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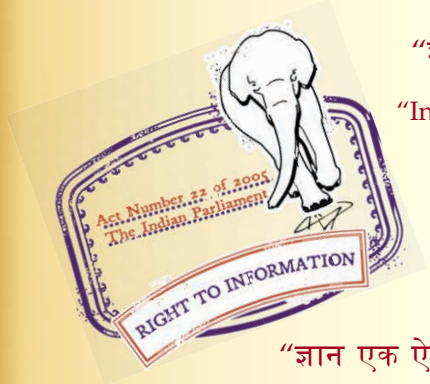
IS 7720 (1991): Criteria for Investigation, Planning and Layout for Barrages and Weirs [WRD 22: River Training and Diversion Works]



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"ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है"
Bhartṛhari—Nītiśatakam
"Knowledge is such a treasure which cannot be stolen"

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IS 7720 : 1991
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भारतीय मानक

बैरेजों और वियरों की जाँच, योजना और विन्यास की कसौटी

(पहला पुनरीक्षण)

Indian Standard

CRITERIA FOR INVESTIGATION, PLANNING AND LAYOUT FOR BARRAGES AND WEIRS

(First Revision)

UDC 627·82 + 627·431/·432

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
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FOREWORD

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

Barrages and weirs are constructed for diverting water from river for various uses like irrigation, navigation, power generation, water supply, etc.

In order to exercise better control on the river and flow conditions, both upstream and downstream and to limit the afflux without recourse to excessive water way, barrages are generally preferred. Where the sediment load carried by the river is heavy or there is need for pondage or for a rail/road bridge over the diversion works, overall considerations may distinctly favour a barrage. However, in rivers carrying a moderate load of fine silt and where the required pond level is considerably below the natural high flood level of the river, the afflux created even by a weir would be small and its adoption could be considered taking into account the economics and regulation requirements.

After establishing the necessity of the barrage or a weir, proper investigation, planning and layout are essential for its economical design and construction, its continued safety and efficient functioning.

This standard was first published in 1975. The revision of this standard has been taken up in the light of experience gained during the last fifteen years in the use of this standard. The important changes in this revision include investigations concerned with the effect of barrage and weir on environment and ecology. This revision also covers constraints imposed by custom, water laws and rights or accepted policy and aspects relating to land required for utility services, during and after construction.

Indian Standard

CRITERIA FOR INVESTIGATION, PLANNING AND LAYOUT FOR BARRAGES AND WEIRS

(First Revision)

1 SCOPE

This standard lays down the criteria for investigation, planning and layout for barrages and weirs.

2 REFERENCES

The Indian Standards listed in Annex A are necessary adjuncts to this standard.

3 INVESTIGATIONS

3.0 Investigations are generally done in two stages:

a) Preliminary investigations, and

b) Detailed investigations.

3.1 Preliminary Investigations

These investigations should include the following:

a) Study of available maps including remote sensing maps;

b) Regional and site geology;

c) Study of foundation strata;

d) Study of available run-off and flood flow data;

e) Study of existing projects upstream and downstream of barrage;

f) Assessment of water requirement;

g) Effect of proposed barrage or weir contemplated on environment and ecology;

h) Limitations or constraints imposed by custom, water laws and rights or accepted policy;

j) Availability of construction materials;

k) Land for utility services; and

m) Communication to the site of work.

3.1.1 *Study of Available Maps Including Remote Sensing Maps*

Study of available maps should be made to have a general idea of the topography and to locate possible sites and their catchment area. Photo imageries sent by remote sensing from satellites may be used to locate the possible sites. Earlier maps, if available, should be consulted as they would provide useful information regarding stability of the river at the site.

3.1.2 *Regional and Site Geology*

It should be studied with particular reference to adverse geological indications, such as faults, fractured zones, shear zones, fissures, solution cavities, seismicity, slide zones, etc.

