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SPECIFICATION FOR

STEEL GIRDER BRIDGES

Part 3A. Loads

B.S. 153 : Part 3A : 1954

Incorporating amendments
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The Institution desires to call attention to the fact that this British Standard does not purport to include all the necessary provisions of a contract.

In order to keep abreast of progress in the industries concerned, British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the committees charged with the revision of the standards to which they refer.

A complete list of British Standards, numbering over 4000, fully indexed and with a note of the contents of each, will be found in the British Standards Yearbook, price 15s. The B.S. Yearbook may be consulted in many public libraries and similar institutions.

This standard makes reference to the following British Standard:
B.S. 648. Schedule of weights of building materials.

British Standards are revised, when necessary, by the issue either of amendment slips or of revised editions. It is important that users of British Standards should ascertain that they are in possession of the latest amendments or editions.

The following B.S.I. references relate to the work in this standard:
Committee reference ISE/55. Draft for comment CO(ISE) 7622.

CONTENTS

	Page
Co-operating organizations	6
Foreword	7
SPECIFICATION	
PART 3A. LOADS	
1. General	9
2. Forces to be taken into account	9
3. Dead load	9
4. Live load	10
5. Impact effect on highway bridges	12
6. Impact effect on railway bridges	12
7. Lurching on railway bridges	13
8. Nosing on railway bridges	13
9. Centrifugal force on railway bridges	14
10. Longitudinal force on highway bridges	14
11. Longitudinal force on railway bridges	14
12. Wind pressure effects	15
13. Temperature effect	17
14. Frictional resistance of expansion bearings	17
15. Forces on parapets	17
16. Combination of forces	18
17. Erection forces and effects	18
18. Anchorage	18
Clauses to be referred to the engineer	18
APPENDIX A. STANDARD HIGHWAY LOADING	
A1. Type HA loading	19
A2. Varied intensity of Type HA loading	19
A3. Application of Type HA loading	19
A4. Type HB loading	25
A5. Application of Type HB loading	25
A6. Equivalent abnormal loading for reinforced concrete slabs	26

Full document details: BS 153-3A:1954
AVA Documents
Document Sharing Hub

CONTENTS—*continued*

APPENDIX B. STANDARD RAILWAY LOADING

	Page
B1. General	26
B2. Type RA loading	26
B3. Type RB loading	28
B4. Lurching	29
B5. Dispersion of wheel loads	29

APPENDIX C. IMPACT FORMULAE

C1. Foxlee-Greet formulae	49
C2. The Government of India formulae	52
C3. American Railway Engineering Association formulae	53

APPENDIX D

Précis of Bridge Stress Committee's Report, 1928	54

APPENDIX E

Rules for designing steel railway bridge members in accordance with Clause 24 of Part 3B	56

TABLES

HIGHWAY BRIDGES

1. Type HA loading	22

RAILWAY BRIDGES

2. Type RA1 loading. Normal standard unit loading for a single line of way for gauges of 4 ft 8½ in and over	32
3. Type RA2 loading. Normal standard unit loading for a single line of way for medium gauges 3 ft 6 in, 1 metre and 3 ft	38
4. Type RA1 loading. Static load per track for 20 units	44

CONTENTS—*continued*

	Page
5. Type RB loading. Total loads for bending moments at all points on the span, including allowance for impact, but excluding lurching	45
6. Type RB loading. Total maximum shears per track, including allowance for impact but excluding lurching, for all speeds up to 6 rev/s.	46
7. Types RA1 and RB loading. Loads on cross girders, per track	47
8. Types RA1 and RB loading. Loads on rail-bearers and stringers, per rail	48
9. Numbers of stress cycles (in millions) for various bridge members and load groups	59

FIGURES

1. Loading curve for type HA highway loading.	23
2. Highway bridges type HB unit loading.	25
3. Railway bridges type RA1 unit loading per track for gauges of 4 ft 8½ in and over.	27
4. Railway bridges type RA2 unit loading per track for medium gauges (3 ft 6 in, 1 metre and 3 ft).	27
5. Railway bridges type RA3 unit loading per track for narrow gauges (2 ft 6 in and 2 ft).	27
6. Train and wheel speeds for various driving wheel diameters.	30
7. Railway bridges type RB unit loading.	31

