SOUTH AFRICAN TRANSPORT SERVICES

BRIDGE CODE

1983

AMENDMENTS

PAGE	DATE	REMARKS

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PART I : PROCEDURES, DRAWINGS AND DESIGN REQUIREMENTS

ANNEXURES

PART I : PROCEDURES, DRAWINGS AND DESIGN REQUIREMENTS

1. GENERAL

1.1 This code covers the requirements of the South African Transport Services for the design and construction of railway bridges, road bridges, footbridges, service bridges and culverts. It supersedes the South African Railways "Code of Procedure for the Design and Construction of Road over Rail and Rail over Road Bridges (revised March 1971)" and consists of the following :
PART I : PROCEDURES, DRAWINGS AND DESIGN REQUIREMENTS
PART II : SPECIFICATION FOR LOADS

1.2 The design requirements are based on the principles of limit state design as detailed in TMH 7 : CODE OF PRACTICE FOR THE DESIGN OF HIGHWAY BRIDGES AND CULVERTS IN SOUTH AFRICA.

1.3 Codes and specifications referred to herein are listed at the end of Part I. The latest revisions are applicable.

1.4 The application and interpretation of this code must be entrusted only to appropriately qualified and experienced professional engineers and construction must be carried out under the direction of appropriately qualified supervisors.

2. DEFINITIONS

The following definitions apply :

Bridge	A structure with clear span lengths greater than 6 m measured square to the supports.
Culvert	A structure with clear span lengths of 6 m or less measured square to the supports.
Railway bridge	A bridge designed to carry rail loading
Road bridge	A bridge designed to carry road loading
Flyover	A rail over rail bridge
Footbridge	A bridge designed to carry pedestrians
Agricultural overpass	A bridge designed to provide access for farm implements over a railway line
Agricultural underpass	A culvert designed to provide access for farm implements under a railway line.

3. APPROVAL OF CONSULTANTS AND CONTRACTORS

Consultants or contractors appointed to design rail carrying structures must be experienced in this work and must be approved by the Chief Civil Engineer of the Transport Services.

4. PRELIMINARY INVESTIGATION

4.1 When bridge structures on the property of the Transport Services are contemplated, the latter's requirements must be ascertained from the System Manager or the Resident Engineer, Construction, concerned. Preliminary proposals must be examined on site with the System Civil Engineer or Resident Engineer, together with the System Electrical Engineer and the System Engineer (Signals and Telecommunications), or their representatives, and the representative of the road authority in order to -

(i) select a suitable site for the bridge structure;

(ii) ensure that the requirements of the Transport Services, the road authority and other interested parties are included in the final scheme.

4.2 Consideration must be given to the provision of possible additional tracks, based on requirements for the next 20 years. The System Manager or the Resident Engineer will liaise with the Works Section and the Planning Section of the General Manager's Office before any preliminary plans are prepared, to determine the anticipated date when additional tracks or any other long term development proposals will be required. The designer must consider the cost of providing for future requirements and prepare an economic appraisal of the design alternatives.

4.3 When comparing the cost of providing for future requirements immediately or at a later date the uninflated cost of later additions, including associated costs such as establishment charges, deviations etc., should be discounted at a rate of 6 % per annum. Where it is clearly economical to provide for future requirements at the later date the structure should be detailed to facilitate, as far as practicable, such future additions. Details should be discussed with the Transport Services' representatives.

4.4 Where the forecast indicates that additional tracks will be required more than 20 years ahead, no provision other than the following should be made for these tracks :

(i) Jack spans.

(ii) Grading of the road approaches to accommodate the additional opening in the absence of jack spans.

4.5 No provision for additional tracks must be made when it is unlikely that such tracks will follow the same alignment.

4.6 When an additional opening under a rail carrying structure is required by the road authority the designer must prepare his economic appraisal based on a forecast by the road authority. The decision regarding the extent of provision for the future must be taken in consultation with the System Manager or Resident Engineer and the road authority, taking all factors into account including the availability of funds.

4.7 The economic appraisal must be submitted together with the site plan when the latter is submitted for approval. Refer also to 8.2.

4.8 When necessary or advisable, provision must be made for an additional or enlarged opening under the road bridge or a road lane on the side of a railway bridge to accommodate maintenance vehicles which normally operate within the railway right of way. In the case of limited access roads, this provision is usually essential. Refer to 17.4.2 and 18.2.

4.9 Due consideration must also be given, inter alia, to the fol= lowing :

(i) The need for separate facilities for livestock.

(ii) Electrification and signalling requirements and the consequent need to increase horizontal and vertical clearances.

(iii) Possible re-alignment and/or regrading of railway lines.

(iv) The use of jack spans instead of wing or return walls (See 16.2).

(v) The number and size of ducts required in the bridge deck to accommodate services.

(vi) Electric lighting.

(vii) Method of construction.

(viii) Precautions and clearances to be maintained during construction and compliance with the Transport Services' safety instructions governing high voltage electrical equipment.

(ix) Possibility of slewing or deviating the track temporarily during construction or deviating the track permanently over or through the structure after construction.

(x) Allocation of responsibilities during construction, and supervision of the works.

4.10 Account must be taken of the desired resistance rating for the structure in terms of report B2 : RECOMMENDATIONS ON THE DESIGN, CONSTRUCTION, STRENGTHENING AND REPAIR OF BRIDGES, published by the National Transport Commission, Land Transport Directorate. This rating must be established in consultation with the Chief Civil Engineer and when applicable with the national or provincial road authority.

4.11 The general layout of the proposed bridge may, if considered necessary, be discussed with the Chief Civil Engineer's bridge office with a view to ascertaining its acceptability.

5. DESIGN RESPONSIBILITY

Approval of drawings does not indicate acceptance of any responsibility for the safety or adequacy of a bridge structure. Examination of drawings by the Transport Services is confined to checking that -

(i) the lateral and vertical clearances are adequate;

(ii) the structure is of suitable general design, is not likely to affect the safety of the track, and is likely to require little maintenance;

(iii) the parapets are acceptable with regard to general size and design;

(vi) suitable provision has been made for attachment of overhead electrical equipment;

(v) the construction methods and clearances during construction are acceptable.

6. CONSTRUCTION AND MAINTENANCE AGREEMENT

An agreement covering the erection and future maintenance of structures and approaches on the property of, but not fully owned by the Transport Services, must be concluded before construction commences. Permission to start physical construction will be given only after this agreement has been concluded and, in cases where the Transport Services is financially involved, only after formal financial sanction has been issued. Refer also to 22.

7. DRAWINGS : GENERAL REQUIREMENTS

7.1 Drawing standards

To ensure adequate reproduction from microfilms, drawings must comply with SABS 0111 and have -

(i) characters which must remain legible and unambiguous in the form of reduced copy or as an image on a microfilm viewing instrument and which must therefore be of uniform height and thickness; be black and of consistent density compatible with the line work; be of open form and devoid of serifs and other embellishments;

(ii) a print reduction scale, 150 mm long and marked off in units of 10 mm;

(iii) a camera alignment mark in the border at the midpoint lines of the drawing, in the form of an arrow or a thick line 25 mm long, i.e. the width of the border.

7.2 Standard drawing symbols

The standard drawing symbols shown in SABS 0111 and in the E13 Specification for Engineering Survey Work must be used to indicate details on the drawings.

7.3 Standard drawing sizes

All drawings, including bending schedules, must conform to size A0 (841 mm x 1189 mm) with a margin of 25 mm in accordance with SABS 0111.

7.4 Title block

The following must be shown in the title block :

(i) Section of railway line, e.g. "Queenstown - Blaney".

(ii) Kilometrage of the bridge at the point of intersection.

(iii) Names of stations, streets, rivers, roads and/or farm names and numbers where relevant.

(iv) Bridge and drawing numbers and other information required by the road authority.

7.5 Space for signatures

An area of 150 mm wide by 200 mm high must be provided on the site plan and an area of 100 mm x 100 mm on the general arrangement drawing for the signatures of Transport Services officials whose approval of the drawings is required. This area should be reserved immediately above the title block.

7.6 Amendments

When a drawing is amended it must be distinguished by an amendment number. The date and nature of the amendment must be noted on the drawing.

7.7 Expiry of approval

Approval of all drawings will lapse if construction of a bridge has not been commenced within 5 years of the date of approval of the site plan.

8. SITE PLAN

8.1 Content

A typical site plan is illustrated in Annexure 11 sheets 1 and 2. The following must be included :

(a) A key plan showing -

(i) the north point;
(ii) cadastral data;
(iii) roads with their numbers, names and destinations;
(iv) railways with their destinations.

(b) A contoured locality plan showing -

(i) survey data listed in Annexure 10, including the position, description and level of a permanent bench mark near the structure;
(ii) contours;
(iii) cadastral data, including road, rail and other service reserves;
(iv) roads and railways (present and future) and their destinations;
(v) road numbers or street names;
(vi) access roads;

(vii) drainage, road and rail;
(viii) the full extent of all the works covered by the Agreement and, in the case of shared cost works, the limits applicable to the works to be shared;
(ix) details of temporary or permanent rail and road deviations, using additional sheets if necessary.

(c) A longitudinal section of track showing -

(i) rail levels;
(ii) grades;
(iii) beginnings and ends of vertical curves;
(iv) beginnings and ends of horizontal curves and transitions;
(v) points of intersection of straights;
(vi) horizontal and vertical curve data;
(vii) original ground line.

(d) A longitudinal section of road showing -

(i) grades;
(ii) beginnings and ends of horizontal and vertical curves;
(iii) horizontal and vertical curve data;
(iv) superelevation data;
(v) points of intersection of straights;
(vi) points of intersection of cross roads;
(vii) original ground line.

(e) An elevation of the structure showing -

(i) type of structure;
(ii) track centres;
(iii) provision for future tracks;
(iv) rail levels;
(v) soffit levels of decks;
(vi) lateral and vertical clearances at tie points ;
(vii) horizontal clearances between foundations and centre line of track, and depths of top of foundations below rail level when tracks are adjacent to abutments and piers;
(viii) table drains.

(f) A plan of the structure showing -

(i) angle of intersection;
(ii) present and future track centres;
(iii) road and rail curvature;
(iv) lateral clearances at tie points;
(v) wing wall layout ;
(vi) the positions of lateral and vertical tie points ;
(vii) the north point ;
(viii) road and rail destinations;
(ix) test hole positions.

(g) A diagrammatic section through the bridge deck showing -

(i) leading dimensions with minimum details (in the case of rail carrying decks refer to Fig. 2);
(ii) road shoulder and sidewalk widths;
(iii) parapet and kerb heights;

(iv) superelevation and/or camber;
(v) service ducts.

(h) A typical section through the approach road embankment showing -

(i) superelevation and/or camber;
(ii) widths of road lanes and shoulders;
(iii) positions of guard rails;
(iv) positions of longitudinal drains or mounds;
(v) thickness and description of road foundation and surfacing layers;
(vi) embankment slopes.

(j) Foundation test hole data showing -

(i) nature of material;
(ii) depth of strata;
(iii) recommended founding level;
(iv) allowable nett bearing pressure;
(v) ground levels at each test hole position;
(vi) position of the water table after 24 hours and available data on inflow;
(vii) S.P.T. results;
(viii) any other information pertinent to the foundation conditions on the site.

In cases where foundation conditions are complicated, a separate sheet may be necessary.

(k) An endorsement by the System Electrical Engineer or his deputy indicating -

(i) the voltage and method of tensioning of existing or future overhead electrical equipment for which provision for attachment to the bridge deck might have to be made;

(ii) in the case of auto tensioning, whether booster return conductors and/or feeder conductors are required;

(iii) the maximum permissible spacing of electrification masts on rail carrying structures, if required.

No details of bolt groups must be shown.

(l) An endorsement indicating what future tracks are required and date required.

8.2 Design by the Transport Services

8.2.1 In cases where the design of the bridge is to be carried out by the bridge office of the Chief Civil Engineer, a sepia of a preliminary site plan including only the following information must be submitted direct to the Chief Civil Engineer for the attention of the bridge office :

(i) Relevant basic information from (a) to (g) of 8.1 for the determination of the outline of the structure.

(ii) Trial pit information, and/or anticipated founding conditions based on local knowledge.

8.2.2 The bridge office will arrange for the foundation investigation, amend the geometric layout of the bridge structure, if necessary, and return the amended sepia together with the foundation recommendation and profiles to enable the site plan to be completed. The economic appraisal described in 4 will in this case be carried out by the bridge office.

8.3 Extension to an existing bridge

The site plan for the extension to an existing bridge may be simplified by the omission of requirements in 8.1 which are not relevant, but essential information such as vertical and horizontal clearances, land boundaries, drainage proposals, foundation information and a cross section of the proposed deck must be shown. The original site plan and that of the bridge extension taken together must provide a complete picture and include all the information required under 8.1.

8.4 Combined drawings

The site plan and general arrangement drawing must not be combined as this results in unnecessary delay in approval and in the erroneous assumption that site plan approval includes approval of the general arrangement drawing.

8.5 Submission of site plans

Six prints of the site plan, signed by the road authority and/or other parties involved, must be submitted to the relevant System Manager or Resident Engineer, Construction, for approval locally and by the General Manager.

The prints must be folded to the shape and dimensions shown in Fig. 1.

8.6 Site plans forming annexures to agreements

A duplicate of the approved site plan forms an annexure to any maintenance agreement required (see 6). Where the parties have agreed to share costs, prints must be coloured to indicate the apportionment of costs as follows :

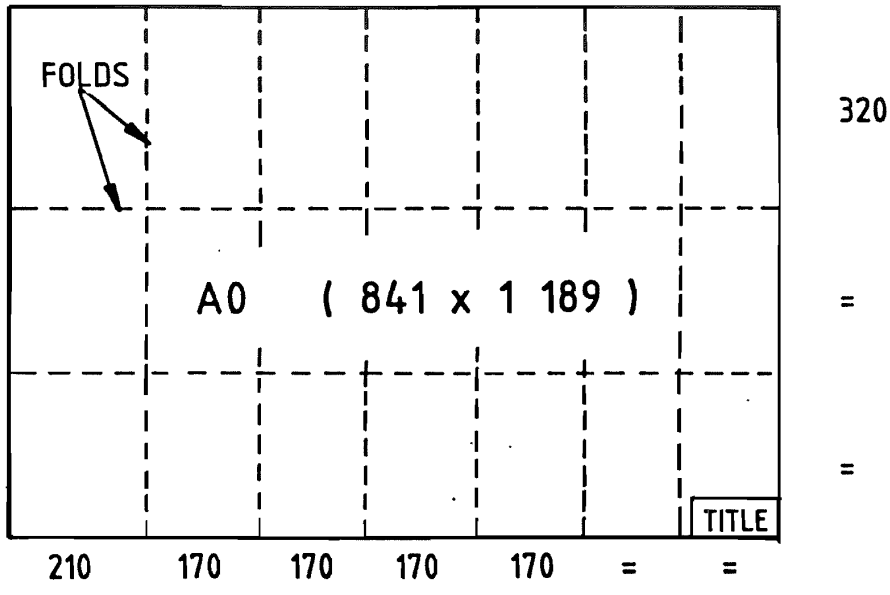
Red : the extent of the shared cost works.

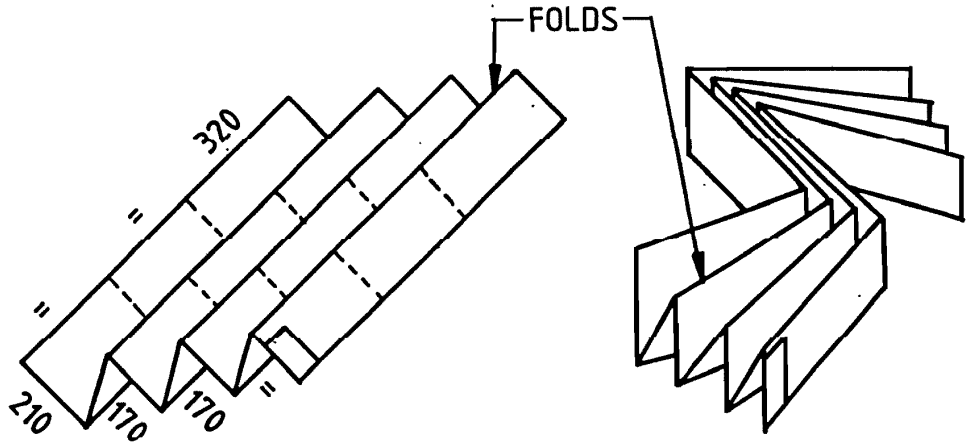
Blue : work paid for solely by the Transport Services.

Brown : work paid for solely by the road authority or other party involved.

Green : future proposals.

Yellow : demolitions.