3.1.3 *Study of Foundation Strata*

Data should be collected by making trial pits, trenches and boreholes and studies of existing nearby deep cuts and wells and reports of other projects in the nearby zone. Possibility of subsidence from mineral extraction or other causes should also be studied.

3.1.4 *Study of Available Run-off and Flood Flow Data*

The study of available data, such as rainfall records in the catchment, river gauges and the corresponding discharges should be made with a view to assessing the available 10-daily and monthly run-off and peak flow diversion or storage.

3.1.5 *Study of Existing Projects Upstream and Downstream of Barrages*

The projects in the river which may name some effort on the functioning of the barrage may be collected.

3.1.6 *Assessment of Water Requirement*

It is necessary to assess the extent of water requirements for diversion during the various periods and the feeding level.

3.1.7 *Effect of Proposed Barrage or Weir on Environment and Ecology*

The effect which the proposed barrage or weir will have upon the ecosystem in which these are placed and especially on the fish, wild life and human inhabitants adjacent to the structure is to be evaluated. The aim should be selection of such a site where the construction of the barrage or weir minimizes environmental disturbances while also creating aesthetic and culturally pleasing conditions under which the environment can be protected and developed to serve the demands of nature and man. Possible adverse erosion of banks and river meandering on the upstream and downstream of proposed project site on account of construction and operation of the barrage may be considered.

3.1.8 *Limitations or Constraints Imposed by Custom, Water Laws and Rights or Accepted Policy*

In most areas the amount of water available may not be sufficient at least during some seasons to satisfy all

potential demands. A system of water laws or rights, interstate treaty on sharing of water, etc, already developed or framed have to be recognized and a careful evaluation is to be made of the human socio-economic factors in the area, their present state, their trends and to the corresponding needs and requirements of the society.

3.1.9 *Availability of Construction Material*

Preliminary investigation should be made to assess the requirement of construction materials and their availability in the vicinity of the sites under consideration.

3.1.10 *Land for Utility Services*

It is necessary to make preliminary investigation to assess whether sufficient and suitable land will be available near the proposed barrage site, for installation of utility services for example workshop, aggregate processing plant, batching and mixing plant, etc, without damaging the environment and ecology and without any encroachment upon the forest land and wild life habitat.

3.1.11 *Communication to the Site of Work*

While deciding on the choice of suitable site, due consideration should be given for easy accessibility and economic transportation of materials to the site of work. Possible sites for the location of the barrage or weir should be marked out on the basis of investigation carried out in accordance with the provisions of **3.1.1** to **3.1.10**. It should be possible to eliminate some of these sites on topographical, environmental and other considerations by site inspection. Further investigation should be carried out for the remaining sites by sub-surface explorations. Gauge discharge observations should also be started, if not already available. Thereafter, considering the merits and demerits of the different sites, the sites chosen can be graded in order of their suitability.

3.2 Detailed Investigations

After preliminary selection of site, the following investigation should be carried out in detail with a view to collect data for the design of the main structure and the appurtenant works for the site chosen:

a) Detailed topographical survey;
b) Collection of hydrological and meterological data;
c) Sediment studies;
d) Design discharge of major hydraulic structure upstream of the proposed site, if any;
e) Surface and subsurface investigation including laboratory tests for foundation engineering purposes;
f) Detailed river morphology and ecological studies;
g) Change in river regime due to construction of the barrage or weir;
h) Land acquisition and rehabilitation problem;
j) Diversion requirements and river training works;
k) Construction materials and borrow areas survey;
m) Communication system; and
n) Other miscellaneous studies, such as :
   i) Pond survey;
   ii) Fish pass;
   iii) Navigation, if any;
   iv) Possible generation of power;
   v) Passage of migratory wild life for example, elephants;
   vi) Rail/road bridge across the barrage;
   vii) Data relating to ice problem; and
   viii) Problem of landslide and erosion of banks near the barrage, if any.