Full document details: BS 153-3A:1954
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CO-OPERATING ORGANIZATIONS

The Iron and Steel Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

Alloy Steels Association
Board of Trade
British Bolt, Nut, Screw and Rivet Federation
British Cast Iron Research Association
*British Constructional Steelwork Association
British Electrical and Allied Manufacturers' Association
*British Iron and Steel Federation
British Ironfounders Association
British Mechanical Engineering Federation
*British Railways Board
British Steel Castings Research Association
Council of Ironfoundry Associations
Council of Iron Producers
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Institute of Marine Engineers
*Institution of Civil Engineers
Institution of Mechanical Engineers (Automobile Division)
Institution of Production Engineers
*Institution of Structural Engineers
Iron and Steel Board
Iron and Steel Institute
Joint Iron Council
Lloyd's Register of Shipping
*Ministry of Defence, Army Department
Ministry of Defence, Navy Department
Ministry of Labour (H.M. Factory Inspectorate)
National Association of Drop Forgers and Stampers
National Physical Laboratory (Ministry of Technology)
Oil Companies Materials Association
Royal Institute of British Architects
Shipbuilding Employers' Federation
Society of British Aerospace Companies Ltd.
Society of Motor Manufacturers and Traders Ltd.

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:

British Welding Research Association
Institute of Welding
Institution of Municipal Engineers
London Transport Board
Ministry of Transport
Ministry of Public Building and Works
National Association of Iron and Steel Stockholders
Republic of South Africa

BRITISH STANDARD SPECIFICATION FOR

STEEL GIRDER BRIDGES

Part 3A. Loads

FOREWORD

B.S. 153 was first published in two volumes: Parts 1 and 2 (Materials and Workmanship) in 1922 and Parts 3, 4 and 5 (Stresses, Construction and Erection) in 1923. These two volumes were then revised in 1933 and 1937 respectively.

As a result of modifications in the loading requirements for railway and highway bridges and of advances in experimental research leading to developments in design procedure, a further revision became necessary. Agreement having been reached on loading requirements, it was considered advantageous to precede the present general revision with the issue in 1954 of Part 3A, 'Loads'. This part replaced Clauses 1 to 12 of Part 3 : 1937 and Appendix No. 1 of Part 3 : 1925.

The work of revising the remaining parts of B.S. 153 has been completed; these have been re-grouped and all the Parts are now published under the authority of the Iron and Steel Industry Standards Committee in three volumes:

Part 1.	Materials and workmanship.
Part 2.	Weighing, shipping and erection.
Part 3A.	Loads.
Part 3B.	Stresses.
Part 4.	Design and construction.

The standard has been considerably enlarged in the present revision, and the design and fabrication procedure have been brought up to date with a view to ensuring consistent methods leading to maximum efficiency in the finished structure.

Except where otherwise stated, reference in this standard to bolts and nuts apply to bolts and nuts in accordance with Subclauses 2*a* and 2*b* of Part 1. The use of high strength friction grip bolts in accordance with Subclause 2*c* of Part 1 is governed by Subclause 50*b* of Part 4.

In the present reprint of Part 3A, the opportunity has been taken to incorporate the three amendments issued so far and to reset the type completely. At the same time, recent changes in B.S.I.'s typographic style have been introduced, e.g. the abbreviations for units are now in accord with B.S. 1991 and international usage, and forces are expressed in pounds-force, tons-force and kilogrammes-force in place of the customary but incorrect use of the pound, the ton and the kilogramme.

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Amendment No. 1 (PD 3262, issued in January 1959 and incorporated in the 1962 reprint) merely corrected an error in the first column of Table 5.

Amendment No. 2 (PD 4070, issued in March 1961 and incorporated in the 1962 reprint) introduced the following changes:

New paragraphs were added to Clause 4 to deal with dual carriageways.