FIRST STAGE FINAL STAGE

Fig. 1 FOLDING OF SITE PLANS AND GENERAL ARRANGEMENT DRAWINGS

9. GENERAL ARRANGEMENT DRAWING

9.1 Commencement

The general arrangement drawing should not be prepared until the site plan has been approved by the Transport Services.

9.2 Content

This drawing must show the following :

(i) Plan, elevation and cross section through the structure, showing an outline of the design with leading dimensions.

(ii) Horizontal and vertical clearances at tie points.

(iii) Type of foundations to be constructed and nett loading intensity.

(iv) Method of construction of deep or piled foundations where located close to existing tracks.

(v) Maximum length of excavation for shallow foundations to ensure compliance with 15.2.

(vi) Details of provisions to be made to attach overhead electrification equipment to deck soffits and sides, in the format shown in Annexures 6 to 8, including bolt size and spacing and stainless steel specification. Fittings must be shown for both present and future tracks.

(vii) An endorsement indicating the voltage and method of tensioning to which (vi) applies.

(viii) Positions of holding down bolts for electrification masts in accordance with Annexure 9 and information given in terms of 8.1 (k) (iii).

(ix) Details of the loading for which the bridge will be designed, including the loading on the parapets and impact loading on the piers.

(x) A space for a list of numbers and titles of all working drawings. On completion of the working drawings this list must be added.

9.3 Submission

Three prints of the general arrangement drawing, signed by the road authority and/or other parties involved, must be submitted to the relevant System Manager or Resident Engineer, Construction, for approval by or on behalf of this officer, the Electrical Engineer concerned and the Chief Civil Engineer. Prints must be folded as shown in Fig. 1.

10. WORKING DRAWINGS

10.1 Commencement

The detailed design and the balance of the working drawings should not be prepared until the site plan and the general arrangement drawing have been approved by the Transport Services.

10.2 Content

10.2.1 The following must be included on the working drawings :

(i) Concrete strength and aggregate size.

(ii) Concrete cover to reinforcement nearest to concrete faces.

(iii) Bearing design requirements.

10.2.2 For rubber or neoprene bearing pads, drawings should also indicate, inter alia -

(i) a brief specification of the pads;

(ii) the maximum compressive stress;

(iii) the maximum compressive strain;

(iv) the maximum shear strain.

10.2.3 For mechanical or metallic bearings, drawings should indicate, inter alia -

(i) the relevant combinations of vertical and horizontal loads;

(ii) the rotational and translational requirements and preset where required;

(iii) the method of attachment including the mandatory provision of adaptor plates;

(iv) the positions at which jacks are to be placed for replacement of bearings.

10.3 Submission

10.3.1 One set of prints of the working drawings, endorsed to the effect that they have been checked, and signed by the designer and by the road authority, where applicable, must be submitted to the Chief Civil Engineer for approval. Prints must not be folded but forwarded in a roll. A copy of the covering letter must be sent to the relevant System Manager or Resident Engineer, Construction.

10.3.2 In the case of railway bridges, fully detailed calculations must be submitted with the working drawings, when requested.

11. AS BUILT DRAWINGS

Working drawings must be amended to show details of the foundations as constructed and alterations, if any, made to

the structure during construction, so as to represent an accurate record of the structure as completed. As soon as possible after the completion of the structure(s), three complete sets of original silver microfilms of the "as built" drawings to specification CCE 9/84 must be forwarded to the System Manager or Resident Engineer, Construction, concerned.

12. HORIZONTAL CLEARANCES

12.1 New electrification masts and other masts must be clear of the structure gauge shown in full lines in Annexure 1, except in certain cases where, with the approval of the Chief Civil Engineer, the structure gauge shown in dashed lines may be applied.

12.2 The horizontal distance of new structures other than masts from the track centre line must be not less than -

(i) 3 000 mm, or

(ii) the clearance listed in Annexure 1,

whichever is the greater.

12.3 Clearances as in 12.2 also apply to extensions of existing structures where such extensions exceed 4 m in length, measured along the track.

12.4 The clearances referred to in 12.2 must be increased to 3 300 mm -

(i) where required for adequate visibility of drivers;

(ii) where table drains occur;

(iii) where required in station yards;

(iv) where 50 kV electrification applies.

12.5 Greater clearances may be necessary to facilitate the construction of deep or piled foundations or to accommodate services. A temporary track deviation should be considered when insufficient space is available to work at a safe distance from the track.

12.6 The top of any wall or platform in the vicinity of a bridge crossing 3 kV fixed or spring tensioned electrified track must, in addition to the requirements of 12.2, 12.3 and 12.4, also conform to the minimum requirements shown in Annexure 5. In the case of 3 kV and 25 kV auto tensioning, clearances to tops of walls within a horizontal distance of 5 m of the centre line of an existing or possible future railway line must be referred to the Chief Civil Engineer.

12.7 Should the horizontal clearances in 12.2 and 12.3 cause excessive cost, the clearance applicable to masts in terms of 12.1 may be applied provided written approval is obtained from the Chief Civil Engineer. Clearances given in Annexure 5 and referred to in 12.6 cannot be reduced.

12.8 The toe of an embankment adjacent to the track must be at least 3 300 mm from track centre line at the formation level defined in 13.5.

12.9 Positioning of shallow foundations must take account of 15.2.

13. VERTICAL CLEARANCES

13.1 Vertical clearance below new structures over electrified lines or lines which could be electrified later must be not less than the appropriate value of V in Annexure 2, enhanced by 150 mm to allow for future lifting of tracks. The increase of 150 mm may be waived with the prior written approval of the Chief Civil Engineer if future lifting is not practicable or when excessive additional cost is involved.

13.2 Vertical clearance below new structures over lines or portions of lines which can never be electrified must be not less than the value of S in Annexure 2, enhanced by 150 mm to allow for future lifting of tracks unless future lifting is not possible.

13.3 The enhancement of 150 mm referred to in 13.1 and 13.2 must be increased, as appropriate, if there is any likely change to rail, sleeper or ballast standards, or any likely change in gradient.

13.4 Vertical clearances to the top of a wall or platform must conform to the minimum requirements shown in Annexure 5.

13.5 Formation level may be taken as 700 mm below rail level.

13.6 A minimum of 1 000 mm must be allowed between rail level and the top of a foundation, for drains or services below formation level. This dimension must be increased where future lowering of the track is envisaged.

14. CLEARANCES ON NARROW GAUGE TRACK

Clearances referred to in 12 and 13 also apply to new structures adjacent to or over 610 mm gauge track unless it is clear that the improved standard will result in unjustifiable additional expenditure. If in doubt, written instruction should be obtained from the Chief Civil Engineer.

15. TEMPORARY CONSTRUCTION CLEARANCES

15.1 Clearances above rail level

In the case of 1 065 mm gauge track, any shuttering, prop or other temporary structure must be clear of the structure gauge indicated by dashed lines in Annexures 1 and 2 and of the full lines where no dashed lines are shown, i.e. at platform level and below. In addition, in the case of electrified track, structures must be clear of the full line given by dimension V in Annexure 2 or such other vertical clearance that may be stipulated by the System Electrical Engineer or his deputy. In the case of 610 mm gauge track, the clearances shown in Annexure 3 apply.

15.2 Clearances below rail level

Any construction operation, including shoring, below rail level must be such that all track-supporting material within 1 500 mm of the track centre line, measured horizontally, is left undisturbed.

16. DESIGN : GENERAL REQUIREMENTS

16.1 Bridge resistance

The design must be carried out taking into account the recommendations of the National Transport Commission's report B2. Cases where this would result in unpractical or uneconomical structures must be referred to the Chief Civil Engineer.

16.2 Jack spans

In the case of bridges over railway tracks, the provision of jack spans instead of wing or return walls is preferred, particularly at or near stations, as these improve visibility and may permit future addition of tracks or roads at relatively low cost. Consideration should be given to providing adequate horizontal and vertical clearances and suitable abutment configurations to permit the use of jack spans for such future additions. Cases where the provision of jack spans would be uneconomical must be referred to the Chief Civil Engineer. In the case of bridges on narrow gauge lines it will seldom be necessary to allow for future doubling if jack spans are provided.

16.3 Concrete cover

Minimum concrete cover to any reinforcement must be in accordance with Table 1 for severe and very severe exposure conditions as defined in SABS 0100, Part II.

TABLE 1 CONCRETE COVER TO REINFORCEMENT

EXPOSURE CONDITION	STRUCTURAL ELEMENT	COVER mm			
		25 MPa	30 MPa	40 MPa	50 MPa
Severe	Inside faces of factory made culvert elements.	-	-	30	30
	Precast pretensioned concrete beams, except soffits	-	-	30	30
	Concrete protected by permanent shutters which will not weather or corrode	30	30	30	30
	In situ concrete in contact with stone ballast	55	50	50	45
	All other concrete not listed above	50	40	40	35
Very severe	Any structural element	-	-	60	50

16.4 Abutments

16.4.1 Abutments must be so designed that each abutment can resist the full applied earth pressure without reliance on -

(i) any propping effect of the superstructure, in the case of cantilever abutments;

(ii) the presence of fill behind the opposite abutment of a framed structure over a waterway, bearing in mind the risk of removal of the fill on one side of the structure during a serious washaway.

Due to vibration created by train loading, no reliance may be placed on earth friction on the back of an abutment wall.

16.4.2 Permanent studs must be cast into abutments adjacent to tracks to indicate the designed rail level under the bridge.

16.5 Piers

16.5.1 Piers must have wall thicknesses not less than 600 mm. In the case of tall hollow supports this will only apply from 1 m below up to 4 m above ground, formation or water level.

16.5.2 In order to comply with the recommendations of report B2, wall-type piers are preferred, particularly in the case of supports between tracks where standard track centres often demand slender supports to maintain the desired lateral clearances. In the case of very wide bridges, 1 m wide gaps must be provided in the piers at approximately 6 m intervals.

16.5.3 Studs must be provided in piers adjacent to tracks as described for abutments in 16.4.2.

16.6 Bearing sills

Bearing sills must be dimensioned to give a minimum clear distance of 90 mm from edge of bearing to the vertical face of the sill. Suitable recesses or sufficiently large gaps must be provided between the sill and deck soffit to accommodate jacks for adjustment or replacement of bearings. These recesses or gaps must be protected from easy access by means of bolted steel plates or plastered brickwork. Adequate bursting reinforcement must be provided to prevent cracking or spalling of a sill under jack or bearing loads.

16.7 Rubber bearings

The design of rubber bearings must be in accordance with Technical Memorandum (Bridges) No. BE 1/76 or UIC code 772 R, subject to the average compressive stress not exceeding 10 MPa and the compressive strain not exceeding 10 %. For designs in accordance with UIC code 772 R the pressures required to satisfy the stipulated no-slip conditions may be multiplied by a reduction factor equal to $(\tan \gamma)/0,7$. In the case of railway bridges, superstructures supported on rubber bearings must be adequately restrained against excessive horizontal movements.

16.8 Decks

16.8.1 A cast-in-situ concrete deck over electrified lines should be avoided, even if vertical clearance in excess of the minimum is available, in view of the difficulty of installing the necessary falsework and formwork. A deck consisting of precast concrete beams and permanent shutter elements supporting cast in situ concrete often provides the cheapest solution. This construction should, however, not be repeated for spans clear of the tracks unless more economical.

16.8.2 Decks must be dimensioned to give a minimum clear distance of 90 mm from edge of bearing to the vertical face of the deck.

16.9 Deck deflections

Vertical deflections due to the application of live loading, including impact, must not exceed the following :

Rail bridges : 1 mm per metre of span.

Road bridges : 1,25 mm per metre of span.

17. DESIGN : RAILWAY BRIDGES

17.1 General

Railway bridges must be designed in accordance with TMH 7 : CODE OF PRACTICE FOR THE DESIGN OF HIGHWAY BRIDGES AND CULVERTS IN SOUTH AFRICA and the additional requirements specified herein. Railway loading is specified in Part 2.

17.2 Serviceability limit states

17.2.1 Reinforced concrete

Design crack widths must not exceed 0,20 mm . Where very severe exposure conditions exist, as defined in SABS 0100, Part II, design crack widths must not exceed 0,10 mm.

17.2.2 Prestressed concrete

Under design loads appropriate to the serviceability limit state, no tensile stress in the direction of prestressing is permitted in prestressed concrete structures or elements (Class 1 structures in terms of TMH 7).

17.3 Hydrological requirements

17.3.1 Design flood

17.3.1.1 Bridge openings must normally allow for the following design floods :

(i) For catchment areas of 100 km^2 or greater the design flood must be 60 % of the maximum flood as calculated according to Report No. TR 105 published by the Department of Water Affairs.

(ii) For catchment areas of less than 100 km^2 but more than 1 km^2 the design flood must be 50 % of the maximum flood as calculated according to Report No. TR 105. The dashed portions of the graphs shown in Figures 6a to 6e of the report may be used to calculate the design flood where applicable.

(iii) For catchment areas smaller than 1 km^2 the design flood must be calculated according to Technical Report No. TR 102, published by the Department of Water Affairs, taking 50 years as the flood return period.

17.3.1.2 While 60 % and 50 % of the maximum flood from TR 105 cannot be associated with a fixed return period, there are strong indications that in most cases these floods will be equivalent or higher than the realistic 1 in 100 or 1 in 50 year floods respectively. This is especially valid in the drier parts of the Republic, but in the wetter Region 1 somewhat shorter than 100 and 50 year return periods can be expected. The designer must take these trends into account when determining the most effective and economic structure at the particular bridge site, aiming at no less than the realistic 100 and 50 year flood passing capabilities for the catch= ment areas defined in 17.3.1.1 paragraphs (i) and (ii) respectively.

17.3.1.3 When relaxation of the standards and guidelines given in 17.3.1.1 and 17.3.1.2 brings about considerable savings, smaller bridge openings may have to be considered in consultation with the Resident Engineer or System Civil Engineer concerned, taking into account -

(i) the disruption to traffic due to flooding of the railway track or damage to the bridge and railway embankment;

(ii) cost of reinstatement of the bridge and approaches to traffic.

17.3.1.4 Attention must be drawn, on the site plans, to any departure from the standards referred to in 17.3.1.1.

17.3.2 Freeboard

The design allowance for freeboard under the lowest part of the soffit of a bridge with a flood calculated in accordance with 17.3.1 must be one fifth of the depth of water, subject to a minimum of 300 mm and a maximum of 1 500 mm.

17.3.3 Site conditions

Due regard must be taken of the risk and consequences of flood damage and the flood history of the site, and the size of the openings increased accordingly as necessary.

17.4 Decks

17.4.1 Deck profile

The required deck profiles are shown in Fig. 2. Where super= elevation on curves is provided for in the ballast profile and not by tilting the deck, it may be necessary to increase the distance to the kerb on the outside of the curve in order to retain the ballast.

17.4.2 Maintenance road

When a maintenance road is provided on the deck, a 200 mm high kerb must be built with the roadside face of the kerb at a distance of 3 000 mm from the track centre line. An allowance for the road way of 4 000 mm must be made between the roadside face of the kerb and the inside face of the parapet.

17.4.3 Cable ducts

A minimum of three 150 mm diameter non-metallic pipes, strong enough to withstand the pressure of wet concrete without deformation, must be provided on each side of the bridge to accommodate signal, telecommunication and electrical cables. Fig. 3 gives an example of acceptable detailing of the pipe connections and drawing chambers, the latter being required at intervals not exceeding 60 m.

When open cable ducts are used they must be drained and filled with crusher run. Open cable ducts must be used only when pipe ducts are impractical.

17.4.4 Parapets

Parapets on all railway bridges except fly-overs must comply with the following :

(i) The height above the side walk must be not less than 1 100 mm.

(ii) The parapets must be robust and maintenance free.

(iii) The lower 200 mm section of the parapet must provide a continuous barrier against spillage of ballast over the edge of the deck.

For parapets on fly-overs refer to 18.3.

