IS 7784-2-1 (1995): Design of cross drainage works -Code of practice, Part 2: Specific requirements Section I Aqueducts [WRD 13: Canals and Cross Drainage Works]

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IS 7784 (Part 2/Sec 1) : 1995

(Reaffirmed 2001)

भारतीय मानक

आर-पार जल निकास कार्यों के डिजाइन — रीति संहिता

भाग 2 विशिष्ट अपेक्षाएँ

अनुभाग 1 जलवाही सेतु

(पहला पुनरीक्षण)

Indian Standard

DESIGN OF CROSS DRAINAGE WORKS — CODE OF PRACTICE

PART 2 SPECIFIC REQUIREMENTS

Section 1 Aqueducts

(First Revision)

UDC 626·823·82 : 624·04 : 006·76

BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

April 1995

Price Group 2

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Cross Drainage Works Sectional Committee had been approved by the River Valley Division Council.

An aqueduct is a cross drainage work in which the carrier channel is carried over the drainage channel and the bottom of the trough or the covering over the drainage openings is above the high flood level in the drainage channel.

This standard is published in two parts. Part 1 of this standard covers general requirements of the design of cross drainage works and Part 2 covers specific requirements of various cross drainage works in the following sections:

Section 1	Aqueducts
Section 2	Superpassages
Section 3	Canal syphons
Section 4	Level crossings
Section 5	Syphon aqueducts

This standard (Part 2/Sec 1) covers specific design requirements of aqueducts.

This standard was first published in 1983. This revision is based on improvements made as a result of experience gained in the use of this standard and in view of the extensive revision of Part 1 of this standard. Suggestions for revision of this standard were received from Central Water Commission and Irrigation Department, Government of Uttar Pradesh. Modifications have been made in this revision so as to align it with Part 1 of the standard. The major modifications made relate to the following aspects:

a) Hydraulic data required for design of carrier channel and drainage channel have been modified,

b) Guidance has been given for splay to be provided in wing walls for drainage,

c) Hydraulic design aspects including fluming have been related to Part 1 of the standard and hence deleted from this revision, and

d) Construction considerations have been laid down for design combinations.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

DESIGN OF CROSS DRAINAGE WORKS — CODE OF PRACTICE

PART 2 SPECIFIC REQUIREMENTS

Section 1 Aqueducts

(First Revision)

1 SCOPE

1.1 This standard (Part 2/ Sec 1) deals with the specific requirements for design of aqueducts.

2 REFERENCES

2.1 The Indian Standards listed below are necessary adjuncts to this standard;

IS No.	*Title*
IS 4410 (Part 15/Sec 5): 1992	Glossary of terms relating to river valley projects: Part 15 Canal structures, Section 5 Cross drainage works
IS 7784 (Part 1) : 1993	Code of practice for design of cross drainage works: Part 1 General features (*first revision*)

3 TERMINOLOGY

3.1 For the purpose of this standard, the definitions given in IS 4410 (Part 15/Sec 5) : 1992 shall apply.

3.2 Wherever the term canal is used, it should be taken to mean 'canal/carrier channel'.

4 TYPES OF AQUEDUCTS

4.1 Depending on the arrangement of canal passing over the drainage, an aqueduct may be classified into the three categories as given below. A typical lay out is shown in Fig. 1.

Type 1 — In this type the canal continues over the drainage channel in its normal earthern section including the banks and earthen slopes. In this case, the length of the culverts through which the drainage water is passed under the canal should be sufficient not only to carry the water section, but

