-44. Minimum loading : (a) Metropolitan bridges H20-S16-44. (b) Bridges on Main roads and Highways : H20-S16 44. (c) Other bridges : Through roads—H20-S16-44 unless H15-S12-44 is considered desirable. Other than Through Roads (such as those serving small group of settlers) lower classes of loading, if desirable. (ii) No successive trains or loads.	Design loading for new bridges for all National Board Roads or Govt. Subsidiary Roads as per A A.S.H.O. H20-S16-44 Truck and Lane loading and H20-S16-T16 truck loading, whichever gives the worst effects.  H20-S16-T16 DESIGN VEHICLE
Clause 2·6* (a) For deck slab design (concrete, steel grid or timber deck), the distance of the wheel to the kerb face may be only 1 ft (see Figs. 1, 2 and 3 in Plate I. (b) No particular lateral disposition.	Based on A.A.S.H.O. Standard HS Truck Disposition. See Fig. 3 in Plate I.
Clause 2·9* (i) 100 per cent of 2 lane loading or of one standard H or HS truck per each lane. (ii) 75 per cent of 4 lane loading or of one standard H or HS truck per each lane. (iii) 75 per cent of 6 lane loading or of one standard H or HS truck per each lane. Where continuous spans are designed, for the truck loading, only one standard H or HS truck per each lane shall be considered on the structure.	(i) 2 Trucks (ii) 75 per cent of 4 trucks =3 trucks (iii) 75 per cent of 6 trucks =4·5 trucks

*Clauses referred to relate to Highway Bridge Design Specifications of N.A. of A.S. Road Authorities (1965).

NORWAY	PHILIPPINES	RHODESIA
Equivalent loading per lane :  $A = 12 + 8x/L$ tons (Class I & II) Class I : $p = 0{\cdot}5 + \dfrac{35}{L+5}$ Class II : $p = 0{\cdot}35 + \dfrac{24}{L+7}$ tonnes per linear metre of lane. Impact included in A and p. L=actual loaded length of lane. Class I and II mainly refer to lane widths for two lane bridges usually used for roadway widths more or less than 6·5 metre respectively.	Class of bridge loading. AA—H20 or H20-S16 A—H15 or H15-S12 B—H10 See Figs. 1, 2, 3 in Plate I & Fig. 14 in Plate IV. Class "AA" bridges for specially heavy traffic units in locations where the passage of such loads is frequent or located in large cities and industrial centres. Class "A" bridges for normally heavy traffic units and the occasional passage of specially heavy loads. Class "B" bridges for light traffic units and the occasional passage of normally heavy loads. Class "B" bridges shall be considered as temporary or semi-temporary structures. There is also loading H-10-35 as given in Fig. 14 in Plate IV.  	HA loading, supplemented with 30 units HB loading allowing 25 per cent increase in permissible working stresses. See Fig. 8 in Plate II for HA loading. For HB loading, see sketch under Great Britain, p. 98. All in accordance with B.S. 153/1954-Part 3—Section A.
The above lane loadings are normally considered uniformly distributed over lane widths from 3·0 to 3·75 metre. Besides, the structure is designed for a local loading of two axles of each 18 t (13 t allowable+5 t impact) with lateral position shown in the sketch below :  Furthermore, the structure is controlled for one up to 30 metre long Class II lane load laterally distributed as the above two right wheel loads (or a corresponding other position, if more unfavourable).	Similar to A.A.S.H.O. Article 1.2.4. Figs. 1 and 3 in Plate I.	(a) 18" from kerb line in any analysis not incorporating a lateral distribution analysis. Accidental loading of a 4 ton wheel is investigated at edge of parapet, allowing 25% increase in permisible working stresses. (b) Symmetrical, unless a lateral distribution analysis is undertaken.
(i) The above equivalent loading in each lane. (ii) -do- -do- (iii) The full equivalent loading in two lanes, 50 per cent in the third lane.	(i) Two headed in the same direction (ii) Two each way (iii) Three each way (load intensity reduced to 90 per cent)	(i) Full HA loading in each lane. (ii) As above. (iii) N/A. (iv) Three lanes. Full HA loading in two adjacent lanes; 1/3 HA in the third lane.

SWEDEN	SWITZERLAND	TURKEY
See Fig. 15 in Plate IV (a) Lane loading consisting of one 14 t axle load+distributed "p" t/m, when p=2·4 t/m for loaded length less than 10 m, and 1·1 t/m for loaded length over 90 m. For loaded length between 10 m and 90 m, "p" varies according to formula $p=2{\cdot}4-\frac{1{\cdot}3}{80}(l-10)$ where l is the loaded length in metres (distance between the zero points of influence curve) or by interrupted loading, the sum of loaded lengths and length of the unloaded parts between. (b) Single truck loading of 100 t. This single truck loading may be assumed as exceptional loading without concurrent loading stress increased by 15 per cent On special roads, it can be prescribed that the above mentioned single truck shall be considered as normal traffic loading.	(i) Main roads : Distributed load of 360 kg per m² and one axle load of 15 t for each lane. Secondary roads : The same with 240 kg per m² and 10 t. (ii) Instead of distributed loading with one axle load, all parts should be checked also for the following train load : 3 axle loads for each lane with 1·5 m distance behind each other of 15 t for main roads, 10 t for secondary roads.	 State Roads H20-S16: P_1 (t) 2, P_1 (t) 8, P_3 (t) 8, e (cm) 51 Provincial Roads H15-S12: P_1 (t) 1·5, P_1 (t) 6, P_3 (t) 6, e (cm) 38 Village Roads H10: P_1 (t) 1, P_1 (t) 4, P_3 (t) 0, e (cm) 25
See Fig. 15 in Plate IV.	The distributed load goes all over the bridge. The train and axle loads in the position which gives the maximum stress.	
(i) Two lane loading or single truck loading. (ii) Each side of the divided highway shall essentially be regarded as belonging to a separate bridge. However, in some cases on long bridges, certain deduction in the loading is often allowed.	(i) Not more as two lanes are loaded with axle or train loads. (ii) & (iii) Not more as two lanes each way have to be loaded with axle or train loads.	One truck for each lane.

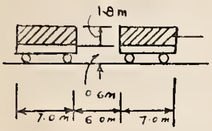
QUESTIONS	AMERICA (U.S. Bureau of Public Roads)	AUSTRIA	CANADA
4. Area of the train of vehicle assumed in elevation for calculating the effective wind pressure.	Article 1.2.14* Wind pressure at the rate of 100 lb per linear ft on moving live load acting at 6 ft above deck. This is to be taken only for group loading combination as explained in Article 1.4.1*.	The Austrian standards adopt a 2·5 m high rectangular traffic area in correspondence with the position of live load.	**TORONTO** A simplified procedure is used for spans 125 ft and under. 100 lb per linear ft transversely. 40 lb per linear ft longitudinally. Both forces applied simultaneously 6 ft above deck. **ONTARIO** Article 1.2.14*
5. Impact factor due to live loads assumed for different types of loads on : (i) Concrete bridges (ii) Steel bridges (iii) Prestressed concrete bridges Variation of impact according to span length.	Article 1.2.12* Impact fraction $I=\frac{50}{L+125}$ (maximum impact factor 30 per cent) L=length in ft of the portion of the span which is loaded to produce the maximum stress in the member. This is applicable only for structural members of group (A). No distinction has been made in impact factor for different types of loads or bridges of different materials. For further explanation, see Article 1.2.12*.	Impact Factor (i) Concrete bridges : L=span of the structural part (metre) 0 10 30 50 70 Platform girder, direct loaded main girder 1.40 1.30 1.20 1.10 1.00 Indirect loaded main girder 1.40 1.25 1.10 1.00 1.00 Floor slab 1.40 (ii) Steel bridges : L in metres 2 4 6 8 10 20 Impact factor Lane I 1.64 1.50 1.41 1.35 1.30 1.18 Lane II 1.32 1.25 1.20 1.17 1.15 1.09 L in metres 40 60 80 100 Impact factor Lane I 1.1 1.07 1.05 1.04 Lane II 1.05 1.03 1.02 1.02 For all following lanes : Impact factor=1	**TORONTO** (i) Concrete bridges—30 per cent (ii) Steel bridges—30 per cent (iii) Prestressed concrete bridges—30 per cent **ONTARIO** Article 1.2.12.*

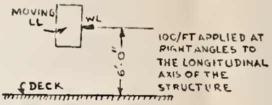
*Articles referred to relate to the A.A.S.H.O. Standard Specifications for Highway Bridges (1961).