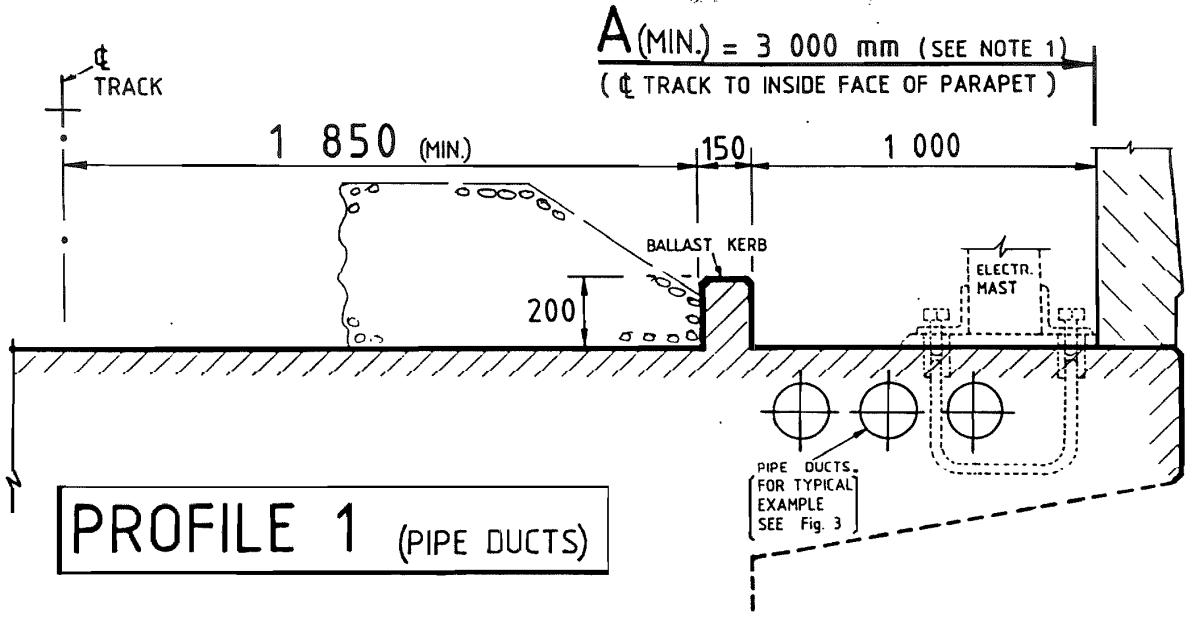
17.4.5 Deck drainage

17.4.5.1 Downlet drains must normally be provided adjacent to the abutment at the lower end of a bridge to prevent erosion of the embankments. All deck surfaces must have a fall of at least 1:100 towards drainage points. Changes in grade below sleepers will not be permitted.

17.4.5.2 Where the deck area of a bridge is larger than approximately 300 m^2 and in all cases where the average grade of the deck is flatter than 1:200, non-metallic pipe drains must be provided through the deck to discharge clear of the roadway or formation below. Where deck drainage is discharged into table drains from a height above formation level the table drains must be concrete lined.

17.5 Backfill behind abutments and wing walls

Only compacted selected material conforming to the requirements of specification E6 may be provided as fill behind abutments and wing walls and an endorsement to this effect must appear on the relevant drawings.



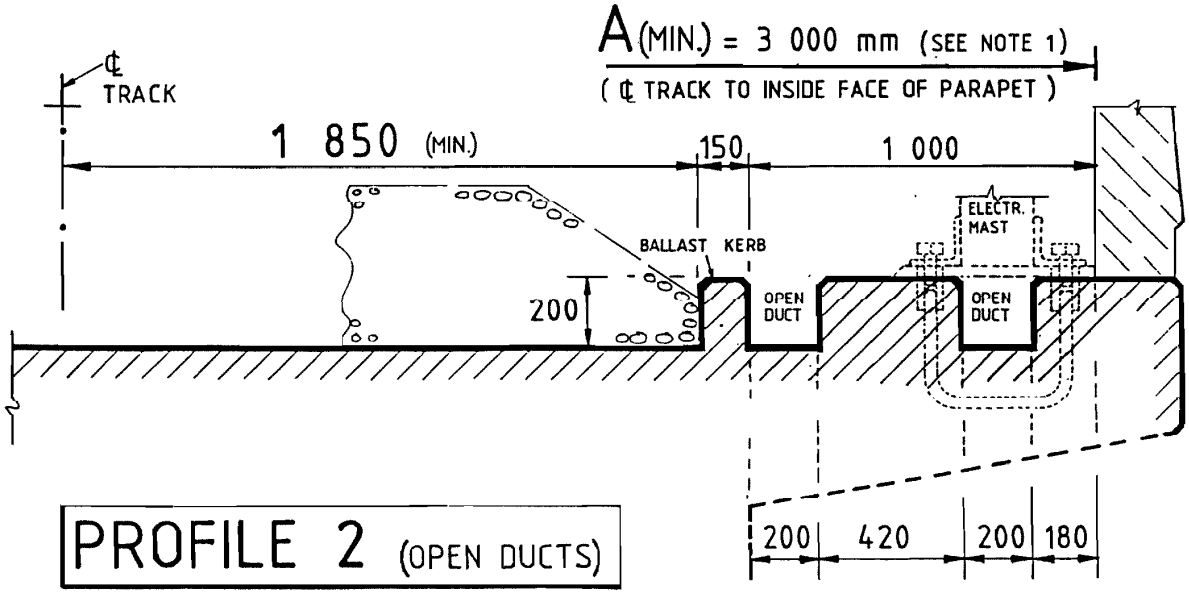
PROFILE 1 (PIPE DUCTS)

NOTE 1

A(MIN.) MUST BE INCREASED WHERE:

(i) ELECTR. MASTS ARE LOCATED ON INSIDE OF CURVE & TRACK RAD. < 800 m
(ADD 380 mm TO APPLICABLE DIMENSION L IN ANNEXURE 1)

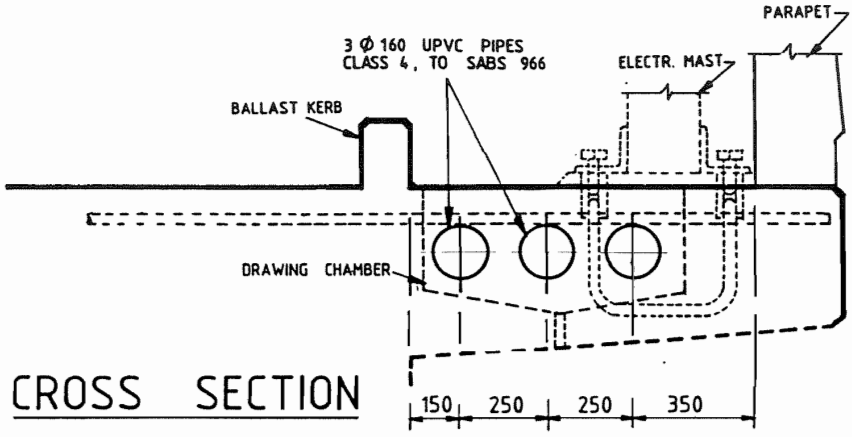
(ii) ELECTR. MASTS ARE LOCATED ON OUTSIDE OF CURVE & TRACK RAD. < 140 m
(ADD 380 mm TO APPLICABLE DIMENSION H IN ANNEXURE 1)



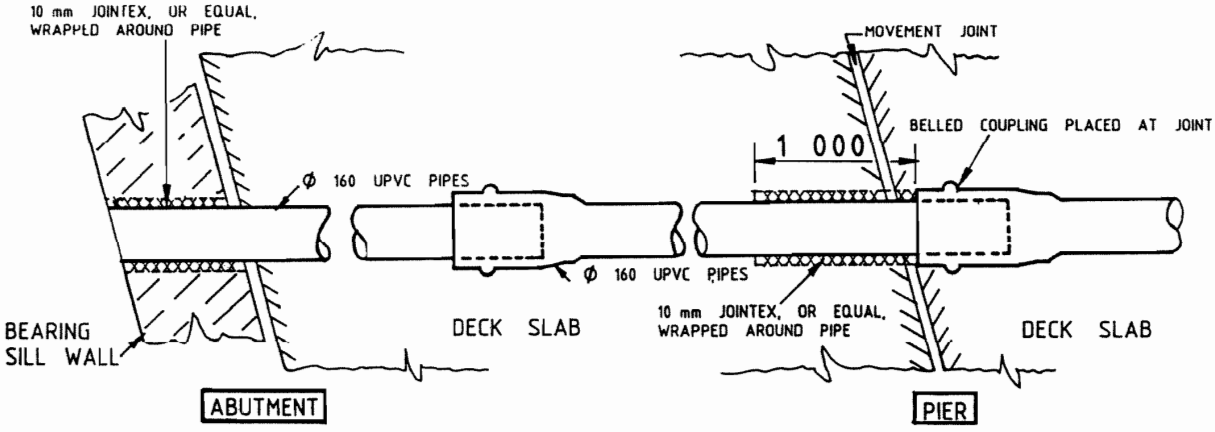
PROFILE 2 (OPEN DUCTS)

NOTE: OPEN DUCTS SHOULD BE USED ONLY WHEN PIPES ARE IMPRACTICAL

Fig. 2 STANDARD DECK PROFILES FOR RAIL BRIDGES

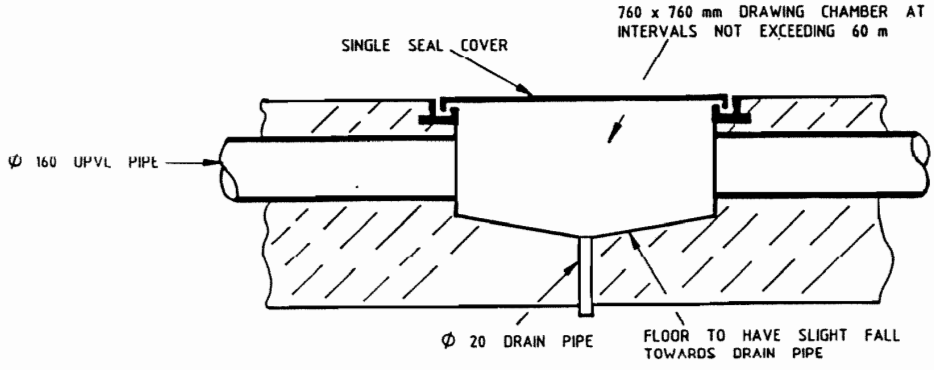


CROSS SECTION



NOTE PIPE COUPLINGS MUST BE AT LEAST 500 mm AWAY FROM BOLT GROUP FOR ELECTR. MASTS

SECTIONAL PLAN SHOWING PIPE COUPLINGS



DRAWING CHAMBER

Fig.3 PIPE DUCTS FOR SERVICES

17.6 Approach slabs

Approach slabs must be provided behind all spill-through abutments and behind all other abutments exceeding 5 m in height, measured from the top of the base slab or pile cap.

18. DESIGN : ROAD BRIDGES

18.1 General

18.1.1 Road bridges must be designed in accordance with the requirements of the road authority of the province in which the bridge is situated, or to such higher standards as may be laid down by the local road authority, and to the additional requirements specified herein.

18.1.2 Where the Transport Services is the road authority the Chief Civil Engineer will advise which design code is applicable.

18.1.3 Agricultural overpasses must have a minimum width of 5 500 mm between the inside faces of the parapets. In the case of New Jersey type parapets this minimum width must be provided at the upper intersection of the parapet face slopes, i.e. approximately 325 mm above finished road level.

18.2 Maintenance road When provision of a maintenance road through the bridge is required, an additional clear width of 4 m must be provided for this purpose. Where the road is adjacent to a railway track a width of 7 m from track centre line is adequate.

18.3 Parapets

18.3.1 Except as otherwise indicated in 18.3.5, parapets on bridges over present or future railway tracks must be of a closed type and not less than 1 500 mm in height, measured from the proposed or future sidewalk or road level. Closed parapets must extend 3 000 mm beyond the centre line of the outermost track, measured at right angles to the track.

18.3.2 Rails or steps which may reduce the effective height of 1 500 mm are not permitted.

18.3.3 The inside faces of parapets must be free of projections. Recesses in these faces must be not deeper than 15 mm and the lower edges of horizontal recesses must be chamfered at an angle of 60° to the horizontal. Ledges on the outside of the parapets are not permitted.

18.3.4 Butting faces of movement joints must be stepped in plan as a protection against possible contact with the overhead electrical equipment.

18.3.5 Open type parapets are acceptable only when the live catenary is more than 3 000 mm below the top of the deck and when pedestrian access to the roadway is prohibited.

18.3.6 As a protection to parapets other than the New Jersey type, kerbs must be provided on both sides of the bridge deck. The height of the kerb must be not less than 150 mm above the road surface and the distance from the face of the kerb to the inside face of the parapet must be not less than 500 mm.

18.4 Ducts

18.4.1 If services are required to be carried over the railway line, ducts must be provided in the sidewalk or, in the case of bridges without sidewalks, within the bridge deck structure below road level. Where, in consultation with the road authority, the possibility of future services crossing the railway line can be foreseen, ducts equivalent to a minimum of two 150 mm pipes must be provided and temporarily blocked.

18.4.2 Ducts may be omitted in cases where, in the opinion of the road authority, future services are unlikely to eventuate.

19. DESIGN : FOOTBRIDGES AND PEDESTRIAN SUBWAYS

19.1 The following principles and standards must be applied when designing footbridges :

(i) Capacity of stairways : 50 persons per minute per metre width of stairway.

(ii) Capacity of level or sloped walkway: 100 persons per minute per metre width of walkway.

(iii) Capacity of a single ticket barrier : 25 persons per minute.

(iv) The stairways giving access to or exit from a footbridge must be critically examined in the light of present and possible future pedestrian volumes. Planning should take account of the result of this examination and the cost aspect.

(v) The following should be considered in the case of footbridges at passenger stations :

(a) The capacity of the walkway and stairways should, if practicable, be sufficient to enable all detraining passengers to enter a stairway within three minutes, taking into consideration that trains can arrive simultaneously.

(b) At how many platform faces can there be simultaneous train arrivals with maximum passenger discharge?

(c) Assuming such simultaneous train arrival is likely, what percentage of the full capacity of the footbridge walkway will be reached in a particular direction?

(d) Can the exit stairway from the footbridge cope with the flow in the direction considered in (c), taking into account that a potential danger area occurs at the top of a stairway ?

If the answer to (d) is no, then sufficient additional width of exit stairway must be provided or alternatively the stairway replaced by a ramp. If the answer to (d) is initially yes but expected to be no at a later stage, the footbridge exit should be planned to allow for a future additional stairway or for the stairway to be replaced by a ramp.

19.2 The principles in 19.1 apply in general also to pedestrian subways but the latter are not favoured and should only be resorted to in cases where the provision of a footbridge is impractical.

19.3 Footbridges must be structually designed in accordance with TMH 7 subject to amendment of the applied loading as specified in Part II. Parapets must be provided in accordance with 18.3.1 to 18.3.4.

19.4 Concrete pedestals

Steel trestles located within 4 m of a track centre line must be supported on concrete pedestals extending 1 200 mm above rail level. The pedestals must be designed for impact loads as specified for supports adjacent to railway tracks in Part II.

20. DESIGN : SERVICE STRUCTURES

20.1 Structures carrying services must be designed in accordance with TMH 7 subject to the additional applied loading as specified in Part II of this code.

20.2 Parapets

If maintenance staff require access to the service, parapets must be provided in accordance with 18.3, and the floor of the bridge must be sealed to prevent accidental contact with electrification wires. If maintenance occurs seldom and only by special arrangement with the System Electrical Engineer in terms of specification E7 Part II, the bridge may be blocked off at both ends by means acceptable to him. Under these circumstances closed parapets and a sealed floor may be omitted.

20.3 Concrete pedestals

For structural steel supports the requirements of 19.4 apply.

21. DESIGN : CULVERTS AND UNDERPASSES

21.1 General

Culverts under railway tracks must be designed in accordance with TMH 7 subject to the application of NR live loading and other loads as specified in Part II of this code.

21.2 Agricultural underpasses

Agricultural underpasses for vehicular access must have a minimum width of 5,5 m and height of 5,0 m. The equivalent dimensions applying to cattle creeps are 2 m x 2 m.

21.3 Serviceability limit states

The requirements of 17.2 apply.

21.4 Hydrological requirements

21.4.1 Design flood

Culvert openings must allow for design floods calculated in accordance with 17.3.1. Pipe culverts should be not less than 900 mm in diameter.

21.4.2 Freeboard and storage

21.4.2.1 Pipe culverts

The freeboard in a pipe culvert must be designed to be at least 10 % of the diameter of the pipe and flooded inlets are not permitted. Ponding, or the utilisation of the storage available upstream of the inlet in order to reduce the flood peak, must be considered unless -

(i) the culvert is situated in an urban or potentially urban area;

(ii) the interests of the Transport Services or those of the owner of the adjoining property are adversely affected thereby.

21.4.2.2 Box and arch culverts

Box and arch culverts must normally be designed to allow a freeboard of 5 % of the height of the culvert opening, subject to a minimum of 100 mm. Ponding must be considered as described in 21.4.2.1. Flooded inlets are permitted only if -

(i) the design flood level is at least 1 000 mm below track formation and not higher than 1,5 H above the upstream invert, where H is the height of the culvert opening;

(ii) the track formation will not be overtopped until the flood is at least 1,5 times the design flood in terms of 17.3.1;

(iii) the level above invert reduces from 1,5 H to H within 1 hour of cessation of precipitation.

21.4.3 Site conditions

Due regard must be paid to the factors referred to in 17.3.3.

21.5 Movement joints

Movement joints must be provided at intervals not exceeding 10 m along the length of the culvert. Vertical and horizontal keys must be provided at such joints unless it is clear that there is no danger of differential alignment or settlement, e.g. when founded on rock. All joints must be veed at the inner faces.