Clause 12, Wind pressure effects, was replaced by a new clause.

A number of minor changes and additions were made to Appendix A.

Amendment No. 3 (PD 5748, issued in March 1966) introduced the following changes:

The foreword was rewritten, the title of Subclause 4A *c* was changed and a new Subclause was added to Clause 15 to make reference to the Ministry of Transport memorandum on parapets for motorway and highway bridges.

In Appendix A, a note was added to Fig. 1. New Subclauses were added to Clauses 2 and 3 in Appendix B; the new Subclauses are now designated B2*c* (the former B2*c* being redesignated B2*d*) and B3*b* and *c*. A new Appendix E, Table 9 and Fig. 7 were added.

NOTE. In place of the customary, but incorrect, use of the ton as a unit of force, the unit called a ton-force (abbreviation tonf) has been used in this standard. It is that force which, when acting on a body of mass one ton, gives it an acceleration equal to that of standard gravity. Similar considerations apply to the pound-force (abbreviation lbf).

SPECIFICATION

GENERAL

1. This specification is primarily intended to apply to the superstructure of simply supported steel bridges of spans up to 300 ft. Where appropriate, the requirements of the specification may be adopted for larger spans or other types of steel bridges, but care should be taken, in these circumstances, to make whatever amendments are necessary for fixity at the supports, continuity and other indeterminate or special conditions, such as, for instance, may apply to opening bridges.

FORCES TO BE TAKEN INTO ACCOUNT

2. For the purpose of computing stresses the following items shall, where applicable, be taken into account:

a. Dead load.
b. Live load.
c. Impact effect.
d. Lurching effect.
e. Nosing effect.
f. Centrifugal force.
g. Longitudinal force.
h. Wind pressure effect.
j. Temperature effect.
k. Resistance of expansion bearings to movement.
l. Forces on parapets.
m. Erection forces and effects.
n. Forces and effects due to earthquakes, ice packs, subsidence and other similar causes.

Subject to the provisions of other clauses, all forces shall be considered as applied and all loaded lengths chosen in such a way that the most adverse effect is caused on the member under consideration.

DEAD LOAD

3. The dead load is the weight of the structure and any permanent loads fixed thereon. The dead load initially assumed shall be checked after the design is made and the design shall be revised as found necessary.

In determining the dead load, actual ascertained unit weights shall be used, but if these are not available unit weights as given in B.S. 648* may be used, as appropriate.

*B.S. 648, 'Schedule of weights of building materials'.

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LIVE LOAD

4. The live load is the weight of traffic and shall be of the type and magnitude specified.

The following standard loadings shall be adopted where appropriate:

A. Standard highway loading.

a. Loading. Standard highway loadings are given in Appendix A.

These are:

Type HA. Equivalent lane loading which is the normal design loading for Great Britain but may be varied in intensity where conditions are other than those prevailing in Great Britain.

Type HB. Abnormal unit loading. To be used when specified by the appropriate authority. In Great Britain 45 units shall be taken for bridges carrying the heaviest class of load. This is an idealized load which allows for the weight of tractors accompanying trailers.

b. Width and number of traffic lanes to be used in conjunction with Standard highway loadings.

(i) *Bridges having a carriageway width of 16 ft 0 in or more.* Traffic lanes shall be taken to be not less than 8 ft nor more than 12 ft wide. The carriageway shall be divided into the least possible number of traffic lanes having equal widths as follows:

Carriageway width	No. of lanes
ft	
16 up to and including 24	2
above 24 up to and including 36	3
above 36 up to and including 48	4
above 48 up to and including 60	5

(ii) *Bridges having a carriageway width of less than 16 ft.* Where the carriageway on a bridge is less than 16 ft in width it shall be taken to have a number of traffic lanes.

$$= \frac{\text{width of carriageway in feet}}{10}$$

(iii) Where dual carriageways are carried on one single superstructure, the number of lanes on the bridge shall be taken as the sum of the number of lanes in each of the single carriageways, as provided in the table above.