FINLAND	FEDERAL REPUBLIC OF GERMANY	GREAT BRITAIN
Height 2 m for the length of loading.	For bridges without load—250 kg/m² For bridges under construction—125 kg/m² For bridges with load —125 kg/m² For pedestrian & cycle bridges—75 kg/m² The above loading acting in case of (a) road bridges at 2.0 m height (b) pedestrian bridges at 1.8 m height.	A plane with a continuous height of 8 ft above the carriageway for highway bridges or 4 ft above the footway for foot-bridges. Allowance may be made for the screening effect of the structure on the plane, based on projected areas.
I=40 per cent when filling h(m) $\geqslant$3 m I=16 (3·0−h) per cent for height of fill varying from 0·5−3·0m For timber bridges always I=20 per cent.	Impact Factor $\varphi=1{\cdot}4-0{\cdot}008\times l\varphi \geqslant 1.0$ $l\varphi$=governing length in metres (See D.I.N. 1073, 1074, 1075 and 1078 for the determination of the value of $l\varphi$).	HB loading has no impact factor. HA loading incorporates an impact factor of 25 per cent on the heaviest axle in the train of vehicles from which HA loading is derived. It is constant for all forms of construction.

INDIA	ITALY
Clause 212.4*—Also see Figs. 9, 10 and 11 in Plate III. The lateral wind force against any expesed moving load shall be considered as acting at 5 ft above the roadway and shall be assumed to have the following values : Highway bridges, ordinary—200 lb per linear ft Highway bridges carrying tramway—300 lb per linear ft While calculating the wind pressure on live load, the clear distance between the trailers of a train of vehicles should not be omitted.	A wind pressure of 250 kg per sq. m. of exposed surfaee shall be taken as acting on the structure when the bridge is unloaded. When the structure is loaded, the pressure should be taken as 100 kg per sq. m. acting on the above said surface increased by a continuous strip 3 m. high raising from the roadway.
Clause 211* (i) (a) Class "A" or "B" loading—Impact fraction $I=\frac{15}{20+L}$; (b) Class "AA" loading—Impact percentage : For spans less than 30 ft : For tracked vehicles—25 per cent for spans upto 15 ft, linearly reducing to 10 per cent for spans of 30 ft. For wheeled vehicles—25 per cent. For spans of 30 ft or more: Tracked vehicles : 10 per cent upto 130 ft span and according to the curve in Fig. 12 in Plate III for more than 130 ft span. Wheeled vehicles : 25 per cent for spans upto 40 ft, for more than 40 ft span in accordance with the curve in Fig. 12 in Plate III. (ii) (a) Class "A" or "B" loading $I=\frac{30}{45+L}$ (b) Class AA loading Tracked vehicles—10 per cent for all spans. Wheeled vehicles—25 per cent for spans upto 75 ft and for over 75 ft spans as per curve in Fig. 12 in Plate III	In order to take into account the dynamic effects for spans upto 100 m, the live loading should be multiplied by the coefficient ϕ where $\phi=1+\frac{(100-L)^2}{100(250-L)}$ L=the span of the bridge between abutments measured in metres. The formula also applies to reinforced concrete beam and slab construction. For spans exceeding 100 m, ϕ is assumed to be unity.

*Clauses referred to relate to the Indian Roads Congress Standard Specifications and Code of Practice for Road Bridges—Sections I and II (1964).

JAPAN	MALAYSIA	
Exposed to wind 	B.S. 153-Part 3A-1954, Clause 12 (a)—(d) A plane with a continuous height of 8 ft above the carriageway for highway bridges and 5 ft above the footway for footway loading. Allowance may be made for the screening effect of the structure on the plane based on projected areas.	
	B.S. 153-Part 3A : 1954 Where type HA loadings are not adopted, the allowance for impact on highway bridges are as follows :	
(i) Concrete bridges— $i=\frac{7}{20+L}$ for main girder $i=\frac{20}{50+L}$ for floor system. (L=span in metres)	(i) Concrete bridges—	25 per cent
(ii) Steel bridges— $i=\frac{20}{50+L}$	(ii) Steel bridges—	25 per cent
(iii) Prestressed concrete bridges—same as for concrete bridges.	(iii) Prestressed concrete bridges—	25 per cent

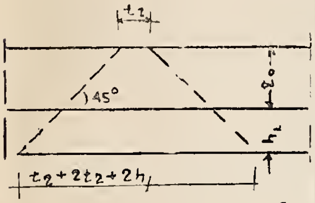
NEW SOUTH WALES	NEW ZEALAND	NORWAY	PHILIPPINES
Clause 2·15* Lateral wind force at 100 lb per linear ft acting at a height of 6 ft above the deck. Alternatively, 66 lb per linear foot laterally plus 33 lb per linear foot longitudinally acting simultaneously.	Wind loads as per A.A.S.H.O. Specifications for longitudinal elevation. See Fig. 3 in Plate I and sketch in Q. 1, p. 101.	Normally no wind pressure is considered on loaded bridge. On bridge without load, wind pressure is assumed equal to 250 kg per m^2 of exposed area.	 See Figs. 1,2 and 3 in Plate I.
Clause 2·13* (a) Impact=10 per cent for steel or concrete substructure above the foundations but not rigidly connected to the superstructure and structures carrying $1\frac{1}{2}$ to 3 ft of fill. (b) Steel or concrete superstructures and those parts of steel or concrete substructure above the foundations which are rigidly connected to the superstructure as in the rigid frames or continuous designs and structures carrying less than $1\frac{1}{2}$ ft of fill. The impact shall be $I=\frac{5000}{L+125}$ per cent (max. 30 per cent) (min. 10 per cent)	Impact factor not dependent on bridge type. Impact factor in use : $I=\left(\frac{50}{L+125}\right)\times 100$ per cent	Impact is included under Q. 1—equivalent loading. The local loading (Q. 2) assumes 5 t impact for an allowable 13t axle load (38·5 per cent) Allowable gross weights of vehicles are established by comparing their effect with the effect of the class II equivalent loading. By this, the above 38·5 per cent impact is added to the heaviest axle, but it is so far considered unnecessary to add impact to the remaining axles.	For all kinds of bridges, $I=\frac{50}{L+125}$ in which I=impact fraction (maximum 30 per cent) L=length in feet of the portion of the span which is loaded to produce the maximum stress in the member.

*Clauses referred to relate to Highway Bridge Design Specifications of N.A of A.S. Road Authorities (1965).