21.6 Simply supported decks

Simply supported decks must be fixed at abutments and piers subject to allowance for free movement on piers at intervals not greater than 10 m. On such piers, decks must be supported on 3 layers of roofing felt to SABS 92, type 60, and must be separated from one another by 3 layers of this felt.

21.7 Deck profile

Dimensional requirements and profiles are detailed in Fig. 4.

21.8 Handrails

Handrails, 1 100 mm high, must be provided where the height of earth bank above a culvert is not greater than 250 mm and the height of the culvert opening is 2 m or greater. In station yards handrails must be provided irrespective of opening height.

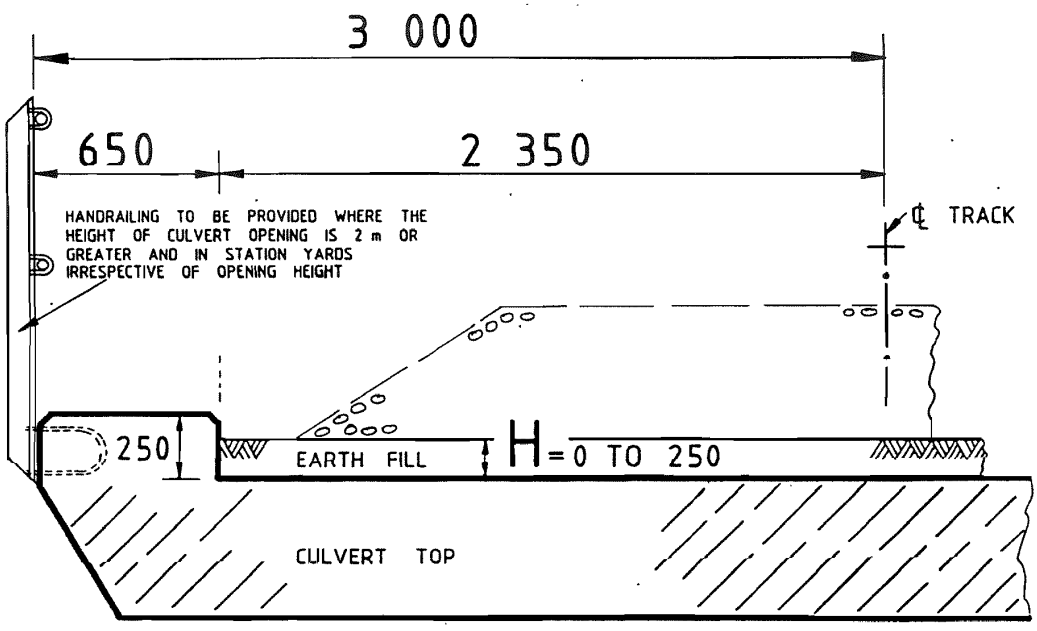
22. TENDER DOCUMENTS

22.1 Two copies of the draft tender documents must be submitted to the Transport Services for approval before tenders are invited.

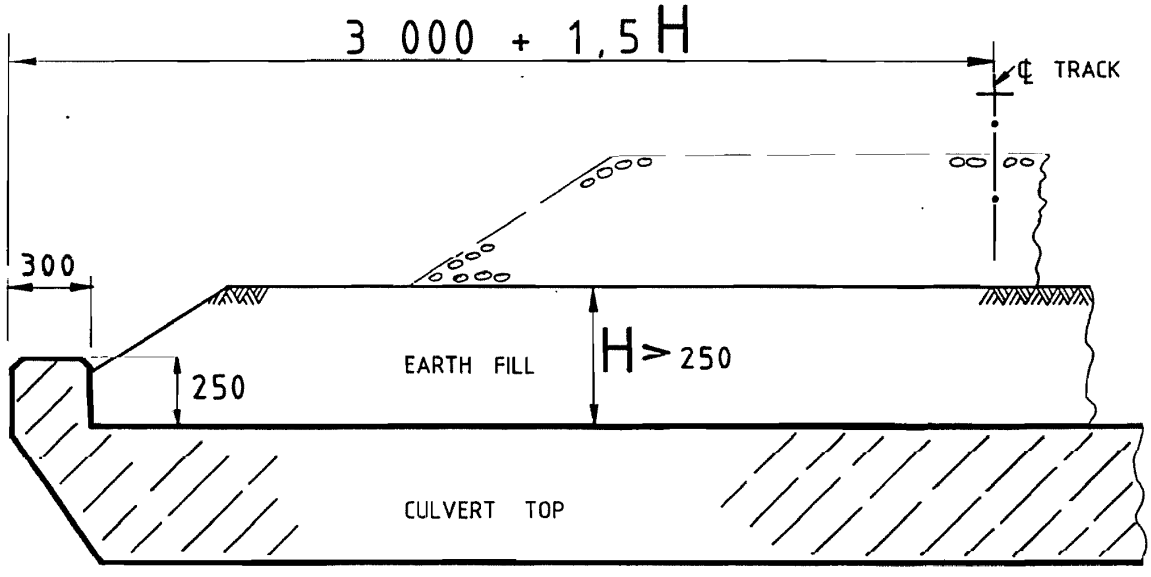
22.2 Tender documents prepared by road authorities, or on their behalf by consultants, will follow the general form used by the road authority but must include the Transport Services specification E7 Part II. In addition, specifications referred to in 22.4, 22.5 and 22.6 must be used where applicable.
The Transport Services specifications must not be retyped but reproduced from updated master copies issued by the Chief Civil Engineer.

22.3 Where the Transport Services, or consultants appointed by the Transport Services, are controlling the work the basic Transport Services format for tender documents must be adopted and the following standard forms and specifications must be included where applicable. They must be bound in the order listed below :

1 Schedule of documents.
2 Notice to Tenderers.
3 Tender form (E4).
4 Site inspection certificate (form E4A).
5 Minimum communal health requirements (form E4B).
6 Statement of works successfully carried out by the tenderer (form E4C).
7 Schedule of plant and equipment (form E4D).
8 Agreement and conditions of contract (form E5).
9 Standard specifications which are relevant, including E7 Part I.
10 Special conditions and specifications.
11 Schedule of prices.
12 Schedule of drawings.
13 Drawings.



PROFILE 1 HEIGHT H OF EARTH FILL = 0 TO 250 mm



PROFILE 2 HEIGHT H OF EARTH FILL > 250 mm

Fig. 4 STANDARD CULVERT PROFILES

22.4 Structures carrying railway tracks must be constructed in accordance with the following Transport Services specifications where applicable :

E8 Concrete work
E17 Concrete bridges and culverts other than pipe culverts
E19 Pile foundations and sheet piling
E49 Concrete pipe culverts and drains
CCE 5/1 Bridge steelwork
CCE 5/2 Jacking of structures

22.5 Earthworks for railway formations and fencing must be in accordance with the Transport Services specifications E6 and E9 respectively.

22.6 As built drawings must be microfilmed in accordance with specification CCE 9/84.

23. APPLICABLE CODES AND STANDARDS

Reference is made in Parts I and II to the following codes and standard specifications :

TMH 7 : Code of practice for the design of highway bridges and culverts in South Africa.

BS 5400 : Steel, concrete and composite bridges, Part 2 : Specification for loads.

Report B2 : National Transport Commission, Land Transport Directorate : Recommendations on the design, construction, strengthening and repair of bridges.

Technical Memorandum (Bridges) No. BE 1/76, Department of the Environment, Highways Directorate : Design requirements for Elastomeric Bridge Bearings.

International Union of Railways (UIC) Code 772 R : Code for the use of rubber bearings for rail bridges.

SABS 0100 : Code of practice for the structural use of concrete : Part 2 : Materials.

SABS 0111 : Standards for drawings.

Report TR 105 : Maximum flood peak discharges in S.A. : Dept. of Water Affairs.

Report TR 102 : Southern African Storm Rainfall : Dept. of Water Affairs.

S.A. Transport Services Specifications :
- E7 Parts I and II : Work on, under, over, adjacent to railway tracks.
- E6 Earthworks.
- E8 Concrete work.
- E9 Fencing.
- E13 Engineering survey work.
- E17 Concrete bridges and culverts other than pipe culverts.
- E19 Pile foundations and sheet piling.
- E49 Concrete pipe culverts and drains.

CCE 5/1 Bridge steelwork.
CCE 5/2 Jacking of structures.
CCE 9/84 Microfilming of drawings.
CCE 3/10 Painting new structural steelwork.

24. ACKNOWLEDGEMENT

Material from BS 5400 : Part 2, is reproduced in PART II hereof by permission of the British Standards Institution, 2 Park Street, London, WIA 2BS. British Standards can be purchased from the SABS in Pretoria.

PART II : SPECIFICATION FOR LOADS

A. GENERAL

NOTATIONS AND DEFINITIONS HEREIN ARE AS GIVEN IN TMH 7 UNLESS OTHERWISE INDICATED. ANY ACTIONS, LOADS AND PARTIAL LOAD FACTORS NOT SPECIFIED IN THIS PART MUST BE APPLIED WITHOUT AMENDMENT IN ACCORDANCE WITH TMH 7, PARTS 1 AND 2.

B. RAILWAY BRIDGES

B1. GENERAL

The rail loading specified in this part is based on BS 5 400 : STEEL, CONCRETE AND COMPOSITE BRIDGES, PART 2 : SPECIFICATION FOR LOADS, amended to suit local conditions.

B2. PRINCIPAL ACTIONS

B2.1 Superimposed dead load

B2.1.1 Nominal superimposed dead load. The nominal weight of the track structure, including ballast, must be taken as 35 kN/m. Service ducts may be considered as filled with concrete and no further allowance need be made for the weight of services.

B2.1.2 For the serviceability limit state the values of the factor γ_{fL} must be as in TMH 7. For the ultimate state the factor γ_{fL} must be 1,4; 1,2 and 1,2 for load combinations 1,2 and 3 respectively.

B2.2 Earth pressure on retaining structures

B2.2.1 Approximately theory for earth pressure

In place of the equivalent fluid pressures given in TMH 7 for Type I and Type II fill material which apply only when the required lateral movement to achieve those values can be obtained, the following equivalent fluid pressures must be considered in the case of unyielding structures or elements such as propped cantilevers and portal frames :

Type I	9,5 kPa per metre depth
Type II	13,5 kPa per metre depth

B2.2.2 The additional horizontal pressure due to railway loading on the fill immediately behind a retaining wall must be taken as 12 kPa in the case of yielding structures and 20 kPa in the case of framed or propped structures. This loading must be applied on the total length of the wall and on the total length of a side wall, but acting only on the part of the side wall more than $(b_1 - 1)$ metres below the formation level, where b_1 is the distance from the centre line of the track to the side wall.

B2.2.3 The vertical surcharge pressure due to railway loading must be taken as 32 kPa for the design of heels of retaining walls.

B2.3 Primary live loads

B2.3.1 Definition of NR rail loading. Nominal NR loading consists of one group of 280 kN concentrated loads preceded and followed by a uniformly distributed load of 100 kN/m. The arrangement of this loading is shown in Fig. 5.

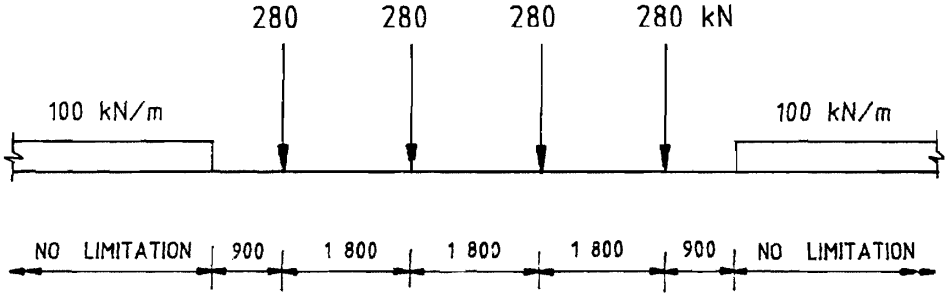


Fig. 5 NR LOADING

B2.3.2 Dynamic effects. The nominal NR loading defined in B2.3.1 is a static loading and must be multiplied by the appropriate dynamic factors in Table 2 to allow for impact, oscillation and other dynamic effects including those caused by track and wheel irregularities. L is the span.

In the case of multiple tracks the dynamic factor needs to be applied to a maximum of three tracks only.

TABLE 2. DYNAMIC FACTOR FOR NR LOADING

DIMENSION L (m)	DYNAMIC FACTOR FOR EVALUATING	
	BENDING MOMENT	SHEAR
Up to 3,6	2,00	1,67
3,6 to 67	$0{,}73 + \frac{2{,}16}{\sqrt{L} - 0{,}2}$	$0{,}82 + \frac{1{,}44}{\sqrt{L} - 0{,}2}$
Over 67	1,00	1,00

L is the span length for simply supported spans, and equals 1,2; 1,3; 1,4; 1,5 times the mean span for 2, 3, 4, 5 and more continuous spans respectively, or the longest span, whichever is greater.
For portal frames and arches L equals half the span.
For unballasted bridges enhanced dynamic factors must be used, details of which may be obtained from the Chief Civil Engineer.

B2.3.3 Dispersal of concentrated loads. For ballasted track it may be assumed that two thirds of the concentrated load applied to the rails is transmitted to the bridge deck by the sleeper immediately below the applied load, and the remaining one third to the two sleepers on either side. The load from a sleeper may be assumed to be dispersed through the ballast at an angle of 5^{o} to the vertical, giving a distribution over an area measuring 0,3 m x 2,0 m at the underside of the ballast. Further distribution through the deck may be taken into account, due allowance being made for the type of construction of the deck.
This method of dispersal has been applied in the derivation of the equivalent uniformly distributed loads in Table 3.

B2.3.4 Deck plates and similar local elements. Deck plates, top slabs of box girders or beam decks, and similar local elements must be designed to support a nominal load of 280 kN at any point of support of a rail. For ballasted track the total nominal load of 560 kN applied to both rails may be distributed to adjacent sleepers and through the ballast and deck as described in B2.3.3. These nominal loads shall be deemed to include all allowances for dynamic effects and lurching and must be applied over a width of 2,0 m measured at the underside of the ballast.

B2.3.5 Application of NR loading. The nominal NR loading, amplified to allow for dynamic effects, must be applied to each track. In order to ascertain the maximum bending moments or shear, the distributed load must be applied to all lengths on the influence lines contributing to such maxima.

B2.3.6 Elements supporting sidewalks and rail loading. The nominal live load on sidewalks carried by elements which also support rail loading must be taken as 5 kPa. Sidewalk loading must be considered in isolation and not in combination with the nominal rail loading. Permanent sidewalks must be checked for derailment loading as specified in B6.

B2.3.7 The factor γ_{fL} to be applied to the nominal load given in B2.3.6 must be as follows :

	ULTIMATE LIMIT STATE			SERVICEABILITY LIMIT STATE		
Combinations	1	2	3	1	2	3
γ_{fL}	1,4	1,2	-	1,0	1,0	-

B3. SUPPLEMENTARY ACTIONS

B3.1 Secondary live loads

B3.1.1 Nosing. An allowance must be made for the lateral loads applied by trains to the track. This must be taken as a single nominal load of 100 kN, acting horizontally in either direction at right angles to the track at rail level and at such a point in the span as to produce the maximum effect in the element under consideration.

TABLE 3

BENDING MOMENTS AND END SHEAR FOR NR LOADING (SIMPLY SUPPORTED SPANS)

SPAN m	EQUIVALENT UDL PER TRACK FOR DETERMINING BENDING MOMENTS		END SHEAR PER TRACK	
	STATIC kN/m	DYNAMIC kN/m	STATIC kN	DYNAMIC kN
1,0	300	600	156	260
1,2	267	533	168	280
1,4	243	486	180	300
1,6	225	450	192	320
1,8	211	420	204	340
2,0	200	400	216	360
2,2	191	382	228	380
2,4	183	367	240	400
2,6	177	354	251	420
2,8	171	343	263	440
3	167	333	275	458
4	164	317	381	617
6	162	274	594	867
8	159	247	757	1036
10	155	226	886	1158
12	149	207	1001	1261
14	144	193	1102	1352
16	140	182	1212	1453
18	137	173	1322	1555
20	134	165	1426	1650
22	131	159	1526	1741
24	129	153	1644	1851
26	127	149	1748	1947
28	125	145	1841	2031
30	124	141	1944	2125
32	123	138	2046	2218
34	121	135	2146	2309
36	120	133	2250	2403
38	119	130	2352	2495
40	118	128	2453	2588
45	117	124	2706	2817
50	115	120	2947	3035
55	114	117	3194	3255
60	113	115	3462	3500
65	112	112	3708	3719
70	111	111	3965	3965
75	110	110	4205	4205
80	110	110	4467	4467
90	109	109	4968	4968
100	108	108	5407	5407
120	107	107	6471	6471
140	106	106	7472	7472
160	105	105	8473	8473
180	104	104	9474	9474
200	104	104	10393	10393

B3.1.2 Centrifugal load. Where the track on a bridge is curved, allowance for centrifugal action of moving loads must be made in designing the elements, all tracks on the structure being considered occupied. The nominal centrifugal load F_c in kN/m per track must be calculated from the formula

$$F_c = P(V_t + 10)^2/127r$$

where P = the static equivalent uniformly distributed load for bending moment in kN/m
r = the radius of curvature in m
V_t = the greatest speed envisaged on the curve in question in km/h.