Where hard shoulders and marginal strips are provided these shall be considered as forming part of the carriageway and the number and width of traffic lanes calculated accordingly.

Where marginal strips are provided without hard shoulders the number of traffic lanes shall be calculated after deducting the widths of the marginal strips from the overall width of the carriageway between the verges or raised kerbs; the intensity of loading on the marginal strip shall be taken as equal to that for the adjacent carriageway lane, except where the adjacent carriageway lane carries HB loading, in which case the marginal strip is unloaded.

c. Application of standard loading on a single superstructure.

Type HA loading. Type HA loading shall be taken to occupy one carriageway lane and to be uniformly distributed over the full width of the lane.

Two lanes shall always be considered as occupied by full Type HA loading, while all other lanes shall be considered as occupied by one third the full lane loading, except where otherwise specified by the appropriate authority.

Type HB loading. One lane shall be loaded with Type HB loading only.

Where one carriageway only is carried on a superstructure, all other lanes shall be considered as occupied by one-third of the full lane loading, except where otherwise specified by the appropriate authority.

Where dual carriageways are carried on one single superstructure, two lanes on the carriageway not carrying HB loading shall be taken as occupied with full HA loading. All other lanes shall be taken as carrying ⅓ HA loading.

B. Standard railway loading. Standard railway loadings are given in Appendix B.

These are:

Type RA. British Standard unit loading, for various gauges.

Type RB. Total uniformly distributed load, including impact, for gauges of 4 ft 8½ in and over. This loading is based on the Bridge Stress Committee's report of 1928, a brief précis of which is given in Appendix D. It is suitable for railways in Great Britain and abroad with a gauge 4 ft 8½ in and over and with locomotive and track characteristics similar to those obtaining on the main railways in Great Britain.

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C. Standard footway loading. The live load due to pedestrian traffic shall be treated as uniformly distributed over the footway. For loaded lengths up to and including 75 ft it shall normally be taken as 80 lbf/ft² and, for lengths over 75 ft as the standard uniformly distributed loads given in Fig. 1 multiplied by a reduction factor of 80/2200. Where crowd loading is likely the live load for the design of members exclusively supporting or forming the footway shall be taken as 100 lbf/ft².

In the case of highway bridges each part of the footway shall be capable of carrying a wheel load of four tons, which shall be deemed to include impact, distributed over a contact area 12 inches in diameter; the working stresses shall be increased by 25 per cent to meet this provision. This provision need not be made where vehicles cannot mount the footway.

IMPACT EFFECT ON HIGHWAY BRIDGES

5. Where Types HA and HB loadings given in Appendix A are not adopted, the allowance for impact on highway bridges shall be taken as follows:

a. An impact allowance of 25 per cent shall be added to the axle-load, or (where there is more than one lane of traffic) the pair of adjacent wheel loads, which produces the greatest bending moment or shear, as the case may be, under the condition of loading for which the member being considered is designed.

b. Where the loaded length required to produce the maximum stress in any member exceeds 100 ft, impact shall be ignored.

No addition for impact shall be made to the live load due to pedestrian or equivalent light traffic.

IMPACT EFFECT ON RAILWAY BRIDGES

6. Appropriate additions shall be made to the live load specified in Clause 4 for impact effects caused by the hammer blow of locomotives, rail joints, and track and wheel irregularities.

In determining these additions due consideration shall be given by the engineer to the standard and maintenance of track and rolling stock, the types and characteristics of locomotives, and the type and characteristics of the bridge.

Type RB loading, which is suitable for the main line railways of Great Britain and other railways having similar locomotive and track characteristics, already includes an allowance for impact and no further additions shall be made. For all other loadings, including type RA, the additions for impact shall be specified by the engineer. For his guidance three methods of calculating the additions, those of Foxlee and Greet, the Government of India and the American Railway Engineering Association, are described in detail in Appendix C.