RHODESIA	SWEDEN	SWITZERLAND	TURKEY
As under Section 12—B.S. 153/1954—Part 3, Section "A".	The wind pressure area of traffic load shall supposed to be a rectangle 2 metre higher from the deck and length equal to loaded length.	For road bridges, 3 metre high band is assumed.	Effective wind pressure is calculated as follows : (a) for unloaded bridge : 1·5 times the height of the full area of the bridge deck including the hand-rails. Load 250 kg per m^2. (b) for loaded bridges : height of the area of the bridge deck elevation $+2{\cdot}0$ m for live load. Wind load 125 kg per m^2.
(i) & (ii) Concrete and steel bridges—Included in HA loading. See B.S. 153/1954. (iii) For Prestressed concrete bridges : As above, but for dynamic stability the following apply : (a) The vertical acceleration of the superstructure under $\frac{1}{2}$ HA loading, travelling at 40 m.p.h. shall not exceed 0·5 ft per sec^2. (b) The natural frequency of the superstructure under a live load of 100 lb per sq. ft. shall not be less than 3 cycles/sec., where the natural frequency equals $0{\cdot}75\sqrt{\frac{EI}{wL^4}}$ cycles/sec. where "E" is Young's Modulus for the superstructure in lb per sq. in., "I" moment of inertia of superstructure ($in.^4$), $w = B \times 100 +$ weight of superstructure in lb/ft run. "B" = breadth of superstructure. "L" = span of superstructure in feet.	40 per cent for lane loading and only for the wheel loads, and not for the uniform load p. When wheel is in contact with railing or another limitation (kerb, etc.) of the roadway, no impact allowance has to be considered. No impact for single truck loading.	$\text{Impact} = 5 \times \frac{100+L}{10+L}$ where L is the length of span in m.	$\phi = 1 + \frac{15}{L+37}$ where L = span length in metres. $\phi_{max.} = 1{\cdot}3$

QUESTIONS	AMERICA (U.S. Bureau of Public Roads)	AUSTRIA	CANADA
6. Ground Contact Area The shape of contact area for design calculations and formulae adopted for dispersion of the wheel loads through the wearing coat and the slab for designing.	Article 1.2.6 and 1.3.2 (c) As per Figs. 1 and 3 in Plate I. For further details, see Article 1.3.2 (c).	For the shape of the contact area, see Q. 1, Loadings. If there is a load distributing layer, concentrated loads may be dispersed under an angle of 45 degrees. The dispersion may be extended to the centroidal axis of the considered structural part only.	**TORONTO** Shape is circular for slabs on soil. Otherwise dispersion is in accordance with "Standard Specifications for Highway Bridges" (A.A.S.H.O.—1961). **ONTARIO** Article 1.3.2*
7. Equivalent UDL or knife edge loading, if adopted for working out : (i) Bending moment. (ii) Shear.	Articles 1.2.7 and 1.2.8* See Fig. 2 in Plate I.		**TORONTO** (i) For bending moment 640 lb per linear ft UDL+18000 lb (in lieu of H20—S16 truck) (ii) For shear 640 lb per linear ft UDL+26000 lb (in lieu of H20—S16 truck) **ONTARIO** None
8. The percentage of the live load on the bridge taken for calculating the braking force in the design of substructure of the bridge.	Article 1.2.13* 5 per cent of L.L. without impact in all lanes carrying traffic headed in the same direction acting at 6 ft above deck. The load shall be lane-load plus knife edge load without impact and reduction as per Q. 3 applied. Longitudinal forces due to friction of beams shall also be provided for in the design.	30 per cent of the weight of the heaviest vehicle (caterpillars excluded).	**TORONTO** 5 per cent **ONTARIO** Article 1.2.13*

*Articles referred to relate to the A.A.S.H.O. Standard Specifications for Highway Bridges (1961).

FINLAND	FEDERAL REPUBLIC OF GERMANY	GREAT BRITAIN
	For ground contact area of wheel load, see Fig. 7 in Plate II. Generally the dispersion of wheel load be taken at 45 degrees. In the case of massive slabs, the dispersion as above will be up to the middle of the slab.	The contact area for a heavy wheel of $11\frac{1}{4}$ tons in the HB loading is taken as 15 in. × 3 in. with the 3 in. in the direction of travel. This load may be dispersed through the wearing course and slab at an angle of 45 degrees longitudinally and transversely. For structural distribution in a slab, normal structural theory may be used, *e.g.*, Pigeaud or Westergaard.
See Q. 1		See Q. 1.
20 per cent	100 per cent	The longitudinal force for HA loading is 10 Tons for spans up to 10 ft, plus 0·5 Ton per foot of span over 10 ft with a maximum of 25 Tons. The longitudinal force for 45 units of HB loading is 45 Tons for all spans.

QUESTIONS	INDIA	ITALY
6. Ground Contact Area The shape of contact area for design calculations and formulae adopted for dispersion of the wheel loads through the wearing coat and the slab for designing.	Clauses 207 and 207·2.* See Figs. 9, 10 and 11 in Plate III, for shape of contact areas. For one way slab dispersion=effective width measured parallel to the supported edges : $e=kx\left(1-\frac{x}{l}\right)+W$ and $e=1{\cdot}2x+W$ for cantilever. Effective dispersed length of slab (in the direction of span)= dimension of tyre contact area in the direction of span+twice the thickness of slab and wearing coat. For two way slabs, dispersion as per rational method.	In slab calculations, the weight of a rear wheel (6t) of the roller is distributed over a rectangle, one side of which is equal to the sum of the width of the roller wheel plus twice the depth of slab and wearing coat; the other side is equal to 10 cm plus twice the depth of slab and wearing coat. For the bridge on highway of category I, an additional calculation must be made in respect of the two rear axles, each of 18t, of load in Type 6. In such a case, the total load of the two axles must be distributed over a rectangle with sides of 2.65×1.12m each side being increased by twice the depth of slab and wearing coat. Normally the calculation is carried out for a slab When the lengths of the sides differ substantially, the slab can be considered as being bound by the longer sides, increasing the rectangular distribution in the direction of those sides by one half of the shorter side. **On main beams** In considering transverse distribution, the loading should be so placed as to give the most unfavourable effects. In the case of beam and slab construction, if a rigorous calculation is not made based on the theory of slabs, then all the beams should be similar and designed to carry the increased edge stresses.
7. Equivalent UDL or knife edge loading, if adopted for working out : (i) Bending moment. (ii) Shear.	Nil	See Table 2 page 131
8. The percentage of the live load on the bridge taken for calculating the braking force in the design of substructure of the bridge.	Clause 214·2* (a) 20 per cent of the first train load plus 10 per cent of the loads of succeeding trains or part thereof, the train loads in one lane only being considered for this purpose. When only part of the first train is on the full span, the braking force shall be only 20 per cent of portion of load on the span. (b) For bridges having more than two lanes : as in (a) above for the first two lanes plus 5 per cent of the loads on the lanes in excess of two. (Effect of impact is not taken into consideration).	Braking force shall be equal to 1/10 of the load superimposed by a continuous train of trucks (Type 1). This force, however, shall not be less than 0·3 of the heaviest axle of the load system being considered.

*Articles referred to re

*Clauses referred to relate to the Indian Roads Congress Standard Specifications and Code of Practice for Road Bridges—Sections I and II (1964).

JAPAN	MALAYSIA
Front Wheel 12·5 cm, 20 cm Rear Wheel 50 cm, 20 cm	B S. 153 : Part 3A : 1954 Appendix A 1(c) and 3(f) Contact area of 15 in. × 3 in., the smaller dimension being in the direction of travel. Dispersal under the wheel load shall be taken at 45 degrees.
For bridges with span length less than 150 m, it is not adopted. For longer spans, equivalent U.D.L may be specified.	B.S. 153 : Part 3A : 1954 Appendix A. See Fig. 8 in Plate II.
10 per cent of T loading.	B.S. 153 : Part 3A : 1954 Clause 10 Span upto 10 ft = 10 Tons Span above 10 ft = 10 Tons + ½ Ton for each ft of span over 10 ft, but not exceeding 25 Tons.

NEW SOUTH WALES	NEW ZEALAND	NORWAY	PHILIPPINES
Clause 2·5* See Figs. 1 & 3 in Plate I. Contact width of each rear tyre equals 1 inch per every 2000 lb of total weight of loaded truck.	The shape of contact area as per A.A.S.H.O. H20-S16-44 loading. Distribution according to the A.A.S.H.O. Specification based on Westergaard method.	The contact area for the wheel load given under Q. 2 is 50 cm lateral, by 20 cm in driving direction. For moment calculation, the above area is increased by thickness of wearing coat+50 per cent of slab thickness in each direction.	See Figs. 1 and 3 in Plate I and also Article 1.3.2 (c) of A.A.S H.O. Bridge Specifications (1961)
Clause 2·5* See Fig. 2 in Plate I Worked out bending moment and shear for various spans is given in Appendix A (pages 172-183) of NAASRA Highway Bridge Design Specifications (1965).	As per A.A.S.H.O H20-S16-44 Lane Loading.	See Q. 2 above. For shear, the actual knife edge load "A" reaches the max. value of 16 tonnes according to formula $\left(x = \frac{L}{2}\right)$	Similar to A.A.S. H.O. Bridge Specifications (1961). Fig. 2 in Plate I.
Clause 2·14* 5 per cent of total live load (without impact) on the bridge loaded to give maximum effect. This shall be taken as acting 6 ft above road level.	None in the case of road bridges.	So far braking force of 8 t for lane lengths upto 5 m increasing to 12 t for 25 m length or more has been adopted. At present the question of increasing braking forces is being considered.	5 per cent of the total lane loading for moment without impact and traffic headed in the same direction subject to reduction in the load intensity as follows : One or two lanes 100 per cent Three lanes 90 per cent Four lanes or more 75 per cent

*Clauses referred to relate to Highway Bridge Design Specifications of N. A. of A. S. Road Authorities (1965).