3.2.1 *Detailed Topographical Survey*

3.2.1.1 Topographical survey consisting of contour plan of the area, cross sections and longitudinal section of the river should be carried out as given in IS 6966 (Part 1) : 1989. The survey should be plotted to suitable scale. The survey should also show all salient features like firm, banks, rock outcrops, deep channels, large shoals and islands, deep pools, important land marks, all existing structures, etc. The length of the survey may depend upon the nature of stream, the size of barrage or weir, upstream and downstream control points and the purpose of diversion. If the river course on the upstream and downstream of the site is straight, the length of survey may be shortened whereas in the case of meandering rivers the length of the survey may be increased so as to cover at least two fully developed meanders on the upstream of the barrage axis and one meander on the downstream or as may be required for detailed model studies. In case of a barrage site at foothill region, the survey should be continued at least for 2 km upstream and one km downstream in the gorge portion from the barrage axis. The extent of upstream stretch necessary for the calculation of the backwater under high flood stage should be surveyed. If felt necessary satellite imagineries on 1 in 50 000 scale may be studied for getting idea of the meandering tendencies of the river.

3.2.1.2 It is desirable to observe the cross sections at closer intervals, say 100 m, up to 2 km upstream and 1 km downstream of the proposed barrage or weir for model studies. In the remaining reach the cross sections may be observed at an interval of 200 m. The cross levels in the river bed may be spaced 5 to 20 m apart depending upon the topography of the river. In the deep channel portion the cross levels may be taken closer. The cross sections should be extended on both banks up to about 2.5 m above the high flood level (observed or ascertained from local enquiry) as far as possible, otherwise to an extent such that proper layout of guide and afflux bunds may be decided. In hilly streams cross sections at closer intervals may be taken and in that case bed levels should also have closer spacing. For plain areas, contour intervals of 0.5 m are required but in bouldery areas, contour intervals of 2 m are suitable.

3.2.2 *Collection of Hydrological and Meteorological Data*

3.2.2.1 The aim of collection of hydrological data is two fold, namely: (a) for computing the design flood and (b) for assessing the 10-daily or monthly run-off on a more realistic basis. For these studies it is necessary to obtain rainfall and run-off data.

3.2.2.2 *Design flood*

The following data should be collected for estimating the maximum anticipated flood:

a) Daily rainfall recorded at different stations in the catchment area and data regarding storms in respect of successive positions of the centre of the storm on the catchment should be collected. Storms causing peak discharges should be separated for unit hydrograph analysis;

b) Flood hydrographs for isolated rain storms for working out unit hydrograph;

c) Catchment characteristics, such as shape, slope, orientation, drainage system and infiltration capacity for developing synthetic hydrograph, if adequate data are not available;

d) Peak flow data for the river for as many years as possible for frequency analysis;

e) Flood marks by local enquiry to estimate maximum flood by slope area method;

f) Daily river gauges should be observed as specified in IS 6966 (Part 1) : 1989. At the time of flow, hourly gauge observation should be carried out for the estimation of peak flow; and

g) For major barrages, cross sections across the river should be taken everyday during the flow season at the site of the gauge discharge observation for correct assessment of the gauge discharge co-relation. If there is an already existing gauge and discharge site which takes regular cross section of river even during the monsoon, then the same data can be suitably co-related to barrage site.

3.2.2.3 *Run-off*

A gauge discharge site should be established at a suitable point in the vicinity of the barrage site. The gauge discharge data should be utilised to evolve a gauge discharge curve for computing the discharge for the period for which river gauge data are available. The run-off data thus obtained should be utilised for estimating dependable yield. If the data available for the site is inadequate, a correlation could be established for utilising the long term data available for a nearby site on the river. If tributaries are meeting the river on which the barrage is contemplated on the upstream of barrage axis, gauge discharge sites should also be established on these tributaries just upstream of barrage axis for estimating their contribution to the run-off at the barrage site.