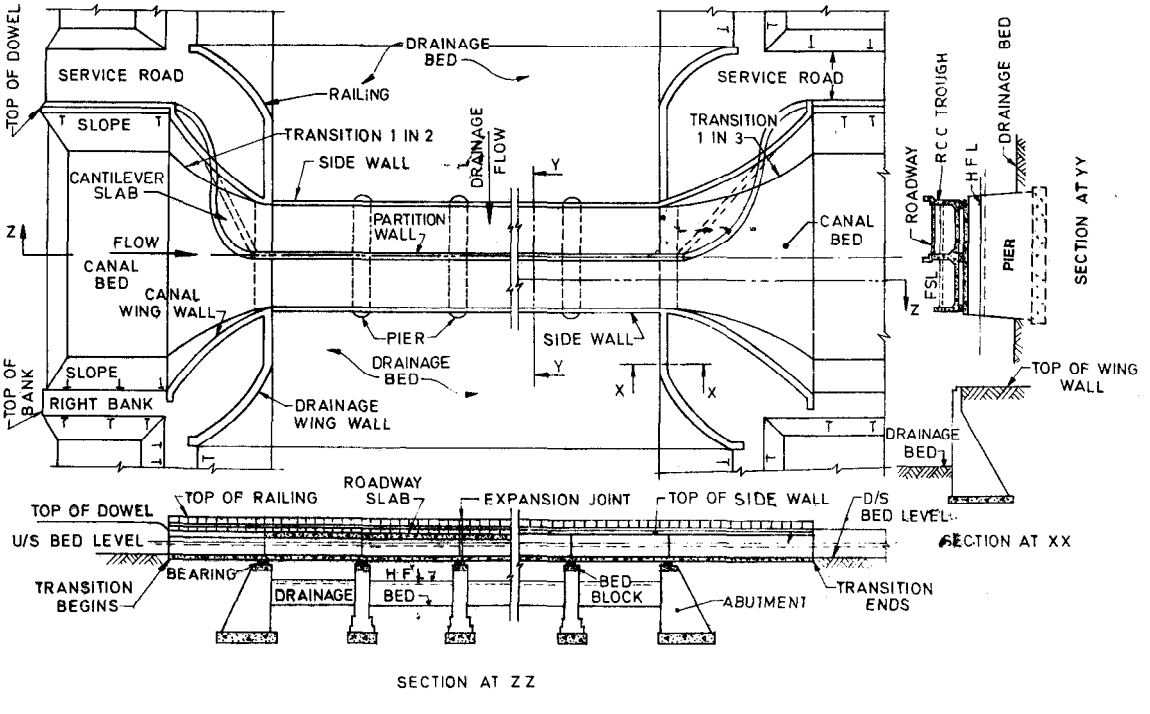


FIG. 1 TYPICAL PLAN AND SECTION OF AQUEDUCT

also to carry the earthen banks of the canal with their slopes (Fig. 2A).

Type 2 – In this type also the canal continues in its earthen section over the drainage channel, but the outer slopes of banks are replaced by retaining walls, thereby reducing the length of drainage culvert to that extent (Fig. 2B).

Type 3 – In this type the earthen banks are discontinued over the drainage channel and the canal water is carried in masonry or concrete trough, box, barrel, pipe or any other suitable section. The sides of the trough are connected on either side of the work to the earthen banks of the canal by means of transition walls. Generally the canal is flumed to effect economy (Fig. 1).

4.2 The choice of the type of aqueduct should depend on consideration of economy which in turn would depend mainly upon the size of the drainage to be passed in relation to the size of the canal and the foundation strata.

4.2.1 Over a small drainage channel, an aqueduct of Type 1 may be suitable as no canal transitions would be required. The savings made due to absence of canal transitions would more than compensate the increased cost due to the length of drainage culverts which would have larger length (across the canal).

4.2.2 Over a large river an aqueduct of Type 3 may be more economical as the length of drainage culverts across the canal is small and the saving made in cost of drainage culverts would be greater than the increased cost of canal transitions.

4.2.3 For intermediate conditions an aqueduct of Type 2 may work out to be more economical. However, techno-economic studies should be carried out to decide the exact type of aqueduct to be constructed.

5 DATA FOR DESIGN

5.1 For working out the design of an aqueduct, the following specific design data should be available in addition to those laid down in IS 7784 (Part 1) : 1993.