The load must be assumed to act radially at a height of 1,8 m above rail level.

B3.1.3 Longitudinal loads. Provision must be made for the nominal loads due to traction and braking as follows :

(i) TRACTION : 20 kN/m per track, with a minimum of 200 kN and a maximum of 2 000 kN.
BRACKING : 15 kN/m per track, with no limiting value.

These loads must be considered as acting at rail level in a direction parallel to the tracks. No addition need be made for dynamic effects. No portion of the applied loads may be assumed to be transmitted by the track to resistances outside the bridge structure.

(ii) Structures and elements carrying single tracks must be designed for the larger of the two loads produced by traction and braking acting in either direction.

(iii) Where a structure or element carries two tracks, both tracks must be considered as being occupied simultaneously. Where the tracks carry traffic in opposite directions, the load due to braking must be applied to one track and the load due to traction to the other. Structures and elements carrying two tracks where traffic on both tracks can be in the same direction, either on a regular or intermittent basis, must be subjected to braking or traction on both tracks, whichever gives the greater effect. When braking on two tracks is considered, however, the braking load applied to the second track may be reduced to 10 kN/m.

(iv) Where appropriate, consideration must be given to braking and/or traction, acting in opposite directions, producing rotational effects.

(v) Where elements carry more than two tracks, longitudinal loads as described in (iii) and (iv) must be considered as applied simultaneously to two tracks only.

B3.2 Impact loads on bridge supports adjacent to railway tracks

B3.2.1 Bridge supports must be considered to be vulnerable to impact loads resulting from derailed vehicles if located within 5 m of the centre line of an existing or future track and not permanently protected as in the case of a support on a platform.

B3.2.2 The nominal impact loads are as follows :

(i) A horizontal longitudinal load of 600 kN parallel to the direction of the track.

(ii) A horizontal transverse load of 200 kN normal to the direction of the track.

One pair of such loads must be applied simultaneously to each support in turn at a height of 2 m above rail level. The transverse load must be distributed longitudinally over the length of a support, or over 2 m, whichever is less.

B3.2.3 Where, notwithstanding what is stated in 16.5.2 of Part I, column supports are contemplated for aesthetic reasons or otherwise, such columns must be designed for nominal impact loads up to five times the value stated in B3.2.2. Such cases must be referred to the Chief Civil Engineer for a decision.

B3.3 Loads on parapets

Parapets on bridges carrying railway tracks must be designed for the loads specified for Class II balustrades in TMH 7.

B4. LOAD COMBINATIONS

All loads that derive from rail traffic, including dynamic effects, nosing, centrifugal load and longitudinal loads, must be considered in combinations 1 and 2 described in TMH 7.

B5. DESIGN LIVE LOADS

B5.1 For primary and secondary railway live loads, γ_{fL} must be taken as follows :

	ULTIMATE LIMIT STATE			SERVICEABILITY LIMIT STATE		
Combinations	1	2	3	1	2	3
γ_{fL}	1,4	1,2	-	1,0	1,0	-

B6. DERAILMENT LOADS

B6.1 Railway bridges must be so designed that they do not suffer excessive damage or become unstable in the event of a derailment. The following criteria apply :

(a) For the serviceability limit state, derailed coaches or light wagons with wheels displaced laterally to points up to 2 m from track centre line must cause no permanent damage.

(b) For the ultimate limit state, derailed locomotives or heavy wagons remaining clear of the parapet must not cause collapse of any major element, but local damage may be accepted. A cantilevered concrete footwalk must be considered a major element.

(c) For overturning or instability, a locomotive and one following wagon balanced on the outermost edge of the bridge or parapet must not cause the structure as a whole to overturn, but other damage may be accepted.

Design loads applied in accordance with B6.2 may be deemed to comply with these requirements.

B6.2 Derailment design load for NR loading

The following equivalent static design loads, with no addition for dynamic effects, must be applied when assessing the effects of derailments. These loads are to be considered in isolation and are not to be considered in combinations 1 and 2.

(a) For the serviceability limit state, either

(1) vertical loads of 20 kN/m on each of two lines 1,0 m apart, parallel to the track and applied anywhere within 2 m of the track centre line; or, if the effect is greater,

(2) an individual concentrated vertical load of 100 kN anywhere within 2 m of the track centre line.

(b) For the ultimate limit state, four concentrated vertical loads of 200 kN (ultimate) at 1,8 m centres on each of two lines 1,0 m apart, parallel to the track, applied anywhere on the deck up to a line 200 mm from a concrete parapet.

(c) For overturning or instability, a vertical load of 100 kN/m applied on the outermost edge of the bridge or parapet, limited to a length of 20 m anywhere along the span.

Loads specified in (a) and (b) must be applied at the top surface of the ballast or other deck covering and may be assumed to disperse at 30 ^{o} to the vertical onto the supporting structure.

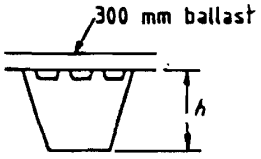
B7. RESTRAINT ACTIONS

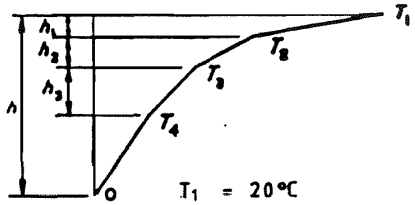
B7.1 Temperature effects

B7.1.1 Adjustment for the presence of ballast. When calculating effective bridge temperatures the effect of ballast on railway bridges may be taken to be equivalent to that of 200 mm of road surfacing. Temperature differences for different types of construction carrying ballasted track are given in Fig. 6.

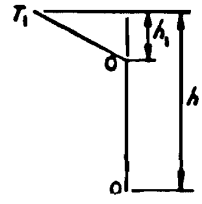
TYPE OF CONSTRUCTION	TEMPERATURE DIFFERENCE °C	
	POSITIVE DIFFERENCE	REVERSE DIFFERENCE

1. Steel deck on steel box girders





$h_1 = 0.1$ m $\quad T_1 = 20$°C
$h_2 = 0.2$ m $\quad T_2 = 12$°C
$h_3 = 0.3$ m $\quad T_3 = 8$°C
$\quad T_4 = 4$°C

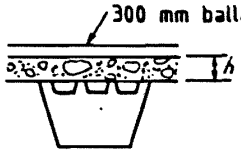


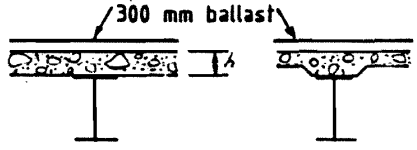
$T_1 = 5$°C $\quad h_1 = 0.5$ m

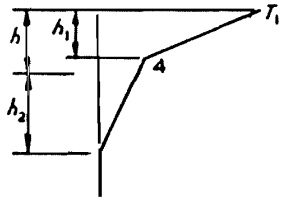
2. Steel deck on steel truss or plate girders

Use differences as for type 1

3. Concrete deck on steel box, truss or plate girders

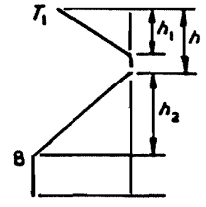






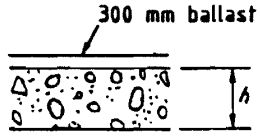
$h_1 = 0.6\,h$
$h_2 = 0.4$ m

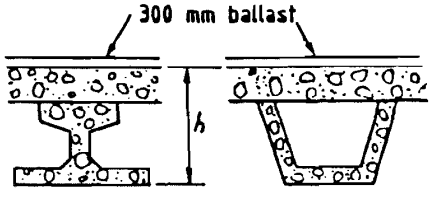
h m	T_1 °C
0.2	8.5
0.3	10

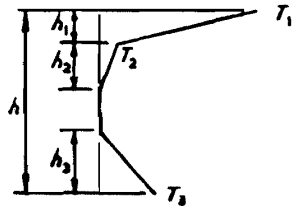


h m	T_1 °C
0.2	1.6
0.3	2.7

4. Concrete slab or concrete deck on concrete beams or box girders

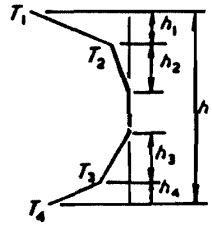






$h_1 = 0.3h \leq 0.15$ m
$h_2 = 0.3h \geq 0.10$ m
≤ 0.25 m
$h_3 = 0.3h \leq$ (0.1 m + surfacing depth in metres)
(for thin slabs, h_3 is limited by $h-h_1-h_2$)

	h m	T_1 °C	T_2	T_3
$\leqslant$	0.2	3.7	2.0	-0.5
	0.4	6.2	1.3	1.0
	0.6	7.2	1.5	1.5
$\geqslant$	0.8	7.5	2.1	1.5



$h_1 = h_4 = 0.2h \leq 0.25$ m
$h_2 = h_3 = 0.25h \leq 0.2$ m

	h m	T_1 °C	T_2	T_3	T_4
$\leqslant$	0.2	0.5	0.2	1.0	1.8
	0.4	2.2	0.5	1.9	4.0
	0.6	3.6	0.6	1.9	5.1
	0.8	4.5	1.0	1.9	6.0
	1.0	4.8	0.9	1.9	5.8
$\geqslant$	1.5	5.0	0.3	1.2	5.6

Fig. 6 TEMPERATURE DIFFERENCE FOR DIFFERENT TYPES OF CONSTRUCTION

C. ROAD BRIDGES

C1. NOMINAL LIVE LOAD

C1.1 Public roads

Road bridges must be designed for the loading specified by the relevant road authority. Where the Transport Services is the road authority, road bridges must be designed for NA, NB 36 and NC 30 x 5 x 40 loading.

C1.2 Agricultural overpasses

Agricultural overpasses must be designed for NA loading only.

C2. NOMINAL IMPACT LOAD ON PARAPETS

On road bridges or overpasses crossing tracks, New Jersey type parapets which are not protected from impact loads by kerbs must be designed for 1,5 times the loading specified for Class I balustrades in TMH 7.

C3. IMPACT LOADS ON BRIDGE SUPPORTS ADJACENT TO RAILWAY TRACKS

Bridge supports adjacent to railway tracks must be designed to carry the nominal impact loads specified in B3.2.

D. FOOTBRIDGES AND SERVICE STRUCTURES

D1. NOMINAL LIVE LOAD

D1.1 Footbridges

Footbridges must be designed for a nominal live load of 8 kPa irrespective of span length. In exceptional cases, where crowds cannot be envisaged, the loading intensity may be reduced to 5 kPa. These loadings include an allowance for the weight of electrical overhead equipment attached to the footbridge. A nominal horizontal live load of 30 kN which may act transversely in either direction at the centre of each span must be included in load combination 1 to cater for the action of underslung electrical overhead equipment.

D1.2 Service structures

Service structures must be designed for the nominal live loads specified in D1.1, except that in the case where access to the structure is restricted to maintenance staff only, the load intensity may be reduced to 3 kPa plus the load imposed by the service.

D2. IMPACT LOADS ON SUPPORTS ADJACENT TO RAILWAY TRACKS

D2.1 Where pedestals are required below supports in terms of 19.4 of Part I they must be designed for the nominal impact loads specified in B3.2. These loads must be taken to act at the top of the pedestals subject to a maximum height of 2 m above rail level.

D2.2 In the case of structures which cannot be readily designed to carry the impact loads specified the Chief Civil Engineer must be consulted.

E. CULVERTS UNDER RAILWAY TRACKS

E1. GENERAL

Culverts under railway tracks must be designed in accordance with the approximate methods used in TMH 7 to assess the effects of vertical earth loading.

E2. HORIZONTAL EARTH PRESSURE

Horizontal earth pressure must be applied as described in B2.2.

E3. PRIMARY LIVE LOADS

NR loading may be applied as a uniformly distributed nominal load equal to that listed in Table 3 for a span of $(b_c + H)$ where b_c is the individual effective span of the culvert in metres, measured perpendicular to its supports, and H is the height of fill in metres above the top of the culvert. The dynamic factor by which this load must be enhanced is the value given in Table 2 for a span of $(b_c + H)$ multiplied by a factor $\left(\frac{b_c}{b_c+H}\right)^2$, subject to a minimum of 1,1. The load must be applied over a width of (2 + 2H) metres measured at right angles to the track, subject to a maximum of 4 m. For precast culverts this width must be reduced to (2 + H) metres, subject to the same maximum.

E4. SECONDARY LIVE LOADS

A nominal longitudinal braking or traction force $F_L = 20\ (b_c - H)$ kN must be considered to act in association with the primary live load at the level of the top of the culvert over a width of (2 + H) metres, measured at right angles to the track, subject to a maximum of 4 m.

E5. LOAD COMBINATIONS

The vertical and horizontal loads that derive from rail traffic, including dynamic effects, must be considered in combination 1 only.

E6. DESIGN LIVE LOADS

For primary and secondary railway live loads, γ_{fL} must be as follows :

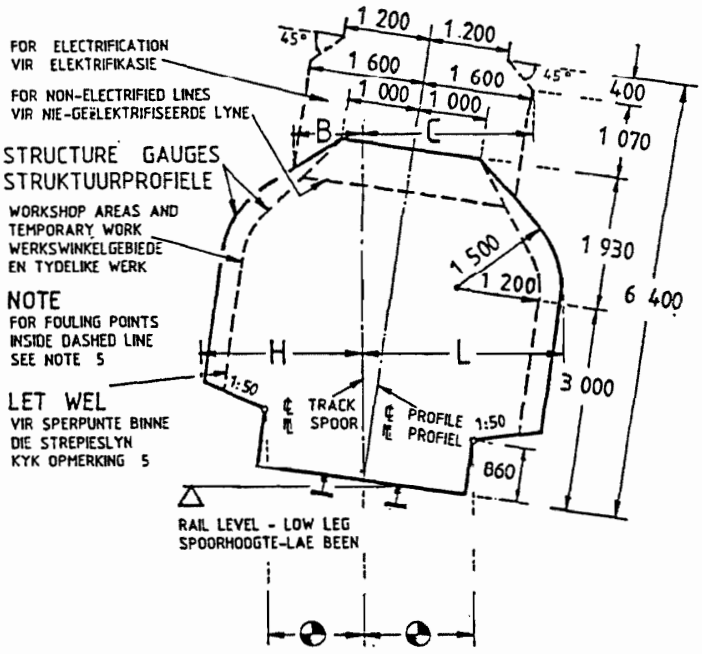
	ULTIMATE LIMIT STATE			SERVICEABILITY LIMIT STATE		
Combinations	1	2	3	1	2	3
γ_{fL}	1,5	-	-	1,0	-	-

E7. HANDRAILS

Where provided, handrails must be designed to resist a nominal load of 1.5 kN/m, acting on the top rail.