LURCHING ON RAILWAY BRIDGES

7. A separate allowance shall be made for lurching, unless this has already been included in the impact effect.

Lurching results from the temporary transfer of part of the live loading from one rail to the other, the total load on the track remaining unaltered. The transfer shall be taken to increase the load on the rail which most adversely affects the member under consideration.

The proportion Q_L of live load on one rail so transferred shall be calculated from the expression:

$$Q_L = \frac{160\,k\,n}{l + 100}$$

where k is a coefficient depending on the type of spring suspension, the weight and height of the rolling stock, and the type of construction and lateral rigidity of the bridge structure;

n is the number of revolutions per second of the driving wheels of the locomotives (see Fig. 6, Appendix B);

l is the effective span in feet, as defined in Clause 4 of Part 1.

NOTE. For conditions corresponding to those ruling on the railways of Great Britain (4 ft 8½ in gauge = 1·44 m gauge), and provided the structure is adequately stiffened laterallly, $k = 1/24$ and $n = 6$ for maximum speed, but with a maximum value of Q_L of 0·25. For conditions other than those ruling on the railways of Great Britain, and where provision for a greater lurching effect is necessary, it is recommended that the value of the coefficient 'k' be increased but to not more than 1/15 with a maximum value for the factor Q_L of 0·40.

Where a member supports or assists in supporting more than one track, provision for the effect of lurching need only be made in respect of one of the tracks where there are two, or in respect of alternate tracks where there are more than two, the track or tracks selected being those on which the transfer of the load has the greatest effect on the member.

Lurching need not be taken into account in the case of an inner main girder assisting in supporting more than one track.

No addition for impact shall be made to the lurching effect.

NOSING ON RAILWAY BRIDGES

8. An allowance shall be made for nosing, and this shall be taken as a single force of 10 tonf, acting horizontally, in either direction, at right angles to the track, at the rail level and at such a point in the span as to produce the maximum effect in the member under consideration. This value is appropriate to the conditions obtaining on railways in Great Britain. In other cases the amount of force may be amended at the engineer's discretion.

Vertical effects shall be disregarded.

On multi-track bridges, a single force as specified above shall be deemed sufficient.

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CENTRIFUGAL FORCE ON RAILWAY BRIDGES

9. Where the track or tracks are curved, allowance for centrifugal action of the moving loads shall be made in designing the members, all tracks on the structure being considered as occupied. The centrifugal force due to the load per track shall be calculated from the following formula:

$$C = \frac{w\,v^2}{15R}$$

where C = the centrifugal force per linear foot considered as a moving load, acting at a height of 6 ft (1·83 m) above the level of the rails, unless otherwise specified by the engineer;

w = the equivalent distributed live load, without impact, per linear foot per track;

v = the allowable maximum speed of the train in miles per hour, as specified by the engineer, and

R = the radius of the track curve in feet.

No addition for impact shall be made to the centrifugal force.

LONGITUDINAL FORCE ON HIGHWAY BRIDGES

10. The following longitudinal force resulting from the traction or braking of vehicles shall be taken as acting horizontally at the level of the carriageway surface, and having the following values for all widths of bridge. The force shall be applied over an area 10 ft wide by 30 ft long, or the length of the bridge, whichever is less, and in that position which will have the worst effect on the member under consideration.

	Type HA loading	Type HB loading for 45 units
Spans up to 10 ft	10 tonf	45 tonf for all spans
Spans above 10 ft	10 tonf plus ½ tonf for each ft of span over 10 ft, but not exceeding 25 tonf	

No increase for impact effect shall be made to the stresses due to longitudinal forces.

Only one such force shall be considered.

LONGITUDINAL FORCE ON RAILWAY BRIDGES

11. Provision shall be made for the forces due to traction and the application of brakes. These forces shall be considered as acting on the rail, and, for the purpose of the design of the structure, shall be taken as the larger of:

a. A force due to traction of 20 per cent of the total axle loads on the coupled or driving wheels on one track without impact. When type RB loading is used, 20 units of type RA loading shall be taken for this purpose.

b. A force due to braking of 10 per cent of the total load on one track without impact.