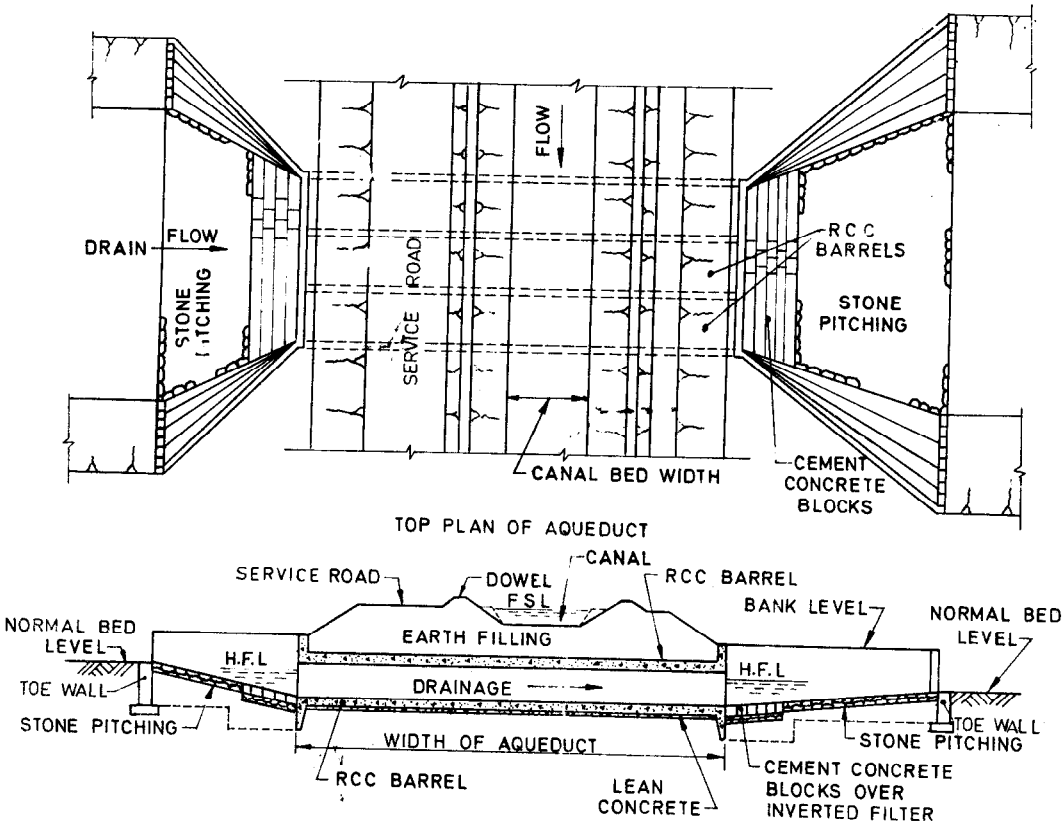
5.1.1 *Hydraulic Data*

5.1.1.1 *Canal/Carrier channel*

a) Width of roadway and class of IRC loading, and
b) Head loss provision at the proposed cross drainage work.

5.1.1.2 *Drainage channel*

a) Nature of bed material and value of Manning's coefficient (n);
b) Allowable afflux in view of water spread,



2A Typical Plan and Section of Aqueduct (Type 1)

FIG. 2 TYPES OF AQUEDUCTS — *Contd*

upstream of the proposed work;

c) Reported or observed scour depth for any near-by structure on the same drainage channel; and

d) Bearing capacity of the foundation strata.

6 LAYOUT

6.1 The layout of the aqueduct should be so fixed that it is preferably in a straight reach of drainage channel. The canal/carrier channel should be at right angles to the drainage channel as far as possible.

6.2 Bank connections to canal and drainage channel should be provided depending upon the properties of the soil available in the area.

6.3 Wing walls for drainage may be provided with 2 : 1 and 3 : 1 splays on upstream and downstream side; the splay should not be flatter than 3 : 1 and 4 : 1 respectively. Drainage wing walls should be suitably connected to high ground.