<table>
<tr><th>RHODESIA</th><th>SWEDEN</th><th>SWITZER-
LAND</th><th>TURKEY</th></tr>
<tr>
<td>Ellipitical, major axis 21 in., minor 9 in. Pigeaud's general dispersion, i.e., 45 degrees from contact area to main reinforcement in structural member.</td>
<td>Shape of contact area—See Fig. 15 in Plate IV.</td>
<td>—</td>
<td>Main reinforcement perpendicular to traffic :

Slab span (S) from 0·6 to 2·0 m

$E=0{\cdot}6S+0{\cdot}76$

Bigger than 2 m $E=0{\cdot}4S+1{\cdot}14$

Main reinforcement parallel to traffic

$E=0{\cdot}175S+0.98$</td>
</tr>
<tr>
<td>(i) N/A

(ii) N/A</td>
<td>See Fig. 15 in Plate IV.</td>
<td>—</td>
<td>

For each lane :
<table>
<tr><th></th><th>q t/m)</th><th>Q(t) Moment</th><th>shear</th></tr>
<tr><td>H20-S16</td><td>1.00</td><td>9.00</td><td>13.00</td></tr>
<tr><td>H15-S12</td><td>0.75</td><td>6.75</td><td>9.75</td></tr>
<tr><td>H-10</td><td>0.50</td><td>4.50</td><td>6.50</td></tr>
</table>
</td>
</tr>
<tr>
<td>See para 10 B. S. 153 (1954) Part 3 Section "A".</td>
<td>Irrespective of the clear width of the roadway, the braking force shall be 7 tonnes for 20 m length & 12 tonnes per 30 m length or more uniformly distributed over the clear width of roadway. For intermediate lengths, linear interpolation is applied.</td>
<td>—</td>
<td>15 per cent of one standard truck for the whole width of the bridge applied on the surface of the deck.</td>
</tr>
</table>

QUESTIONS	AMERICA (U.S. Bureau of Public Roads)	AUSTRIA	CANADA
9. The surcharge effect considered in the design of abutments of the bridge due to the live load on the approach fill.	Article 1.2.19* Surcharge effect on the abutment due to the live load on approach fill=2 ft. No sucharge, if adequately designed R.C.C. approach slab is provided.	No special standards.	**TORONTO** Equivalent to an additional 2 ft of backfill. **ONTARIO** 2 ft surcharge without approach slab. None if approach slab is used.
10. Footpath loading (state) min. width of footpath acceptable.	Article 1.2.11 (c)* No minimum width of footpath.	Minimum width $=1{\cdot}50$ m	**TORONTO** Normal use-100 lb per sq. ft.
(i) Crowd load assumed per sq. ft.	(i) 85 lb per sq. ft. for slab, stringers and immediate supports.	Bridge Class I $=0{\cdot}5$ t per m^2 Bridge Class II $=0{\cdot}4$ t per m^2	
(ii) Any variation in the above load for change in the span length.	(ii) For girders, trusses, arches, etc. 0—25 ft span —85 lb/sq. ft. 26—100 ft span —60 lb/sb. ft. Over 100 ft span, $P=\left[30+\frac{3000}{L}\right]\left[\frac{55\text{-}W}{50}\right]$ where P=L.L. per sq. ft. (max. 60 lb per sq. ft.) L=loaded length of side-walk in feet. W=width of side-walk in ft	Nil	Nil
(iii) Any special loading specified for the accidental mounting of vehicles on the footpath and in that case overstressing, if any, allowed.	(iii) No such loading.	One truck of 25 tonnes (16 tonnes) placed to produce maximum stress. No overstressing allowed.	Not definite. **ONTARIO** Article 1.2.11*

*Articles referred to relate to the A A.S.H.O. Standard Specifications for Highway Bridges (1961).

FINLAND	FEDERAL REPUBLIC OF GERMANY	GREAT BRITAIN
$q = \frac{1}{12}F + \frac{2}{3}P$ q in kg per m^2 F in kg P in kg per m See Q. 1.	Earth surcharge and earth pressure are determined from the characteristic value of the soil at site. The traffic load considered in the design of bridge should be placed at the unfavourable positions. Individual loads can be substituted by uniformly distributed loading.	The surcharge effect is taken as being equivalent to two feet height of fill.
Minimum width=1·5 m		80 lb per sq. ft.; minimum width normally accepted is 6 ft.
(i) 400 kg per m^2	(i) 0·5 t per m^2 in case of spans less than 10 m	100 lb per sq. ft.
—	(ii) $0{\cdot}550 - 0{\cdot}005L \geqslant 0{\cdot}4$ t per m^2 L=span in metre	These loadings may be reduced in the same proportion as the uniformly distributed load in HA loading, for spans above 75 feet.
Discrete wheel load F (See Q. 1) Stressing : Concrete & reinf. 65 per cent Steel $\leqslant$ Yield point	(iii) No	A four ton wheel load occupying a 12-in. diameter circle. 50 per cent overstress is permitted.

QUESTIONS	INDIA	ITALY
9. The surcharge effect considered in the design of abutments of the bridge due to the live load on the approach fill.	Clause 217* (a) When adequately designed R.C.C approach slab covering the entire width of roadway, with one end resting on the abutment, and extending for a length of not less than 12 ft into the approach is provided, no live load surcharge need be taken. (b) Otherwise surcharge load should be taken as per Table 1-p. 130.	No details given.
10. Footpath loading (state) min. width of footpath acceptable.	Clause 209* 5 ft minimum width. The peak crowd load	Uniformly distributed load including impact effects 500 kg per sq. m. The above should be checked for the effect of a 5 t including impact wheel load.
(i) Crowd load assumed per sq. ft.	(i) Normal 58 lb per sq. ft. In case of bridges located near town of pilgrimage or large congregational fairs, 100 lb per sq. ft.	
(ii) Any variation in the above load for change in the span length.	(ii) The main girders, trusses, arches or other members supporting the footways shall be designed for the following live loads per sq. ft. of footway area. (a) for effective spans of 25 ft or less—85 lb or 100 lb as the case may be : (b) 26—100 ft spans $P=P'-\frac{(L-25)}{3}$ (c) over 100 ft spans $P=\left(P'-55+\frac{3000}{L}\right)\left(\frac{55-W}{50}\right)$ where $P'=85$ lb/sq. ft. or 100 lb/sq. ft. as the case may be, $P=$L.L. in lb per sq. ft; $L=$Eff. span of main girder, truss or arch in ft ; $W=$ width of footway in feet.	If the foot-path is carried on a cantilever slab, then the load can be distributed along the root of the cantilever for a length equal to twice the distance of the centre of the load to the root or a constant moment per metre of root can be applied of : $\frac{PL}{L\times 2}=\frac{P}{2}$ t per m At the free ends of the slab, such moment shall be doubled.
(iii) Any special loading specified for the accidental mounting of vehicles on the footpath and in that case overstressing, if any, allowed.	(iii) 4 Tons (including impact) distributed over a contact area 12 in. in diameter. In that case, working stress to be increased by 25 per cent.	