HORIZONTAL CLEARANCES
HORISONTALE VRY RUIMTES

TRACK GAUGE
SPOORWYDTE 1 065 mm



SEE PLATFORMS IN ANNEXURE 4
KYK PLATFORMS IN BYLAE 4

RADIUS m	B mm	C mm
90	1 130	2 100
300	1 250	1 900
600	1 340	1 830
1 000	1 380	1 760
2 000	1 440	1 660
3 000	1 500	1 600
5 000 AND OVER INCLUDING STRAIGHTS	1 600	1 600

STRAAL m	WITH CANT H mm	WITH CANT L mm	NO CANT H & L
90	2 730	3 090	2 780
100	2 700	3 030	2 750
120	2 650	2 970	2 700
140	2 620	2 920	2 660
170	2 590	2 870	2 630
200	2 570	2 820	2 600
250	2 550	2 790	2 580
300	2 540	2 760	2 560
350	2 530	2 730	2 540
400	2 520	2 710	2 530
500	2 510	2 680	2 520
600	2 500	2 660	2 510
800	2 490	2 620	2 500
1 000	2 480	2 600	2 490
1 200	2 480	2 580	2 490
1 500	2 480	2 550	2 480
2 000	2 480	2 500	2 480
3 000	2 470	2 470	2 470
5 000 EN OOR, REGUIT GEDEELTES INGESLUIT	2 460	2 460	2 460

1 USE OF TABLES

1.1 H IS THE REQUIRED HORIZONTAL CLEARANCE ON THE OUTSIDE OF THE CURVE BASED ON MINIMUM CANT

1.2 L IS THE REQUIRED HORIZONTAL CLEARANCE ON THE INSIDE OF THE CURVE BASED ON MAXIMUM CANT

1.3 FOR CURVE RADII NOT SHOWN IN TABLES USE CLEARANCES FOR NEXT SMALLER RADIUS EXCEPT IN THE CASE OF B WHERE NEXT LARGER RADIUS APPLIES
THE DISTRICT ENGINEER MAY INTERPOLATE WHEN NECESSARY

1.4 FOR WORKSHOP AREAS AND TEMPORARY WORK CLEARANCES H AND L MAY BE REDUCED BY 300 mm

1 GEBRUIK VAN TABELLE

1.1 H IS DIE VEREISTE HORISONTALE VRY RUIMTE AAN DIE BUITEKANT VAN DIE DRAAI GEBASEER OP MINIMUM KANTING

1.2 L IS DIE VEREISTE HORISONTALE VRY RUIMTE AAN DIE BINNEKANT VAN DIE DRAAI GEBASEER OP MAKSIMUM KANTING

1.3 VIR DRAAIE MET STRALE NIE IN TABELLE AANGETOON NIE GEBRUIK VRY RUIMTE VIR VOLGENDE KLEINER STRAAL BEHALWE IN DIE GEVAL VAN B WAAR DIE VOLGENDE GROTER STRAAL VAN TOEPASSING IS DIE DISTRIKSINGENIEUR MAG INTERPOLEER WANNEER NODIG

1.4 VIR WERKSWINKELGEBIEDE EN TYDELIKE WERK MAG VRY RUIMTES H EN L MET 300 mm VERMINDER WORD

2 APPLICATION AT CURVES

APPLY CLEARANCES FOR CURVES UP TO POINTS 3m BEYOND THE ENDS OF THE CIRCULAR CURVE.
FOR TRANSITIONED CURVES, REDUCE CLEARANCES TO THE CLEARANCES FOR STRAIGHT TRACK AT A UNIFORM RATE OVER THE REMAINDER OF THE TRANSITION CURVE.

FOR NON - TRANSITIONED CURVES, REDUCE CLEARANCES TO THE CLEARANCES FOR STRAIGHT TRACK AT A UNIFORM RATE OVER A FURTHER 15m.

2 TOEPASSING BY DRAAIE

PAS VRYRUIMTES TOE VIR DRAAIE TOT 3m VERBY DIE ENTE VAN DIE SIRKELVORMIGE DRAAI.
BY OORGANGSDRAAIE, VERMINDER DIE VRYRUIMTES EWEREDIG TOT DIÉ VIR REGUIT SPOORLYNE OOR DIE RES VAN DIE OORGANGSDRAAI

BY DRAAIE SONDER OORGANGSDRAAIE, VERMINDER DIE VRYRUIMTES EWEREDIG TOT DIÉ VIR REGUIT SPOORLYNE OOR 'N VERDERE 15m.

3 NEW STRUCTURES

SEE BRIDGE CODE

3 NUWE STRUKTURE

KYK BRUGKODE

4 TUNNELS

SEE DRAWING BE 82-35

4 TONNELS

KYK TEKENING BE 82-35

5 FOULING POINTS

SEE CLAUSE 9015 OF PERMANENT WAY INSTRUCTIONS

ALLOWANCE FOR CURVATURE IS BASED ON 15 000 mm BOGIE CENTRES AND 21 200 mm VEHICLE BODY LENGTH

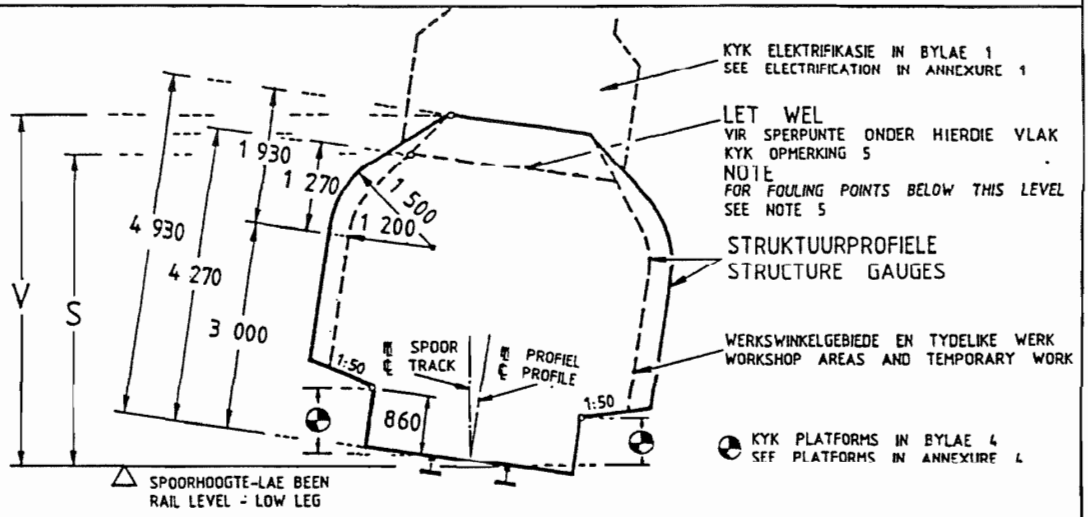
5 SPERPUNTE

KYK KLOUSULE 9015 VAN SPOORBAANINSTRUKSIES

TOELATING VIR KROMMING IS GEBASEER OP 'N DRAAISTELHARTAFSTAND VAN 15 000 mm EN 'N VOERTUIGBAKLENGTE VAN 21 200 mm

VERTIKALE VRY RUIMTES
VERTICAL CLEARANCES

SPOORWYDTE
TRACK GAUGE 1 065 mm



LIGGING		NIE GEËLETRIFISEER NIE (KYK OPMERKING 1.2) NOT ELECTRIFIED (SEE NOTE 1.2)	GEËLEKTRIFISEER (HUIDIG OF TOEKOMSTIG) ELECTRIFIED (PRESENT OR FUTURE) 3 kV & 25 kV	50 kV (SISHEN-SALDANHA)	LOCATION	
	STRAAL m	S mm	V mm	V mm	RADIUS m	
ALLE GEBIEDE BEHALWE HIERONDER DEUR * AANGEDUI	100	4 470	5 050	5 400	100	ALL AREAS OTHER THAN THOSE INDICATED BY * BELOW
	300	4 410	5 020	5 370	300	
	600	4 370	5 000	5 350	600	
	1 000	4 350	4 990	5 340	1 000	
	1 500	4 310	4 960	5 310	1 500	
	2 000	4 290	4 940	5 290	2 000	
	3 000	4 270	4 930	5 280	3 000	
	5 000 EN OOR, REGUIT GEDEETES INGESLUIT	4 270	4 930	5 280	5 000 AND OVER INCLUDING STRAIGHTS	
* OOR OF NABY WISSELS EN KRUISINGS INDIEN DEUR DIE ELEKTRIESE HOOFINGENIEUR VERLANG, ONGEAG STRAAL		—	5 650	6 000	* OVER OR NEAR POINTS AND CROSSINGS IF REQUIRED BY THE CHIEF ELECTRICAL ENGINEER IRRESPECTIVE OF RADIUS	

1 GEBRUIK VAN TABEL

1.1 V IS DIE VEREISTE VERTIKALE VRY RUIMTE BEHALWE WAAR VERMINDERDE VRY RUIMTE S VAN TOEPASSING IS

1.2 S IS DIE MINIMUM VERTIKALE VRY RUIMTE VIR:
- (i) TYDELIKE WERK OOR NIE-GEËLEKTRIFISEERDE LYNE
- (ii) STRUKTURE OOR NIE-GEËLEKTRIFISEERDE LYNE

1.3 VIR DRAAIE MET STRALE NIE IN TABEL AANGETOON NIE GEBRUIK VRY RUIMTE VIR VOLGENDE KLEINER STRAAL DIE DISTRIKSINGENIEUR MAG INTERPOLEER WANNEER NODIG

2 TOEPASSING BY DRAAIE

PAS VRYRUIMTES TOE VIR DRAAIE TOT 3m VERBY DIE ENTE VAN DIE SIRKELVORMIGE DRAAL
BY OORGANGSDRAAIE, VERMINDER DIE VRYRUIMTES EWEREDIG TOT DIÉ VIR REGUIT SPOORLYNE OOR DIE RES VAN DIE OORGANGSDRAAI

BY DRAAIE SONDER OORGANGSDRAAIE, VERMINDER DIE VRYRUIMTES EWEREDIG TOT DIÉ VIR REGUIT SPOORLYNE OOR 'N VERDERE 15m.

3 NUWE STRUKTURE

KYK BRUGKODE

4 TONNELS

KYK TEKENING BE 82-35

5 SPERPUNTE

KYK KLOUSULE 901.5 VAN SPOORBAANINSTRUKSIES

1 USE OF TABLE

1.1 V IS THE REQUIRED VERTICAL CLEARANCE EXCEPT WHERE REDUCED CLEARANCE S APPLIES

1.2 S IS THE MINIMUM VERTICAL CLEARANCE FOR:
- (i) TEMPORARY WORK OVER NON-ELECTRIFIED LINES
- (ii) STRUCTURES OVER NON-ELECTRIFIED LINES

1.3 FOR CURVE RADII NOT SHOWN IN TABLE USE CLEARANCE FOR NEXT SMALLER RADIUS
THE DISTRICT ENGINEER MAY INTERPOLATE WHEN NECESSARY

2 APPLICATION AT CURVES

APPLY CLEARANCES FOR CURVES UP TO POINTS 3m BEYOND THE ENDS OF THE CIRCULAR CURVE.
FOR TRANSITIONED CURVES, REDUCE CLEARANCES TO THE CLEARANCES FOR STRAIGHT TRACK AT A UNIFORM RATE OVER THE REMAINDER OF THE TRANSITION CURVE.

FOR NON - TRANSITIONED CURVES, REDUCE CLEARANCES TO THE CLEARANCES FOR STRAIGHT TRACK AT A UNIFORM RATE OVER A FURTHER 15m.

3 NEW STRUCTURES

SEE BRIDGE CODE

4 TUNNELS

SEE DRAWING BE 82-35

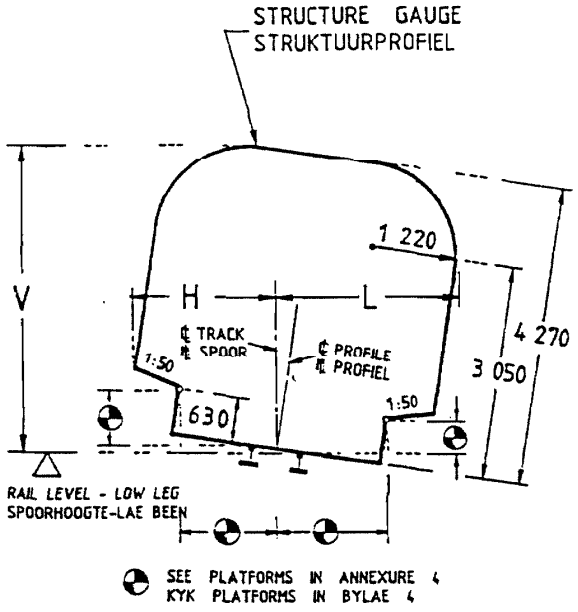
5 FOULING POINTS

SEE CLAUSE 901.5 OF PERMANENT WAY INSTRUCTIONS

BE 82-12 | ISSUED/UITGEREIK 19/11/17

CLEARANCES
VRY RUIMTES

TRACK GAUGE
SPOORWYDTE 610 mm



SEE PLATFORMS IN ANNEXURE 4
KYK PLATFORMS IN BYLAE 4

RADIUS m	WITH CANT H mm	WITH CANT L mm	NO CANT H & L mm	V mm
50	2 370	2 490	2 400	4 320
70	2 310	2 420	2 330	4 310
100	2 260	2 370	2 280	4 310
140	2 220	2 340	2 250	4 310
200	2 200	2 300	2 220	4 300
300	2 190	2 270	2 200	4 300
500	2 180	2 230	2 190	4 290
700	2 170	2 200	2 180	4 270
1 000	2 170	2 170	2 170	4 270
2 000 AND OVER INCLUDING STRAIGHTS	2 160	2 160	2 160	4 270

1 USE OF TABLE

1.1 H IS THE MINIMUM HORIZONTAL CLEARANCE ON THE OUTSIDE OF THE CURVE BASED ON MINIMUM CANT

1.2 L IS THE MINIMUM HORIZONTAL CLEARANCE ON THE INSIDE OF THE CURVE BASED ON MAXIMUM CANT

1.3 V IS THE MINIMUM VERTICAL CLEARANCE

1.4 FOR CURVE RADII NOT SHOWN IN TABLES USE CLEARANCE FOR NEXT SMALLER RADIUS
THE DISTRICT ENGINEER MAY INTERPOLATE WHEN NECESSARY

1 GEBRUIK VAN TABEL

1.1 H IS DIE MINIMUM HORISONTALE VRY RUIMTE AAN DIE BUITEKANT VAN DIE DRAAI GEBASEER OP MINIMUM KANTING

1.2 L IS DIE MINIMUM HORISONTALE VRY RUIMTE AAN DIE BINNEKANT VAN DIE DRAAI GEBASEER OP MAKSIMUM KANTING

1.3 V IS DIE MINIMUM VERTIKALE VRY RUIMTE

1.4 VIR DRAAIE MET STRALE NIE IN TABELLE AANGETOON NIE GEBRUIK VRY RUIMTE VIR VOLGENDE KLEINER STRAAL
DIE DISTRIKSINGENIEUR MAG INTERPOLEER WANNEER NODIG

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BY OORGANGSDRAAIE, VERMINDER DIE VRYRUIMTES EWEREDIG TOT DIÉ VIR REGUIT SPOORLYNE OOR DIE RES VAN DIE OORGANGSDRAAL

BY DRAAIE SONDER OORGANGSDRAAIE, VERMINDER DIE VRYRUIMTES EWEREDIG TOT DIÉ VIR REGUIT SPOORLYNE OOR 'N VERDERE 15m.

3 NEW STRUCTURES

SEE BRIDGE CODE

3 NUWE STRUKTURE

KYK BRUGKODE

4 TUNNELS

SEE DRAWING BE 82-35

4 TONNELS

KYK TEKENING BE 82-35

5 FOULING POINTS

SEE CLAUSE 9015 OF PERMANENT WAY INSTRUCTIONS

5 SPERPUNTE

KYK KLOUSULE 9015 VAN SPOORBAANINSTRUKSIES

ALLOWANCE FOR CURVATURE IS BASED ON 9 700 mm BOGIE CENTRES AND 13 700 mm VEHICLE BODY LENGTH

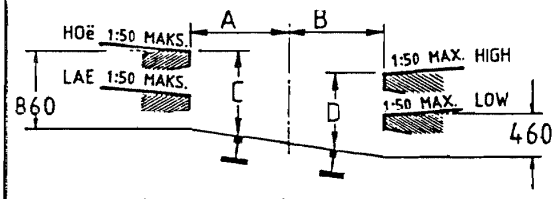
TOELATING VIR KROMMING IS GEBASEER OP 'N DRAAISTELMARTAFSTAND VAN 9 700 mm EN 'N VOERTUIGBAKLENGTE VAN 13 700 mm

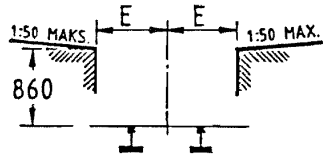
BE 82-13 | FILE/LÊER 19/11/62/3 | AMEND./WYG.