Where the structure carries two tracks, one up and one down, both tracks shall be considered as being occupied simultaneously, and the force due to braking shall be applied to one track and the force (in the same direction) due to traction to the other.

Where the structure carries more than two tracks, the longitudinal forces shall be considered as applied to two tracks only, unless otherwise specified by the engineer, the worst case being taken as regards its effect on any part of the structure.

Some relief in the effect of the longitudinal force on the bridge and its supports may be taken into account where the tracks are capable of transmitting part of these forces to resistances outside the bridge structure.

No addition for impact shall be made to the longitudinal force.

WIND PRESSURE EFFECTS

12. *a.* **General.** Where the effect of wind has to be taken into consideration, it shall be treated as a moving load (i.e. taken of such length along the span as to produce the maximum stress in the member under consideration) acting at the centroids of the exposed areas as defined below.

The maximum effects from the wind blowing in either lateral direction on the loaded or unloaded structure shall be taken, having regard to the disposition of the live load.

For conditions normally prevailing in Great Britain the wind pressures specified below shall be used, but where owing to the position of the bridge or any special conditions the assumed wind speeds cannot be realized or may be exceeded, the engineer shall at his discretion specify different values. For this purpose the wind pressure shall be assumed to vary as the square of the wind speed.

b. **For maximum lateral effect.**

(i) *On unloaded structures.* A wind pressure of 30 lbf/ft² corresponding to a wind speed of 90 mile/h, shall be taken as acting horizontally and normal to the sides of the bridge on a total exposed area of the superstructure made up of the following areas as applicable:

Windward girder, deck and bracing. The net exposed area in normal projected elevation of the windward girder, deck construction, bracing and parapet.

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Leeward girders. The following fractions (not exceeding unity) of the net exposed area in normal projected elevation of the leeward girder:

$\frac{n}{16}$ when the windward girder is a plate girder

$\frac{n}{8} + 0{\cdot}5$ when the windward girder is a trussed girder

where n = ratio of distance, centre to centre between the windward and outermost leeward girder, to the depth of the windward girder.

Where there are more than two main girders, only that fraction of the area of the outmost leeward girder as calculated above shall be taken.

In cases where a leeward girder projects in elevation beyond the windward girder, the full net exposed area of the projection as seen in elevation shall be treated as subject to full wind pressure.

(ii) *On loaded structures.* In arriving at the total effective area exposed to wind on a loaded structure, allowance shall be made for the screening effect, based on projected areas, of the structure on the live load, or of the live load on the structure, or of live loads on each other.

A. *Highway and footway bridges.* A wind pressure of 15 lbf/ft², corresponding to 63 mile/h, shall be taken as acting horizontally and normal to the sides of the bridge on the exposed area of the superstructure (calculated as in (i) above) and of live load taken as a single vertical plane surface having a continuous height of 8 ft above the carriageway or 4 ft above footway and cycle tracks, as applicable.

B. *Railway bridges.* A wind pressure of 30 lbf/ft² corresponding to a wind speed of 90 mile/h, shall be taken as acting horizontally and normal to the sides of the bridges on the exposed area of the superstructure (calculated as in (i) above) and of live load taken as a single vertical plane surface having a continuous height of 12 ft above the rail.

c. **For longitudinal effect.**

A longitudinal wind force shall be combined with a corresponding lateral wind force equal to half the total lateral force given in *b* above and the two shall be distributed compatibly.

The longitudinal wind forces shall be determined as follows:

(i) *For plate girder bridges:* a quarter of the total lateral wind forces on the superstructure in the unloaded condition (see Subclause *b*(i) above); or a quarter of the total lateral wind forces on the superstructure and half the total lateral wind forces on the live load, in the loaded condition (see Subclause *b*(ii) above).

(ii) *For trussed girder bridges:* half the total lateral wind forces on the superstructure in the unloaded condition (see Subclause *b*(i) above); or, half the total lateral wind forces on the superstructure and live load, in the loaded condition (see Subclause *b*(ii) above).

d. **For maximum overturning effect.**

On the bridge and its supports, the following shall be taken into account:

(i) In addition to the lateral and longitudinal wind forces specified above, an upward vertical pressure of 5 lbf/ft² acting over the net exposed area of the bridge in plan.