*Articles referred to relate

*Clauses referred to the Indian Roads Congress Standard Specifications and Code of Practice for Road Bridges—Sections I and II (1964).

JAPAN	MALAYSIA	NEW SOUTH WALES
It is not specified, but considered as the case may be.	2 ft surcharge of earth is assumed in abutment design.	Clause 2·19* Surcharge effect on the abutment due to the live load approach fill shall be equal to not less than 4 ft of earth. No surcharge effect to be taken if adequately designed R.C.C. approach slab is provided.
	B.S. 153 : Part 3A; 1954 Clause 4C	Clause 2·12* 5 ft minimum width
(i) 500 kg per m²	(i) 100 lb per sq. ft. upto 75 ft	(i) 80 lb per sq. ft. of footway area for design of footway, stringers and their immediate supports. For metropolitan areas, it should be 100 lb per sq. ft.
(ii) No	(ii) Over 75 ft length, the standard uniformly distributed loads given in type HA loading multiplied by a reduction factor of 80/2200.	(ii) Girders, trusses, arches and members of main structure shall be designed for the following L.L. per sq. ft. of footway area : Span 0—25 ft—80 lb ,, 26—100 ft—60 lb ,, Over 100 ft—40 lb
(iii) No	(iii) A wheel load of 4 Tons, distributed over a contact area of 12 in. in diameter. The working stress shall be increased by 25 per cent to meet this provision.	(iii) An isolated concentrated extra load of 4,000 lb

* Clauses referred to relate to Highway Bridge Design Specifications of N.A. of A.S. Road Authorities (1965).

NEW ZEALAND	NORWAY	PHILIPPINES
When highway traffic can come within a distance from the top of the structure equal to one half the height, the pressure shall have added to it a surcharge pressure equal to not less than 2 ft of filling.	Usually a surcharge of 2 t per sq. metre has been considered for abutment design. A differentiation between low and high abutments ought to be introduced.	2 ft L.L. surcharge to be added to earth pressure.
Minimum width 4 ft	For design of footpath structures : 400 kg per m^2	Minimum width—2 ft 6 in. clear.
(i) 60 lb per sq. ft. (50 per cent of this when combined with main traffic live loads).	(i) Contemporary footpath loading and local load according to Q. 2 200 kg per m^2 footpath.	(i) 85 lb per sq. ft.
(ii) No	(ii) Contemporary footpath loading and equivalent loading according to Q. 1 : $0{\cdot}1 \times P$ per sq. metre foot-path and not more than 200 kg per m^2.	(ii) Spans upto 0—25 ft 85 lb per sq. ft. Spans from 26 ft to 100 ft—60 lb per sq. ft. Over 100 ft spans— $P = \left(30 + \frac{3000}{L}\right)\left(\frac{55-W}{50}\right)$ P=L.L. per sq. ft. (maximum 60 lb per sq. ft.) L=loaded length of side-walk in ft W=width of side-walk.
(iii) No allowance	(iii) Control for a "runway" wheel of 6·5t (without impact) placed with its contact area close to railing. 50 per cent overstressing permitted.	(iii) Concentrated wheel load of 15600 lb applied one foot from the face of rail. Stress fs=30000 p.s.i. fc= 1670 p.s.i. N= 10

RHODESIA	SWEDEN	SWITZERLAND	TURKEY
See clause 1·4 B S. 153/1954 Part 3 Calculations of forces on structures, page 16 et. seq. Civil Engineering Code of Practice No. 2 (1951) "Earth Retaining Structures" issued by the Institution of Structural Engineers, London.	1·5 t per m^2 each lane of 3 m width. For more than 2 lanes, the surcharge may be reduced in the same proportion as the loading, i.e. for more than two lanes, only 50 per cent extra lanes is to be added. This surcharge may be considered uniformly distributed over the width of abutment.	2 tonnes per m^2	0·80 m extra height of earth fill.
Minimum width 2 ft 6 in.	Minimum width—1·5 m. Separate footpath		Minimum width—0·75 m
(i) 80 lb per sq. ft.	(i) 400 kg per m^2 uniformly distributed when loaded length exceeds 10 m. The above mentioned load be reduced for main girders and arches to 1/6 pt. per m^2 P=uniform lane loading as per Fig. 15 in Plate IV.	(i) Main roads..... 360 kg per m^2 Secondary roads... 240 kg per m^2	(i) 300 kg per m^2 (for spans upto 30 m)
(ii) Clause 4C, B.S. 153/1954 Part 3 Section A		(ii) No	(ii) $p=\left(0{\cdot}3+\frac{0{\cdot}9}{L}\right)\left(5{\cdot}5-\frac{W}{3}\right)$ (t per m^2) for spans bigger than 30 m L=span length in m. W=footpath width in m
(iii) Accidental loading of a 4 Ton wheel is investigated at edge of parapet, allowing 25 per cent increase in permissible working stresses.	(iii) Single axle load of 14 t (without impact) placed near the railing. For dead load plus single axle load of 14 t the stressess allowed may not exceed lower yield point of steel and 1/2 cube strength of concrete respectively.	(iii) Single wheel load of 6 tonnes (No over stressing)	

QUESTIONS	AMERICA (U.S. Bureau of Public Roads)	AUSTRIA	CANADA
11. Foot bridges.	Article 1.2.11*		**TORONTO**
(i) The minimum width of foot bridge acceptable.	(i) No such minimum widths specified.	(i) No standard dimensions.	(i) Variable
(ii) The loading specified in the design of the deck in (a) Urban areas (b) Rural areas	(ii) No distinction made.	(ii) Austrian standards assume no different loads for rural and urban areas. Bridge class I—uniform load of 0·5 per t m² Bridge class II—uniform load of 0·4 t per m²	(ii) Urban areas and Rural areas } 100 lb per sq. ft.
(iii) Loading stipulated for the design of hand-rails.	(iii) See Fig. 5 in Plate I.	(iii) 0·08 t per m on the upper edge of the hand-rail in horizontal and vertical direction.	(iii) No definite specification **ONTARIO** (i) As required (ii) Article 1.2.11* (iii) 1.2.11 revised interim (1964)
12. Any formulae stipulated for calculating the impact on piers and abutments due to floating objects in the river	Article 1.2.17*		**TORONTO**
(i) floating timber	(i) No details given.		(i) & (ii) None since Canada's climate dictates that ice is normally critical.
(ii) vessels and small river craft	(ii) No details given.		
(iii) ice	(iii) No details for impact of ice are given. However ice pressure on piers to be taken at 400 lb per sq. in. The thickness and height of ice to be determined by site investigation.		(iii) Dictated by site conditions (*i.e.* size of river, water velocity etc.) **ONTARIO** Article 1.2.17*
13. Any other information supplied.	Clearance. For structures over Interstate Highway System—16 ft clear over the entire width of roadway including shoulders.		

*Articles referred to relate to the A.A.S.H.O. Standard Specifications for Highway Bridges (1961).

FINLAND	FEDERAL REPUBLIC OF GERMANY	GREAT BRITAIN
(i) 4·0 m	(i) —	(i) 6 ft
(ii)	(ii) No special specification	(ii)
(a) 400 kg per m² or 7 ton axle		(a) 100 lb per sq. ft.
(b) —do—		(b) 80 lb per sq. ft.
(iii) Uniformly distributed load 80 kg per m concentrated load 100 kg (vertical or horizonal).	(iii) Horizontal-80 kg per m	(iii) Between 50 lb and 100 lb per linear foot according to situation. The force to be applied 3 ft above the footway.
(i) protection required (ii) 1·0......3·0 t per m (iii) 10......20 t per m solid 10......50 t per m floating	No specification.	Each case is considered on merits and no standard formulae are used.
		Minimum headroom provided (a) overall roads-16 ft 6 in. (b) In pedestrian subways-7 ft. (c) In cycle or combined cycle and pedestrian subways-7 ft 6 in. (d) In cattle creeps-8 ft For detailed information refer B.S. 153—Girder Bridges Part 3 loads-stresses, Section—A loads, and Ministry of Transport Memorandum No. 771.