PLATFORMS

VRY RUIMTES
CLEARANCES

1 SPOORWYDTE TRACK GAUGE 1 065 mm





RADIUS	PASSASIERS / PASSENGERS A	B	E	D	GOEDERE / GOODS E
90	1 690	1 820	890	810	1 840
100	1 650	1 790	890	810	1 810
120	1 610	1 740	890	810	1 760
140	1 580	1 700	890	810	1 720
170	1 550	1 660	890	810	1 690
200	1 530	1 630	890	820	1 670
250	1 520	1 600	890	820	1 640
300	1 520	1 580	890	830	1 620
350	1 520	1 560	880	830	1 600
400	1 520	1 550	880	840	1 590
500	1 520	1 540	880	850	1 580
600	1 520	1 530	870	850	1 570
800	1 520	1 520	860	860	1 560
1 200	1 520	1 520	860	860	1 550
2 000	1 520	1 520	860	860	1 540
3 000	1 520	1 520	860	860	1 530
REGUIT	1 520	1 520	860	860	1 520

KANTING

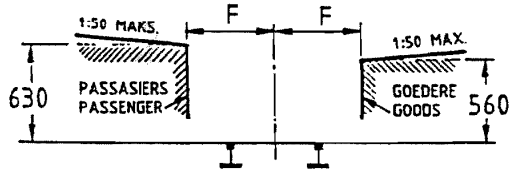
GEEN KANTING WORD VOORSIEN NIE BEHALWE WANNEER DIE GOEDERE PLATFORM LANGS 'N LOOPLYN IS

CANT

NO CANT TO BE APPLIED EXCEPT WHEN THE GOODS PLATFORM IS ON A RUNNING LINE

2 SPOORWYDTE TRACK GAUGE 610 mm

ALLE PLATFORMS
ALL PLATFORMS



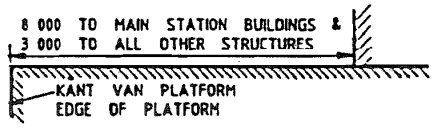
(GEEN KANTING / NO CANT)

RADIUS	F
50	1 550
60	1 510
80	1 460
100	1 430
120	1 410
140	1 390
170	1 380

RADIUS	F
200	1 370
250	1 360
300	1 350
600	1 330
1 000	1 320
2 000	1 320
REGUIT	1 310

3 STRUKTURE OP PLATFORMS STRUCTURES ON PLATFORMS

1 065 EN AND 610 SPOORWYDTE TRACK GAUGE



VIR DRAAIE MET STRALE NIE IN TABELLE AANGETOON NIE GEBRUIK VRY RUIMTE VIR VOLGENDE KLEINER STRAAL BEHALWE IN DIE GEVAL VAN C WAAR DIE VOLGENDE GROTER STRAAL VAN TOEPASSING IS
DIE DISTRIKSINGENIEUR MAG INTERPOLEER WANNEER NODIG

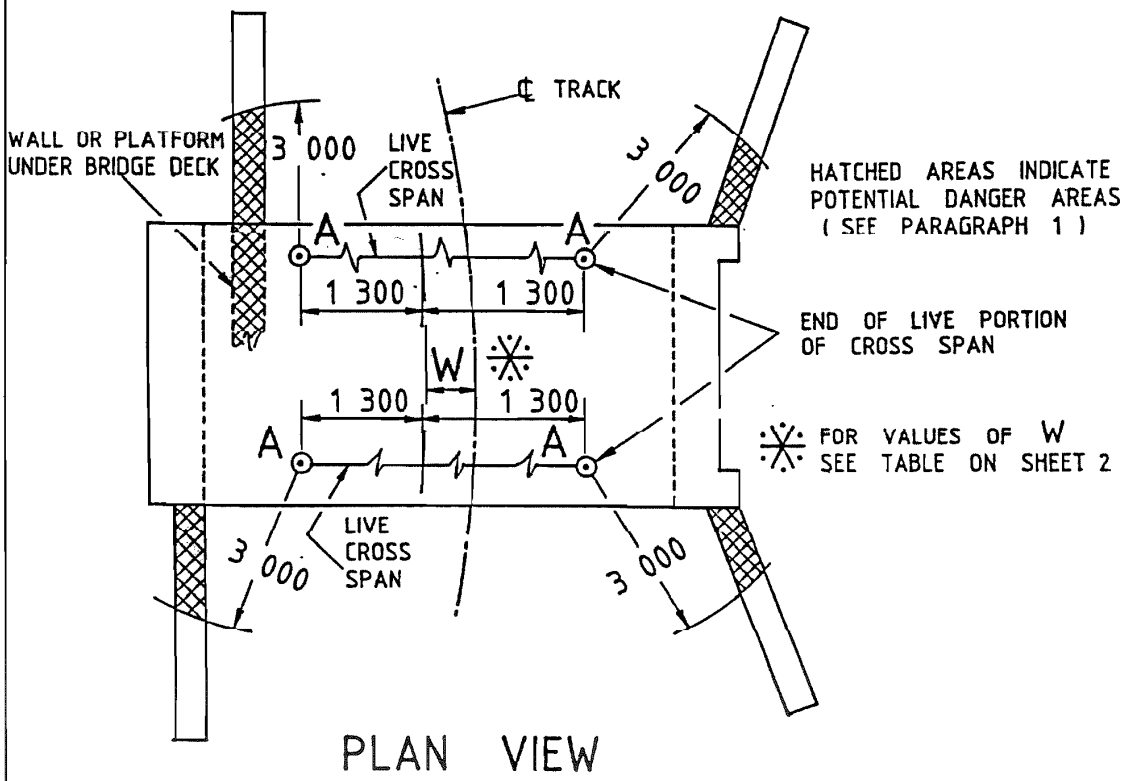
FOR CURVE RADII NOT SHOWN IN TABLES USE CLEARANCE FOR NEXT SMALLER RADIUS EXCEPT IN THE CASE OF C WHEN NEXT LARGER RADIUS APPLIES
THE DISTRICT ENGINEER MAY INTERPOLATE WHEN NECESSARY

CLEARANCES REQUIRED FOR COMPLIANCE WITH HIGH VOLTAGE REGULATIONS

3 kV FIXED OR SPRING TENSIONING

1. The top of any wall or platform at a bridge crossing 3 kV fixed or spring tensioned electrified track must be clear of the clearance lines in diagram 1 on sheet 2 if the following 3 conditions apply simultaneously:
   (i) Live cross spans are provided under the bridge deck.
   (ii) The top of the wall or platform is less than 3 000 mm from the points marked "A" in the plan view below, measured horizontally.
   (iii) The top of the wall or platform is more than 300 mm below the plane containing the deck soffit but not less than 900 mm above adjacent rail level.

2. If one or more of these 3 conditions do not apply, the top of the wall or platform must be clear of the clearance line in diagram 2. This requirement applies also to walls and platforms not in the vicinity of bridges.



PLAN VIEW

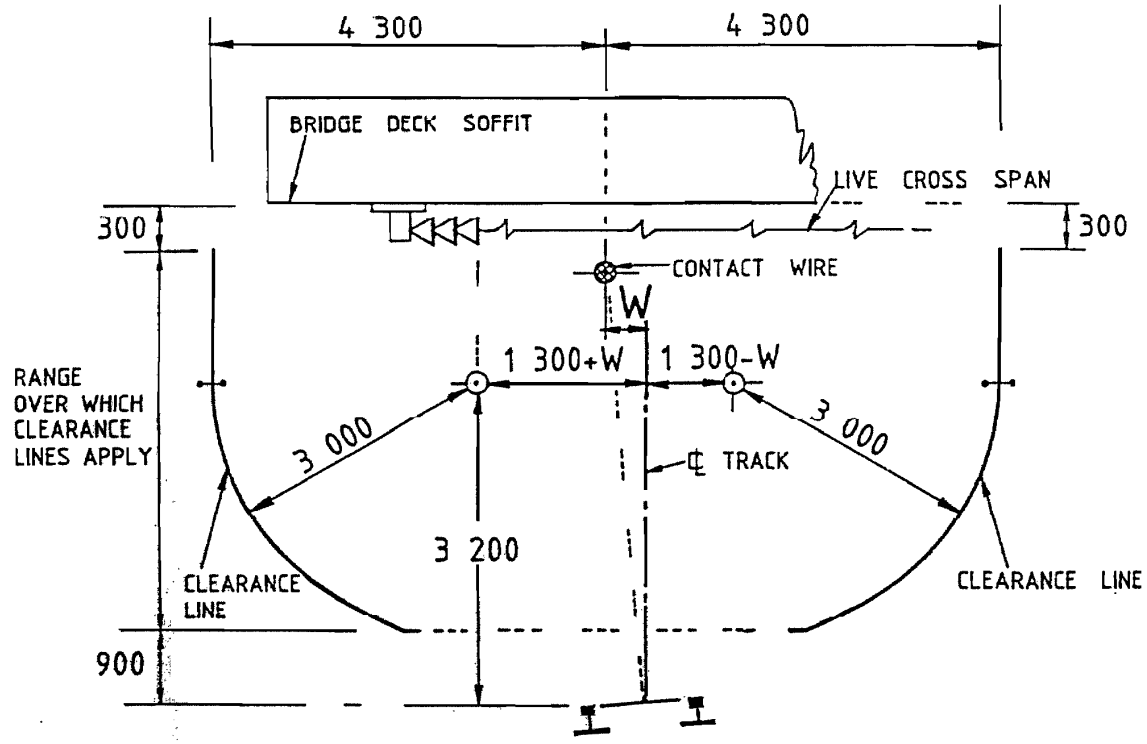


DIAGRAM 1

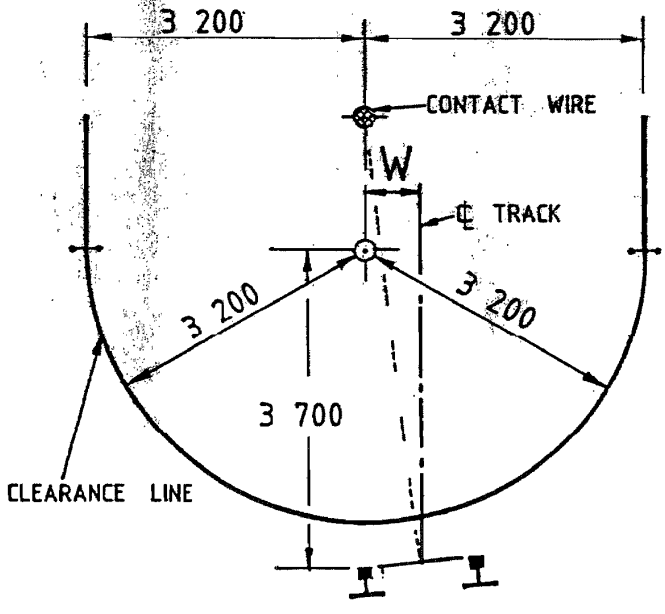
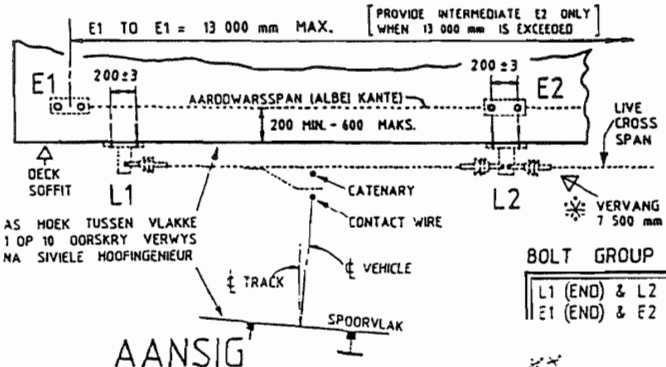
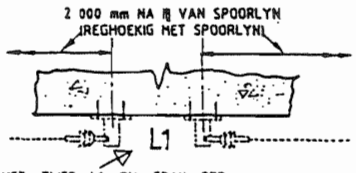


DIAGRAM 2

TRACK RAD m	W mm
140	460
200	420
300	370
400	340
600	280
800	240
1 200	160
2 000	110
3 000	60
> 5 000	NIL

SECTIONS IN DIAGRAMS 1 & 2 ARE AT RIGHT ANGLES TO TRACK

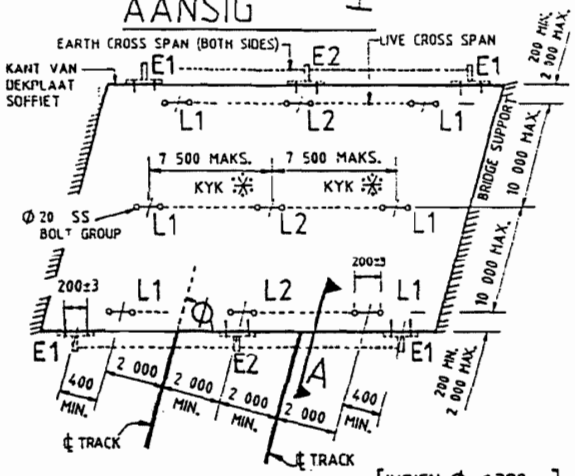




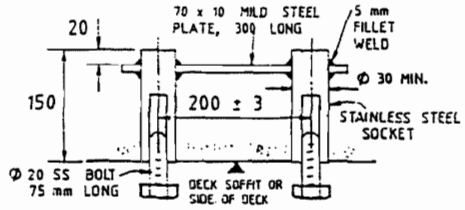
AANSIG

BOLT GROUP DESIGNATIONS

L1 (END) & L2 (INTERMEDIATE) = LIVE WIRE BOLT GROUPS
E1 (END) & E2 (INTERMEDIATE) = EARTH WIRE BOLT GROUPS



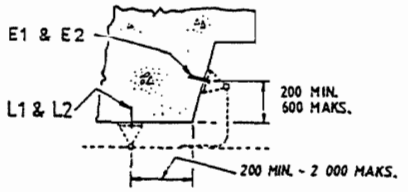
PLAN VAN DEK [INDIEN Ø < 32° VERWYS NA S.H.I.]



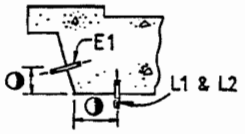
NOTE:- STAINLESS STEEL TO BS 970 GRADE 304 S 15 OR AISI 304

FIXING BOLTS FOR BRACKETS

[BRACKETS SUPPLIED & FIXED BY S.A. TRANSPORT SERVICES]



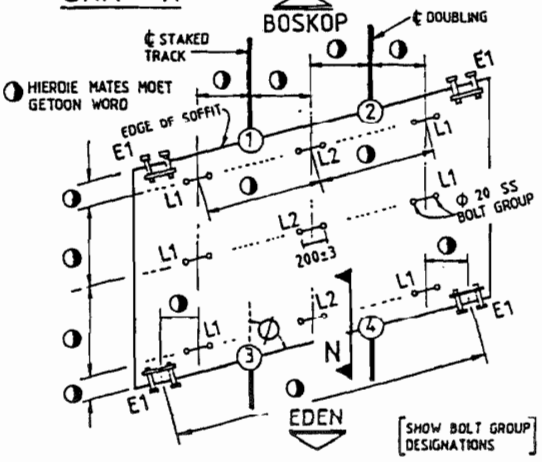
SNIT A



SNIT N

VERTIKALE VRYRUIMTE

POSISIE	SOFFIET HOOGTE	SPOOR HOOGTE	VERTIKALE VRYRUIMTE
1			
2			
ENS			



[SHOW BOLT GROUP DESIGNATIONS]

SLEUTELPLAN WAT BOUTGROEPE VIR ELEKTRIFIKASIESTEUNE TOON

TIPIESE VEREISTES VIR ALGEMENE RANGSKIKKINGSPLANNE [APARTE KLEIN SKAAL TEKENING]

DRAWN | CHECKED

NOTES

1 THE FOLLOWING CASES MUST BE REFERRED TO THE CHIEF CIVIL ENGINEER:-
(a) VERTICAL CLEARANCE EXCEEDING 5,6 m AT ANY POINT BELOW DECK.
(b) POINTS AND CROSSINGS OR CROSS-OVERS LOCATED UNDER OR ADJACENT TO BRIDGE.

2 IN THE CASE OF MULTIPLE SPAN BRIDGES, THE EARTH CROSS SPAN MAY BE CONTINUOUS OVER THE FULL LENGTH OF THE BRIDGE I.E. ONLY 2 END-BRACKETS E1 ARE REQUIRED WITH INTERMEDIATE E2 BRACKETS AT DISTANCES NOT EXCEEDING 13 m.