(ii) In considering the overturning effect due to wind on live load, the live load shall consist of standard loading or of unloaded wagons or vehicles of the lightest tare, whichever produces the maximum overturning effects. The latter shall be taken as not greater than 800 lbf per linear foot of bridge for railway bridges and not greater than 400 lbf per linear foot of bridge for highway bridges.

TEMPERATURE EFFECT

13. Allowances shall be made for the forces resulting from the following conditions:

a. Any portion of the superstructure being restrained from moving when subjected to variations of temperature.

For this purpose in Great Britain a minimum of 20°F and a maximum between 80°F and 120°F, depending on the location of the structure, shall be taken. Elsewhere the temperature limits shall be based on local conditions.

b. Any portion of the superstructure being at a temperature different from the rest of the structure, due to the effect of sun and shade. For this purpose the maximum difference of temperature shall be taken as 15°F.

In determining forces and movements due to change of temperature the coefficient of expansion of steel shall be taken as 0·000 006 5 per Fahrenheit degree.

FRICTIONAL RESISTANCE OF EXPANSION BEARINGS

14. For expansion and contraction of the structure due to variations of temperature or to other causes, the forces due to friction on the expansion bearings under dead load only shall be taken into account and the following coefficients of friction shall be used:

For roller bearings with 1 or 2 rollers	0·01
For roller bearings with 3 or more rollers	0·05
For sliding of steel on hard copper alloy bearings	0·15
For sliding of steel on cast iron or steel	0·25

FORCES ON PARAPETS

15. *a.* **Footbridge parapets.** Consideration shall be given to the strength and stability of parapets. Parapets may be subject to horizontal loads acting at a height of 3 ft above the level of the footway, ranging from 50 to 100 lbf per linear

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foot according to circumstances. The maximum load will only be encountered in extreme cases of crowd loading.

The value of the loading shall be taken at the discretion of the engineer.

b. **Motorway and other highway bridge parapets.** Reference should be made to the Ministry of Transport memorandum on the subject.

COMBINATION OF FORCES

16. The following combinations of forces shall be considered:

a. The worst combination possible of dead load with live load, impact, lurching and centrifugal force.

When a member whose primary function is to resist longitudinal and nosing forces due to live load is under consideration the term live load shall include these forces.

b. The worst combination possible of any or all of the forces listed under *a* to *l* inclusive in Clause 2.

c. The worst combination possible of forces during erection.

d. The worst combination possible of any or all of the forces listed in Clause 2, at the discretion of the engineer.

ERECTION FORCES AND EFFECTS

17. The weight of all permanent and temporary material, together with all other forces and effects which can operate on any part of the structure during erection, shall be taken into account.

ANCHORAGE

18. The stability of the structure and its parts shall be investigated and weight or anchorage shall be provided so that the least restoring moment, including anchorage, is not less than the sum of:

1·1 × dead load overturning moment

and 1·4 × overturning moments due to applied loads.

Account shall be taken of possible variations of dead load for repair or other temporary purposes to ensure stability at all times.

This margin of stability in so far as stresses are concerned shall be deemed to be covered in respect of all parts of the structure which have been designed for their working loads to the permissible stresses in this British Standard.

In complying with the requirements of this clause it is necessary to ascertain that the resulting pressures and shears deemed to be communicated by the bearings to the substructure will not produce failure.

The following clauses in Part 3A contain points on which the decision of the engineer is required and concerning which information is to be supplied at the time of inviting tenders.

Clauses 4A*a*, 6, 7, 8, 9, 11*b*, 12*a*, 13*a*, 15, 16*d*.