QUESTIONS	INDIA	ITALY	JAPAN
11. Foot bridges.	Clause 116*	No details given.	
(i) The minimum width of foot bridge acceptable.	Shall be designed to resist a lateral horizontal force and a vertical force, each of 100 lb per linear foot applied simultaneously at the top.		(i) 1·5 m
(ii) The loading specified in the design of the deck in			(ii) For urban and rural areas.
(a) Urban areas			(a) 500 kg per m² for deck
(b) Rural areas			(b) 350 kg per m² for main girder
(iii) Loading stipulated for the design of hand-rails.		Parapets must not be less than one metre high and should be loaded with a horizontal force of 250 kg per m run applied along the hand-rail.	(iii) 250 kg per m
12. Any formulae stipulated for calculating the impact on piers and abutments due to floating objects in the river	No details given.	No details given.	
(i) floating timber			(i)
(ii) vessels and small river craft			(ii)
(iii) ice			(iii)
			(iv) Car—[100 t in car direction, 50 t in other directions at height of 1·2 m
13. Any other information supplied.			

*Articles referred to relat

*Clause referred to relates to the Indian Roads Congress Standard Specifications and Code of Practice for Road Bridges-Sections I & II (1964).

MALAYSIA	NEW SOUTH WALES	NEW ZEALAND
(i) 6 ft	Clause 2.12* (i) not given	(i) Minimum width between rails to be 6 ft.
(ii)	(ii) same as Q. 10(i) & (ii)	(ii)
(a) 100 lb per ft		(a) Live load 100 lb per sq. ft.
(b) —do—		(b) Live load 60 lb per sq. ft. (except over motorways)
(iii) 25-100 lb per linear ft Clause 15, B.S. 153—Part 3A:1954	(iii) Top members of railings Lateral horizontal force of 150 lb per linear ft and simultaneous vertical force of 100 lb per linear foot applied at top of railing. Lower railing: Lateral horizontal level force for 150 lb per linear ft.	(iii) Lateral load of 60 lb per linear ft applied at top rail level.
Nil	Clause 2.17* (i) Force to be calculated on the assumptions that the log weighs 2 Tons and travels at normal stream velocity. The log shall be stopped in a distance of 1 foot for timber piers, 6 in. for column type piers and 3 in. for solid type concrete piers. Should fender piles or timber sheathing be placed upstream from the pier to absorb the energy of the blow, distances may be increased. (ii) No details given. (iii) —do—	Not taken into account.

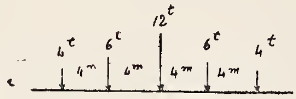
*Clauses referred to relate to Highway Bridge Design Specifications of N.A. of A.S. Road Authorities (1965).

NORWAY	PHILIPPINES	RHODESIA
So far no specifications adopted.	(i) 5 ft (clear roadway) (ii) (a) 100 lb per sq. ft. (b) —do— (iii) 150 lb per sq. ft. horizontal force with simultaneous vertical force of 150 lb per sq. ft. applied at the top of railing.	(i) 2 ft 6 in. 8 ft, if combined with cycle track bridge. (ii) Section 4 C, B. S. 153/1954 Part 3 Section A (a) 50 lb per sq. ft. (b) —do— (iii) 500 lb horizontal force at 2 ft 6 in. above surface level.
So far no specifications adopted.	Velocity of flowing water only considered. $P=KV^2$ where V=Velocity of water in ft per sec. K=a constant which is $1\frac{1}{3}$ for square ends, 1/2 for angle end where the angle is 30 degrees or less and 2/3 for circular pier. P=pressure in lb per sq. ft.	(i) No particular formulae adopted. Each structure treated according to the vegetation types predominant in its catchment area, e.g. heavy large trees, excessive bush, etc. (ii) N/A (iii) N/A

SWEDEN	SWITZERLAND	TURKEY
(i) 2,5 m	(i) Not prescribed.	(i) 2.5 m
(ii) 400 kg per m². In special case, the load may be reduced to 250 kg per m².	(ii) 360 kg per m² and one over load of one t.	(ii) (a) 400 kg per m² (b) 250 kg per m²
(iii) Transverse live load of 100 kg per m applied at the top of railing.	(iii) 120 kg per m in towns 60 kg per m outside the towns.	(iii) 100 kg per m
(i) Nil	Not prescribed	(i) ———
(ii) Nil		(ii) ———
(iii) Between 10 and 20 t per m of abutment or pier in question. In flowing water with ice, block pressure parallel to the stream may be assumed between 0·5 to 1·5 t per m of span length and 1/5th thereof perpendicular to the stream.		(iii) 30 kg per cm² multiplied by the area consisting of the width of the pier and the thickness of ice.
Vertical clearance (i) Roadway 4·6 m (ii) Cycle track 2·5 m (iii) Foot-path 2 2 m		

BELGIUM

1. Normal train loading



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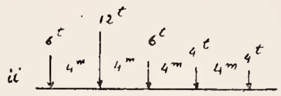

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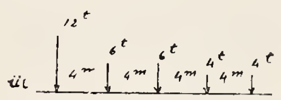
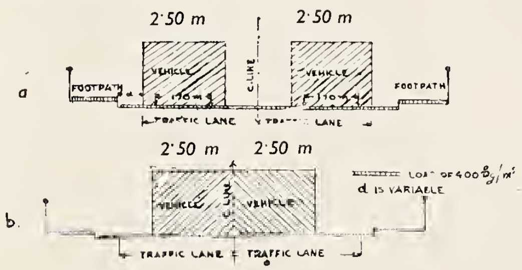


Over traffic lane 2·50 m² minimum wide to 4 m maximum wide and simultaneously a load of 400 kg per m² uniformly distributed on the carriageways and footpaths.

2. Lateral disposition of train loading



3. Number of train loadings

One train loading over traffic lane plus a load of 400 kg per m².

4. Effective wind pressure

The area of the train of vehicles assumed in elevation is a rectangular screen 2 m high with a length equal to the length of the train.

5. Impact factor

The impact factor due to live loads is the same for in question No. 1—*i*, *ii*, *iii*; and is given by the following formula :

$$\varphi = 1 + 0.377 \frac{v}{\sqrt{l\alpha}} \sqrt{1 + \frac{2Q}{P}}$$

where

v=speed in kilometre per hour, always greater than 60

l=distance between supports, in metre

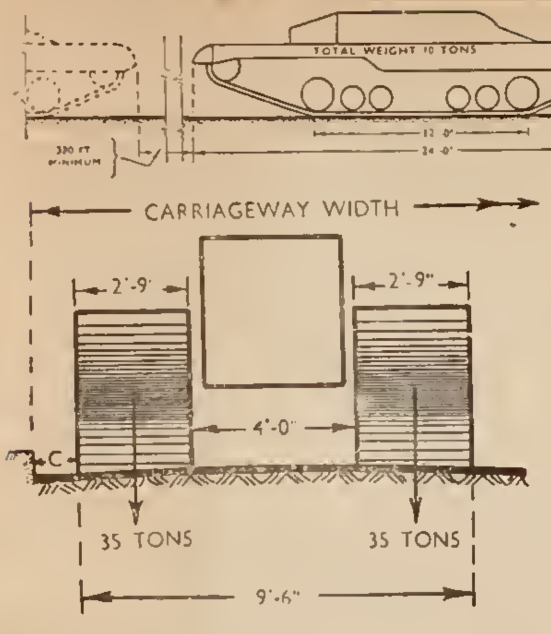
$\alpha = \frac{l}{f_s}$

f_s=static deflection, in metre, due to dead weight

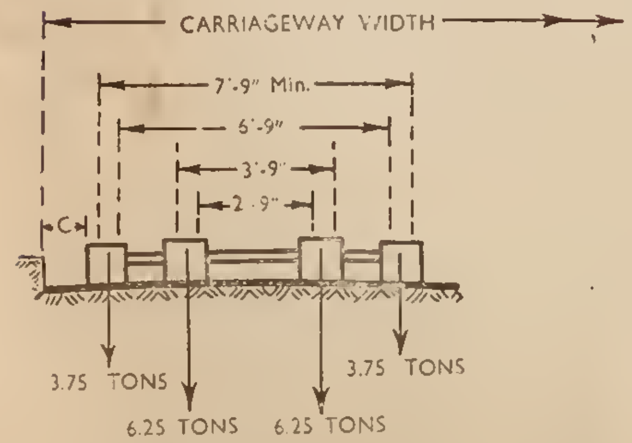
Q =moving loads on the bridge deck, in tonnes