6.4 Canal transitions should preferably be provided with 2 : 1 and 3 : 1 splays on upstream and downstream side, but not flatter than 3 : 1 and 5 : 1 respectively. However, it should be ensured that the flow follows the boundaries of the transition.

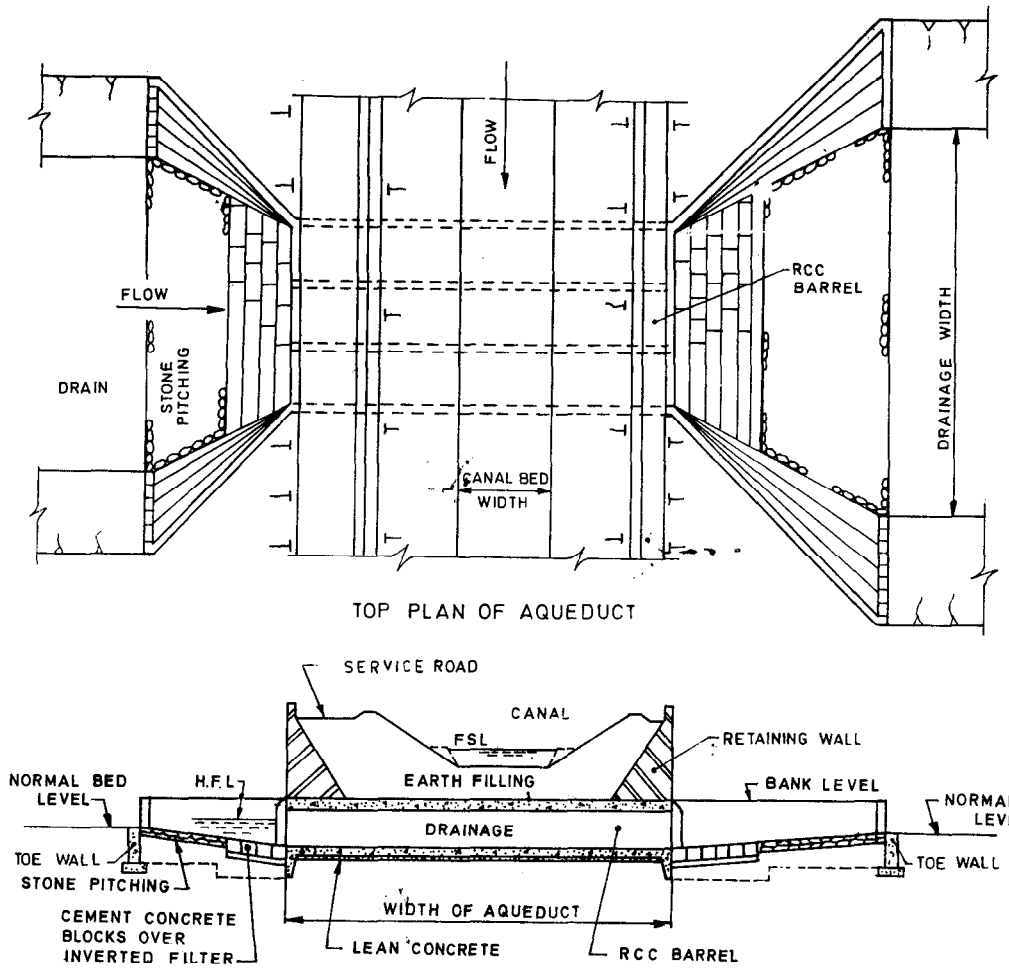
6.5 The drainage channel shall be directed towards the structure by suitable training works like training walls, guide banks, spurs, etc. The canal banks adjacent to the cross drainage work should be protected by suitable protective measures such as turfing, pitching and launching apron, wherever necessary.

7 HYDRAULIC DESIGN ASPECTS

7.1 The hydraulic design aspects should be as per IS 7784 (Part 1) : 1993.

8 JOINTS

8.1 Joints should be provided across and along the drainage barrel length. The maximum spacing of these joints in either direction should be limited to 20 m. A gap of 15 mm with water stops at all the joints across and along the barrel should be provided to accommodate the movements.