APPENDIX A

STANDARD HIGHWAY LOADING

TYPE HA LOADING

A1. Type HA loading consists of *a* and *b*, or *c*, viz:

a. A uniformly distributed lane loading. The values for this load per linear foot of traffic lane are given in Table 1 and Fig. 1.

b. One knife edge load uniformly distributed across the width of the traffic lane. The values of this load, which shall be applied in accordance with Subclause A3*a* below, are given in Fig. 1.

c. Two wheel loads each 11¼ ton weight in line transversely to the direction of traffic flow spaced at 3 ft centres and having a contact area of 15 in × 3 in, the smaller dimension being in the direction of travel, to be used in the following cases:

(i) Where the member supports a small area of roadway, such that it may be called on to carry the weight of one or two wheels, and where the proportion of distributed load and knife edge load which would be allocated to it is small and on cantilever projections not exceeding 6 ft.

(ii) Where deck slabs are designed as supported on all four sides and the distance between supports in one direction is less than twice the distance in the other direction.

In this respect the edge stiffening of slabs as required by Clause A3*j* of this Appendix shall not be deemed as providing adequate support for this purpose.

VARIED INTENSITIES OF TYPE HA LOADING

A2. Where a different intensity of loading is required, Type HA loading may be varied proportionately, each item of the loading being varied pro rata.

When making any reduction it should be borne in mind that an impact allowance of 25 per cent as specified in Subclause 5*a* has been taken into account in this loading. This allowance is considered adequate for conditions in Great Britain, but may not necessarily be sufficient elsewhere.

APPLICATION OF TYPE HA LOADING

A3. *a.* The knife edge load shall be taken as acting as follows:

(i) *On reinforced concrete slabs effectively supported on two sides and on cantilever slabs exceeding 6 ft.* In a direction parallel to the supporting members.

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(ii) *On longitudinal girders, stringers, etc.* In a direction at right angles to the member.

(iii) *On cross members, including transverse cantilever girders.* In a direction in line with the member.

b. Where longitudinal members are spaced at less than half the width of the lane the loading to be taken on these members shall be that appropriate to a half lane width.

c. The total end live load shear on any longitudinal beam shall be taken as not less than 6 000 lbf per foot width of carriageway supported by the member.

d. No allowance shall be made for impact or dispersal of load in respect of the distributed load or knife edge load.

e. No allowance shall be made for impact under the wheel loads.

f. Dispersal under the wheel loads, where it can occur, shall be taken at 45°.

g. It shall be permissible in considering the effects of the 11¼ ton wheel loads to allow a 25 per cent overstress.

h. Reinforced concrete slabs shall be designed on the basis of one foot wide strips carrying one tenth of the appropriate lane loading as given in Table 1 and Fig. 1 except when using the wheel loads (Subclause A1*c*).

Distribution reinforcement transverse to the span of the slab shall be provided throughout. For spans not exceeding 20 ft, its amount in the area of sagging moment shall be sufficient to resist not less than 50 per cent of the maximum live load moment at the sections considered and it shall be so placed as to ensure effective resistance to transverse bending.

j. Where the wheels of vehicles using the bridge can travel on or near the unsupported edge parallel to the main reinforcement of slab decks, edge stiffening or its equivalent shall be provided capable of carrying live load as described below, in addition to the live load which would normally be allocated to it.

(i) *Longitudinal slabs.* That proportion of loading from Fig. 1 and Table 1 appropriate to a strip of slab having a width equal to one quarter of the span, but not more than 5 ft 0 in, nor less than 2 ft 0 in.

Alternatively, the slab may be extended beyond the edge of the carriageway for a distance equal to one quarter of the span, but not more than 5ft 0 in, nor less than 2 ft 0 in.

(ii) *Transverse slabs.* That proportion of loading from Fig. 1 and Table 1 appropriate to a strip having a width equal to two thirds of the span.

k. Where elements of a structure can sustain the effects of live load in two ways, i.e., as elements in themselves and also as parts of the structure (as, e.g., the top flange of a box girder functioning as a deck plate), the elements shall be designed to resist the sum of the effects of the appropriate loading for each condition.

Where the wheel loads of Subclause 1*c* are used, the 25 per cent overstress permitted in Subclause 3*g* shall be applied in considering the sum of the effects.

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