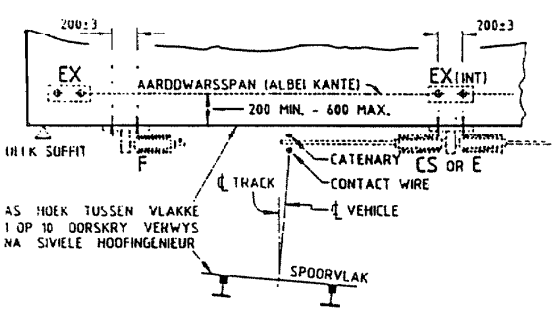
S.A. TRANSPORT SERVICES • JOHANNESBURG • S.A. VERVOERDIENSTE

FIXED & SPRING TENSION 3 kV VASTE & VEERSPANNING

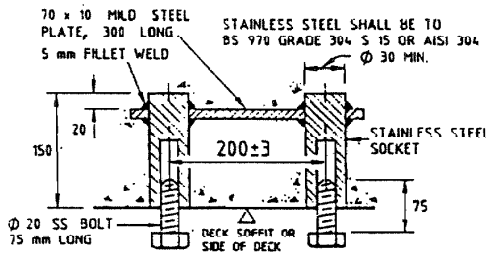
ATTACHMENT OF OVERHEAD TRACK EQUIPMENT TO BRIDGES

VASMAAK VAN BOBAANTOERUSTING AAN BRÛE

SEN. DESIGN ENG. (BRIDGES)	CHIEF CIVIL ENG.	SECTION 507	PLAN NO. BE 82-02
	DATE 1982-06-21	FILE 19/11/3/5	AMENDMENT

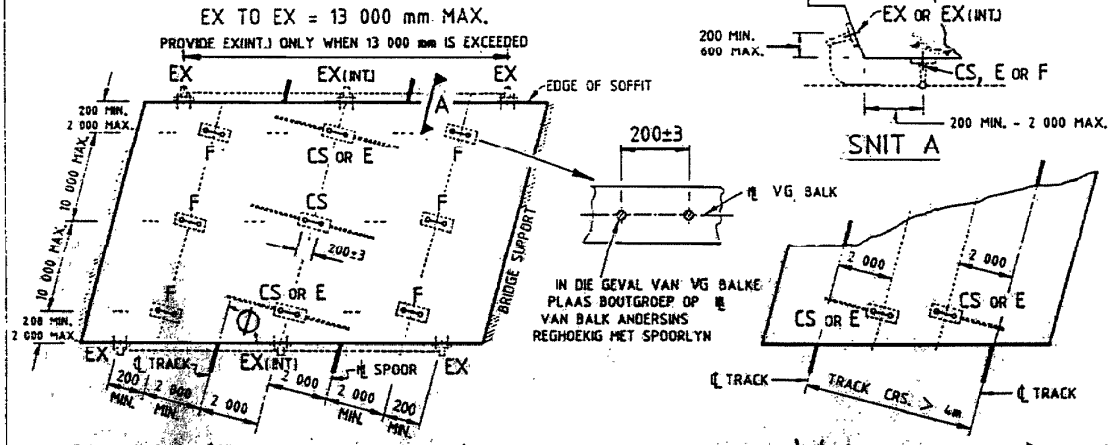


AANSIG



FIXING BOLTS FOR BRACKETS

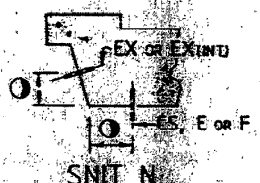
(BRACKETS SUPPLIED & FIXED BY S.A. TRANSPORT SERVICES)



PLAN 'A' (TRACK CRS. = 4m)

PLAN 'B' (TRACK CRS. > 4m)

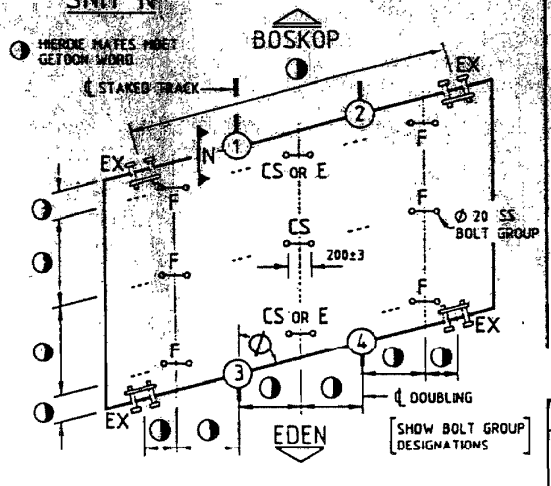
(FURTHER DETAILS AS FOR PLAN 'A')



SNIT N

VERTIKALE VRYRUIMTE

POSISIE	SOFFIET HOOGTE	SPOOR HOOGTE	VERTIKALE VRYRUIMTE
1			
2			
ENS			



SLEUTELPLAN WAT BOUTGROEPE VIR ELEKTRIFIKASIESTEUNE TOON

BOLT GROUP DESIGNATIONS

CS = CATENARY SYSTEM BOLT GROUP
E = EARTH BRACKET BOLT GROUP
F = FEEDER CONDUCTOR BOLT GROUP
EX & EX(INT) = EARTH CROSS SPAN BOLT GROUP

NOTES

1 THE FOLLOWING CASES MUST BE REFERRED TO THE CHIEF CIVIL ENGINEER:-
(a) VERTICAL CLEARANCE EXCEEDING 5,6 m AT ANY POINT BELOW DECK.
(b) POINTS AND CROSSINGS OR CROSS-OVERS LOCATED UNDER OR ADJACENT TO BRIDGE.
(c) SINGLE TRACK UNDERPASSES.

2 IN THE CASE OF MULTIPLE SPAN BRIDGES, THE EARTH CROSS SPAN MAY BE CONTINUOUS OVER THE FULL LENGTH OF THE BRIDGE I.E. ONLY 2 END-BRACKETS EX ARE REQUIRED WITH EX(INT) BRACKETS AT DISTANCES NOT EXCEEDING 13 m.

TIPIESE VEREISTES VIR ALGEMENE RANGSKIKKINGSPLANNE

[APARTE KLEIN SKAAL TEKENING]

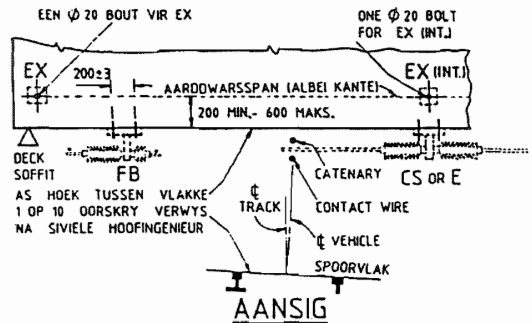
S.A. TRANSPORT SERVICES JOHANNESBURG S.A. VERVOERDIENSTE

AUTO TENSION 3kV OUTO SPANNING

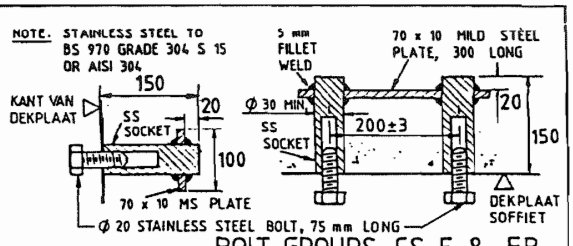
ATTACHMENT OF OVERHEAD TRACK EQUIPMENT TO BRIDGES

VASMAAK VAN BOBAANTOERUSTING AAN BRUE

DRAWN	CHECKED	SEN. DESIGN ENG. (BRIDGES)	CHIEF CIVIL ENG. DATE	SECTION 507	PLAN NO. BE 82-03
				FILE 19/11/3/5	AMENDMENT



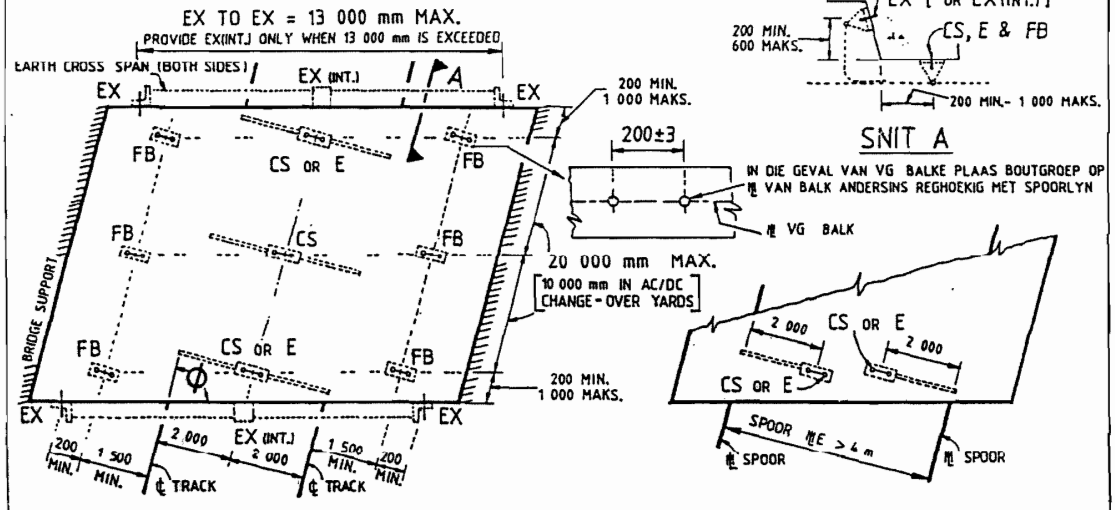
AANSIG



BOLT EX

BOLT GROUPS CS, E & FB

[BRACKETS SUPPLIED & FIXED BY S.A. TRANSPORT SERVICES]

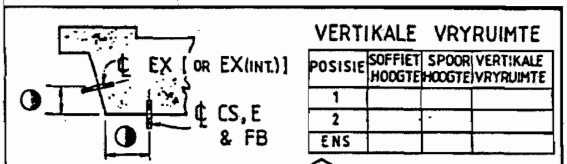


SNIT A

PLAN 'A' (TRACK CRS. = 4 m)

PLAN 'B' (TRACK CRS. > 4 m)

(FURTHER DETAILS AS FOR PLAN 'A')



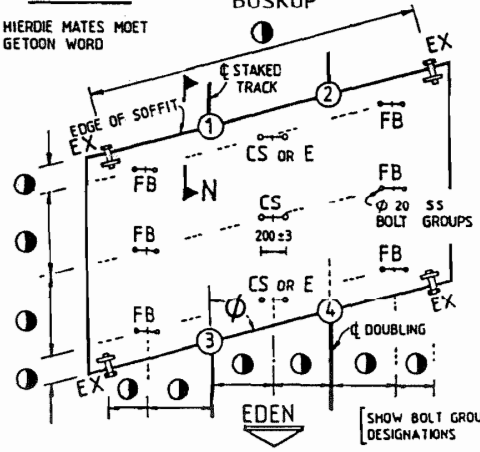
SNIT N

VERTIKALE VRYRUIMTE

POSISIE	SOFFIET HOOGTE	SPOOR HOOGTE	VERTIKALE VRYRUIMTE
1			
2			
ENS			

◑ HIERDIE MATES MOET GETOON WORD

BOSKOP



SLEUTELPLAN WAT BOUTGROEPE VIR ELEKTRIFIKASIESTEUNE TOON

TIPIESE VEREISTES VIR ALGEMENE RANGSKIKKINGSPLANNE

[APARTE KLEIN SKAAL TEKENING]

DRAWN ____ CHECKED ____

BOLT GROUP DESIGNATIONS

CS = CATENARY SYSTEM BOLT GROUP
E = EARTH BRACKET BOLT GROUP
FB = FEEDER & BOOSTER CONDUCTOR BOLT GROUPS
EX & EX (INT.) = EARTH CROSS SPAN BOLT GROUP

NOTES

1 THE FOLLOWING CASES MUST BE REFERRED TO THE CHIEF CIVIL ENGINEER:-
- (a) VERTICAL CLEARANCE EXCEEDING 5,6 m AT ANY POINT BELOW DECK.
- (b) POINTS AND CROSSINGS OR CROSS-OVERS LOCATED UNDER OR ADJACENT TO BRIDGE.
- (c) SINGLE TRACK UNDERPASSES.

2 IN THE CASE OF MULTIPLE SPAN BRIDGES, THE EARTH CROSS SPAN MAY BE CONTINUOUS OVER THE FULL LENGTH OF THE BRIDGE I.E. ONLY 2 END-BRACKETS EX ARE REQUIRED WITH EX(INT) BRACKETS AT DISTANCES NOT EXCEEDING 13 m.

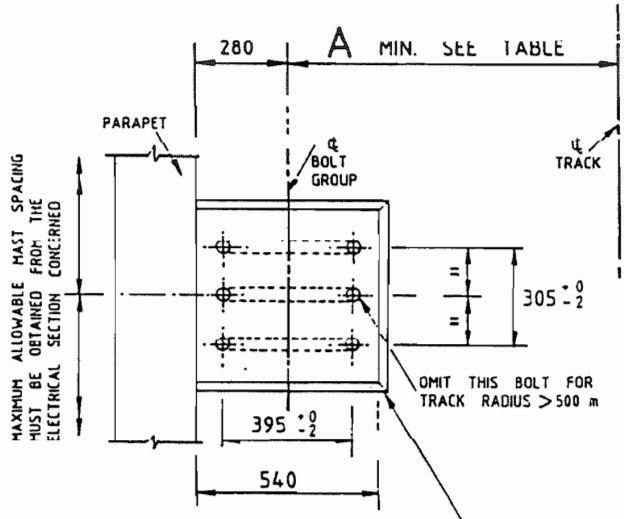
S.A. TRANSPORT SERVICES • JOHANNESBURG • S.A. VERVOERDIENSTE

AUTO TENSION 25 kV OUTO SPANNING

ATTACHMENT OF OVERHEAD TRACK EQUIPMENT TO BRIDGES

VASMAAK VAN BOBAANTOERUSTING AAN BRÛE

SEN. DESIGN ENG. (BRIDGES)	CHIEF CIVIL ENG. DATE	SECTION 507	PLAN NO. BE 82-04
		FILE 19/11/3/5	AMENDMENT

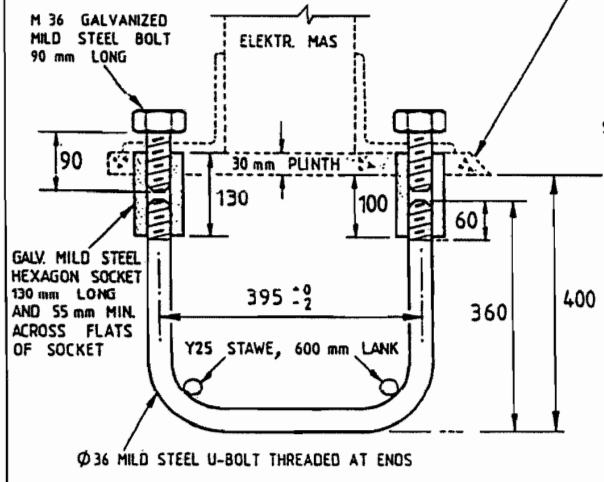


TRACK RADIUS (m)	A (mm) MIN.	
	INSIDE OF CURVE	OUTSIDE OF CURVE
200	2 930	2 720
300	2 870	
400	2 840	
500	2 810	
600	2 780	
700	2 750	
800 AND OVER, INCLUDING STRAIGHTS	2 720	

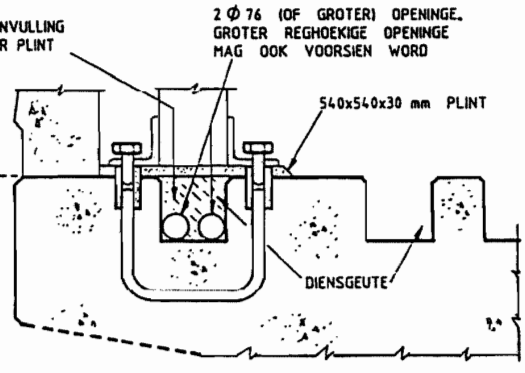
PLAN VIEW ON BOLT GROUP

540 x 540 x 30 mm PLINTH

(i) 1:2 CEMENT / SAND MIX
(ii) TOPS OF SOCKETS MUST LIE IN A PERFECTLY HORIZONTAL PLANE AFTER DECK CONCRETING HAS BEEN COMPLETED
(iii) PLINTH MUST BE CAST FLUSH WITH SOCKETS & SCREEDED LEVEL



BOUT DETAIL



BOUTGROEP BY OOP DIENSGEUTE

NOTE: GALVANIZING OF BOLTS AND SOCKETS TO SABS 763

S.A. TRANSPORT SERVICES • JOHANNESBURG • S.A. VERVOERDIENSTE

HOLDING DOWN BOLTS FOR ELECTR. MASTS ON BRIDGE DECKS

ANKERBOUTE VIR ELEKTR. MASTE OP BRUGDEKKE

SEN: DESIGN ENG. (BRIDGES)	CHIEF CIVIL ENG. DATE 1981-05-27	SECTION 507 FILE 19/11/3/5	PLAN NO. BE 82-05 AMENDMENT

DRAWN | CHECKED

SURVEY DATA REQUIRED FOR PREPARATION OF SITE PLAN

Angle of intersection between road and rail centre lines.

Rail kilometrage of point of intersection.

Rail kilometrage of existing level crossings.

Rail levels (low leg on curves).

Radii of road and rail curves.

Rail kilometre and grade posts.

Kilometre distance along road and rail.

Turnouts (Give distance along track if unable to show positions).

Signals (" " " " " " " " ").

Signal wire runs.

Electrification masts.

Telephone and telegraph routes.

Power routes.

Cables (signal, power and communication).

Water mains.

Other services such as sewer, stormwater and gas.

Manholes.

Spot levels.

Road levels.

Cuttings and banks (road and rail).

Fences and land beacons.

Servitudes.

Culverts.

Natural drainage and drainage improvements.

Structures affected by planning.

Access to adjoining properties.

Position of foundation test holes with reduced ground levels.

North point.

Any special features.