2B Typical Plan and Section of Aqueduct (Type 2)

FIG. 2 TYPES OF AQUEDUCTS

8.2 In the case of barrels resting on compressible soils, collars encircling the joint should be provided. This will protect the water stop from shearing due to differential settlement between two segments.

8.3 In case of multibarrels, units of three or four barrels can be adopted side by side with longitudinal joints having water stops all around.

8.4 In case the canal trough is supported on separate piers, expansion joints of sufficient width shall be provided in the trough at the centre of the piers.

8.5 Water stops shall be provided at all joints as given in IS 7784 (Part 1) : 1993.

9 STRUCTURAL DESIGN ASPECTS

9.1 For the construction of various components of an aqueduct prestressed concrete or reinforced cement concrete or masonry or a combination of these may be used depending upon the desired ease of construction and relative economy.

9.2 A suitable arrangement for supporting the section of the aqueduct may be decided depending upon the nature of foundation, difference between HFL of the drain and bed of canal and height between bed of canal and bottom of stream/drain and the afflux allowable in the drain. An economical span can be worked out by a judicious combination of the substructure and superstructure of the aqueduct. Multi-duct canal sections can also be adopted.

9.3 To carry the service/inspection road across the drainage, a suitable arrangement may be provided. For economical reason a causeway may also be considered. In case a road bridge is provided over the aqueduct it should be designed for at least IRC class A loading.

9.4 Design Load and Structural Stability

The forces acting on the various parts of the structure are evaluated and the worst combination of forces is taken in the design.

9.4.1 The loads and forces to be considered in designing aqueducts are as follows:

a) Dead load;
b) Water load;
c) Live load;
d) Impact or dynamic effect of the live load;
e) Longitudinal forces caused by the tractive effort or by braking force of vehicles and/or those caused by restraint to free movement of bearings;
f) Wind load;
g) Horizontal force due to water currents;
h) Centrifugal forces – in case the aqueduct and/or the road is curved in plan;
j) Buoyancy;
k) Earth pressure;
l) Forces due to temperature variation;
m) Erection loads;
n) Seismic load; and
p) Water pressure.

NOTE – (d) and (e) are applicable only in case a road bridge is provided over the aqueduct.

9.4.2 Generally the following design combinations should be considered:

a) Canal empty and stream/drain at its low water level – normal condition without earthquake;
b) Canal running full up to its F.S.L. and stream/drain at its low water level — normal condition without earthquake;
c) Canal empty and stream/drain at its H.F.L. without earthquake;
d) Canal running full up to F.S.L. and stream/drain at its H.F.L. without earthquake.
e) *Construction condition*
   i) Pier is constructed and superstructure is not constructed and stream/drain at it's H. F. L (design) without earthquake.
   ii) Superstructure is constructed on one side of a pier and stream/drain at it's H.F.L (design) without earthquake.

NOTE – (a) and (b) combinations of loadings may also be checked for seismic conditions after accounting for higher permissible stresses.

9.4.2.1 Wind load should not be considered simultaneously with earthquake.

9.4.2.2 For design of aqueducts the effect of earthquake forces in all the three directions that is longitudinal (L), transverse (T) and vertical (V) should be taken into account. The combination of these should be either $T + V$ or $L + V$ at a time.

10 MISCELLANEOUS DETAILS

10.1 Weep holes and bearings should be provided as per IS 7784 (Part 1) : 1993.

10.2 Uplift pressure and exit gradient caused by seepage flow from the canal when it is running full and the drainage channel is dry, be accounted for in design. For reducing the uplift pressure and exit gradient, *pucca* floor should be provided for in the canal bed in adequate lengths upstream and downstream of the work with cut-off walls at the ends. *Pucca* floors of adequate lengths should be provided at either end of the barrel in the drain with cut-off wall at the end.

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This Indian Standard has been developed from Doc No. RVD 17 (105).

Amendments Issued Since Publication

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