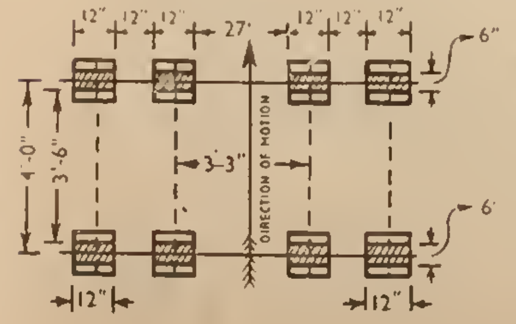
P=deadweight of the bridge, in tonnes

INDIAN ROADS CONGRESS BRIDGE LOADINGS



TRACKED VEHICLE





Plan : **WHEELED VEHICLE**
Class AA tracked wheeled vehicles (Clause 207·1)
Fig. 9.

Notes :

1. The nose to tail spacing between two successive vehicles shall not be less than 300 ft.

2. For multi-lane bridges and culverts, one train of Class AA tracked or wheeled vehicles, whichever creates severer conditions shall be considered for every two-traffic-lane width.

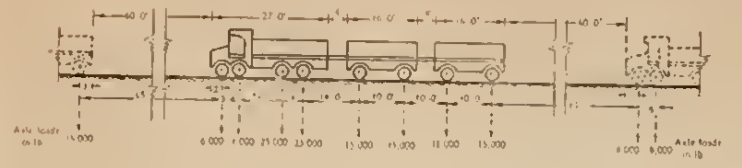
No other live load shall be considered on any part of the said 2-lane width carriageway of the bridge when the above mentioned train of vehicles is crossing the bridge.

3. The maximum loads for the wheeled vehicle shall be

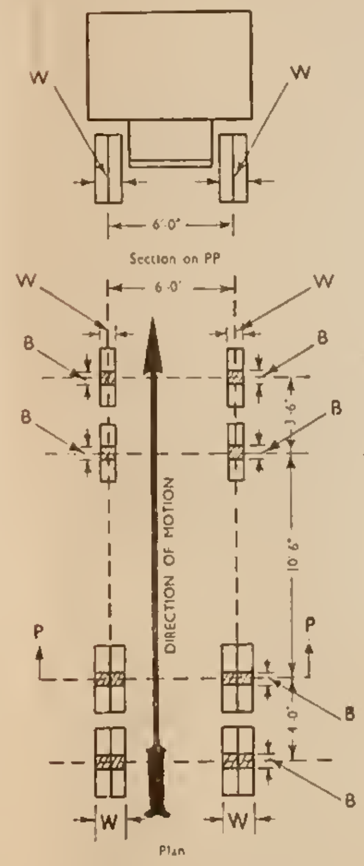
20 tons for a single axle, or 40 tons for a bogie of two axles spaced not more than 40 ft centres.

4. The minimum clearance between the road face of the kerb and the outer edge of the wheel or track, C, shall be as under :

Carriageway Width	Minimum Value of C
Single Lane Bridges	
12 ft and above	1 ft-0 in.
Multiple Lane Bridges	
Less than 18 ft	2 ft-0 in.
18 ft or above	4 ft-0 in.



Class A train of vehicles



Class A train of vehicles
Driving vehicle
(Clause 207.1)

Notes :

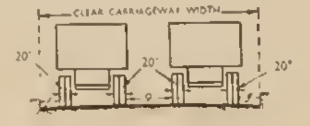
1. The nose to tail distance between successive trains shall be 60 feet.

2. No other live load shall cover any part of the carriageway when a train of vehicles (or trains of vehicles in a multi-lane bridge) is crossing the bridge.

3. The ground contact area of the wheels shall be as under :

Axle load lb	Ground contact area B in inches	W in inches
25,000	10	20
15,000	8	15
6,000	6	8

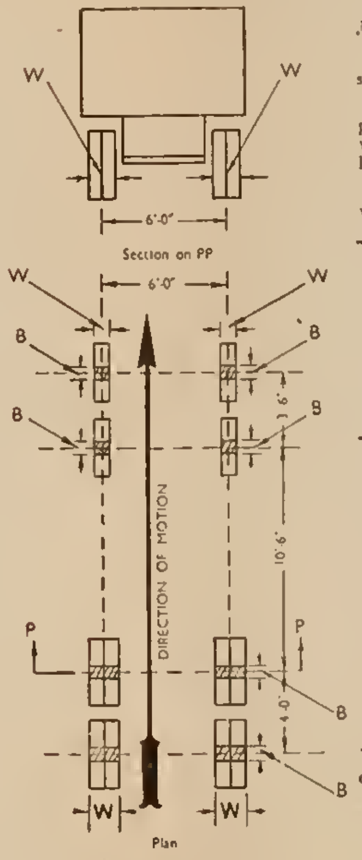
4. The minimum clearance, *f*, between the outer edge of the wheel and the roadway face of the kerb, and the minimum clearance, *g*, between the outer edges of passing or crossing vehicles on multi-lane bridges shall be as given below :



Clear carriageway width	g	f
18 ft to 24 ft	Uniformly increasing from 1 ft 4 in. to 4 ft	6 in. for all carriageway widths
Above 24 ft	4 ft	

Fig. 10.

Class B Train of Vehicles



Class B train of vehicles
Driving vehicle
(Clause 207-1)

Notes :

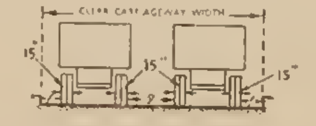
1. The nose to tail distance between successive trains shall be 60 ft.

2. No other live load shall cover any part of the carriageway when a train of vehicles (or trains of vehicles in a multi-lane bridge) is crossing the bridge.

3. The ground contact area of the wheels shall be as under :

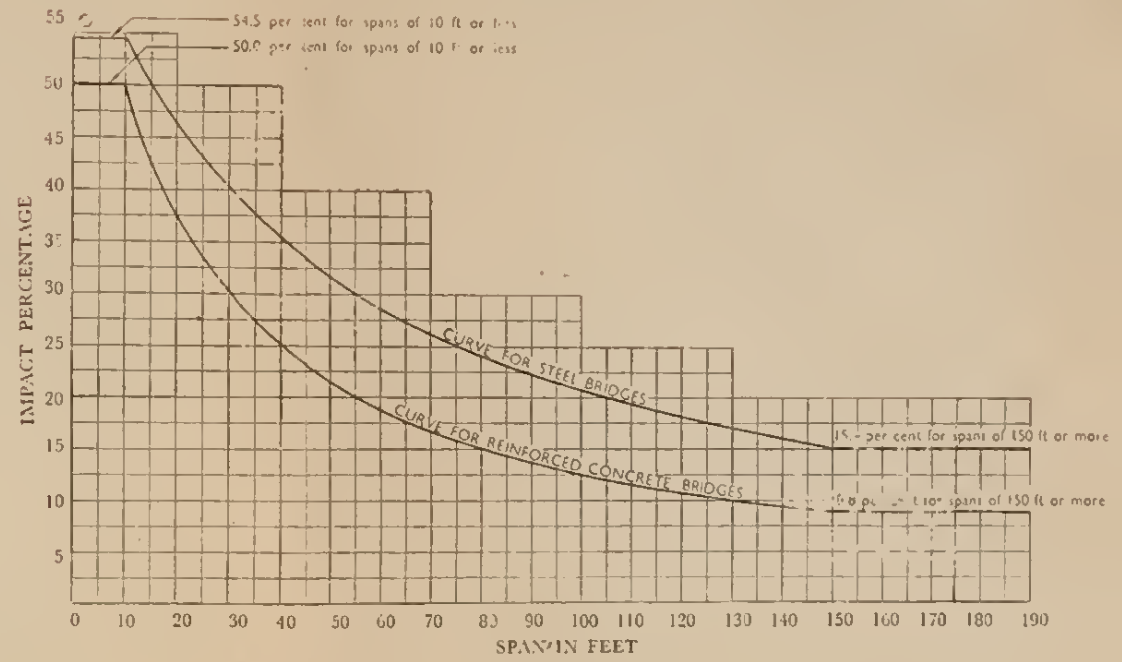
Axle load lb	Ground contact area B in inches	W in inches
15,000	8	15
9,000	6	12
3,600	5	7

4. The minimum clearance, *f*, between the outer edge of the wheel and the roadway face of the kerb, and the minimum clearance, *g*, between the outer edges of passing or crossing vehicles on multi-lane bridges shall be as given below :



Clear carriageway width	g	f
18 ft to 24 ft .	Uniformly increasing from 1 ft 4 in. to 4 ft	6 in. for all carriageway widths
Above 24 ft	4 ft	

Fig. 11.



Impact percentage Curves for Highway Bridges for class A and class B loadings.
(Clause 211.2)
Fig. 12.

PLATE IV

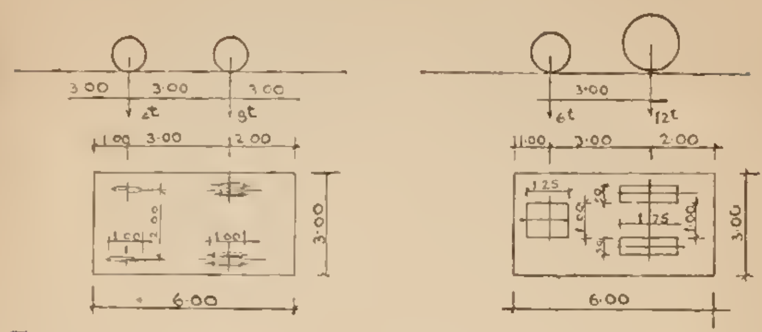
ITALY
CIVIL LOADING

Type 1

CONTINUOUS TRAIN OF 12t TRUCK

Type 2

SINGLE 18t STEAM ROLLER

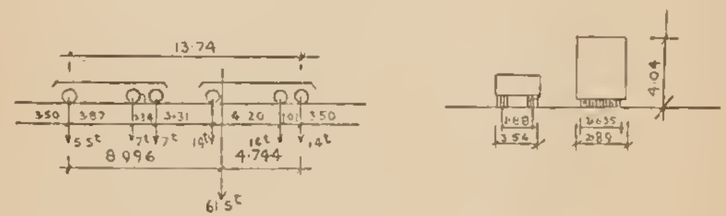


Type 3

CROWD LOAD OF 400 Kg/Sq m²

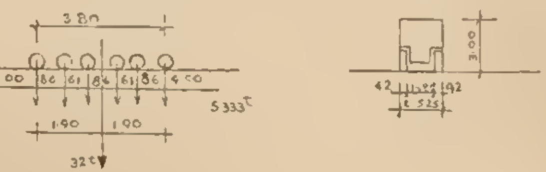
Type 4

CONTINUOUS TRAIN OF MILITARY LOAD OF 61·5 t



Type 5

CONTINUOUS TRAIN OF MILITARY LOAD OF 32t



Type 6

SINGLE MILITARY LOAD OF 74·5 t

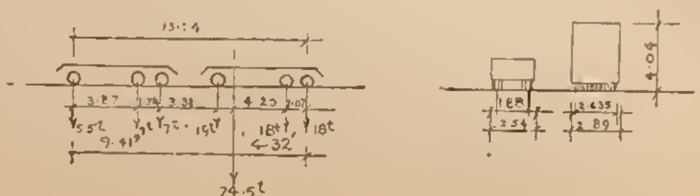


Fig. 13

PHILIPPINES

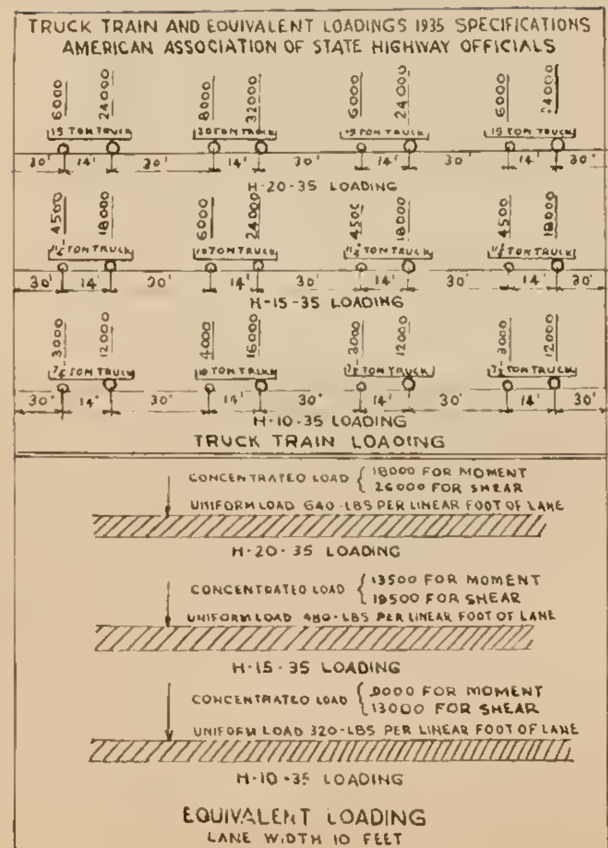


Fig. 14.

SWEDEN

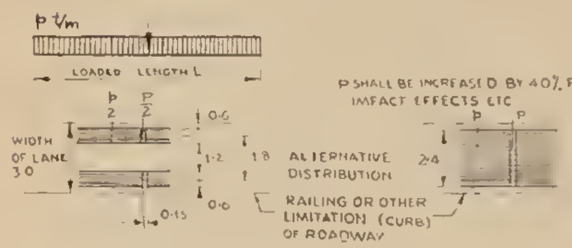
TRAFFIC LOADING FOR BRIDGES

Cl. Lane Loading

1. One = 14T Axle-Load Plus Distributed Load P t/m.

P = 14t

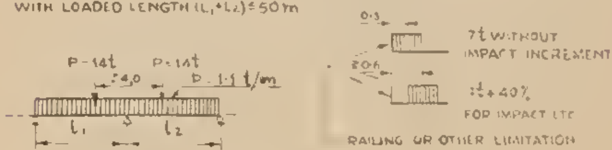
L < 10	p = 2·4
L = 10 − 90	$p = 2{\cdot}4 - \frac{13(L-10)}{80}$
L > 90	p = 1·1



2. TWO 14t AXLE-LOADS PLUS DISTRIBUTED LOAD 1·1 t/m

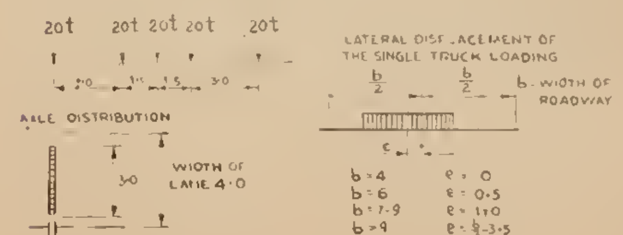
CONTINUOUS STRUCTURE WITH LOADED LENGTH (L₁+L₂) ≤ 50 m

3. SINGLE 7t WHEEL, ARBITRARILY PLACED



P SHALL BE INCREASED BY 40% FOR IMPACT EFFECT ETC

b. SINGLE-TRUCK LOADING



LENGTHS IN METRES FOR b < 7 m INTERMEDIATE VALUES ARE INTERPOLATED LINEARLY

Fig. 15.

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