3.2.3 *Sediment Studies*

3.2.3.1 If no data of sediment load carried by the river are available, sediment observations should be started immediately with the gauge discharge observations as soon as the barrage or weir is contemplated. The quality and quantity of sediment carried by the river water, especially during flood season, is necessary for planning sediment exclusion or prevention works and to frame a suitable mode of regulation. The suspended sediment samples should be collected in accordance with IS 4890 : 1968.

3.2.3.2 In case the sediment charge brought by the river is excessive, due margin should be given for sedimentation while fixing the pond capacity, particularly in case where pondage is proposed to be provided to meet diurnal power fluctuations.

3.2.4 *Design Discharge of Major Hydraulic Water Structure Upstream of the Proposed Site*

If there is any major hydraulic structure for example, a storage dam on the upstream of the proposed barrage, the peak flood discharge and rating curve for that dam are to be collected for ascertaining the design discharge of the barrage. The water availability at the barrage site will also depend on the release from the dam. Hence, regulation manual of the dam should be collected.

3.2.5 *Surface and Subsurface Investigation Including Laboratory Tests for Foundation Engineering Purposes*

The detailed provisions in this regard are covered in relevant Indian Standards.

3.2.6 *Detailed River Morphology and Ecological Studies*

3.2.6.1 The environmental science is a subject of interdisciplinary nature and it would be desirable to associate the various experts like environmental and ecology experts, fish biologists, wild life preservation experts, recreational consultants, landscape architects, botanists, etc, with the environmental problems from the investigation stage of a barrage or weir project. The principal environmental factors which may be affected are : wild life (both land and aquatic species), natural scenic values, recreational historical and archaeological.

3.2.6.2 The environmental and ecology experts team should investigate in detail the damages which may be caused to the environment and ecosystem of the site due to construction of the barrage or weir and should submit a list of criteria which the planner and the designer of the barrages should encompass for minimizing the environmental disturbance while also creating conducive environment which serves both the demand of nature for ecological balance and the demands of man for social and psychological balances.

3.2.6.3 The impact on fish and aquatic life and its amelioration is to be investigated. Critically important

to the survival of fish population are water quality, water temperature and mobility. The impact on wild life including insects and birds are to be studied. There may be three effects on wild life : removal of feeding areas, loss of habitat and limitations of mobility. There may be loss of forest areas and natural vegetation and natural scenic value of the site and recreational facilities. These should be properly investigated and corrective measures like compulsory afforestation, etc, to be suggested. Loss of mineral, fuel, agricultural land, transportation system and loss of means of livelihood of the local inhabitants should be evaluated. Historical and archaeological places of importance should not be allowed to submerge under barrage pond, as far as possible.

3.2.7 *Change in River Regime Due to Construction of the Barrage or Weir*

Barrage or weir is essentially an obstruction in the normal flow of the river and effects changes in the river regime both upstream and downstream. A barrage or weir increases the tortuosity of the river upstream and downstream. Necessary data is to be collected for model studies to evaluate the possible change in river regime and its reduction by adjustment of the location and length of the barrage.

3.2.8 *Land Acquisition and Rehabilitation Problem*

3.2.8.1 Thorough and detailed investigation should be made in respect of land to be acquired for construction of barrage or weir with all appurtenant structures and land needed for ponding, utility and enabling works. Not only the present use of the submerged area, but its potential uses should also be considered. Total agricultural land, forest land, pasture land, orchards, homestead land to be acquired is to be accurately assessed. Value of property submerged should be low in relation to expected benefits.

3.2.8.2 During investigation care should be taken to select such a site where minimum forest land is submerged or damaged. The possibility of submergence of mineral deposits or of petroleum products should also be examined. Proper investigation should be made for alternative sites for rehabilitation of displaced families so that they may have better quality of life and may continue with their existing professions. Necessary investigations should be made to assess the facilities and means of livelihood enjoyed by the displaced persons which need relocation.

3.2.9 *Diversion Requirements and River Training Works*

Diversion and river training works should be worked out in accordance with the needs of the project. Necessary data for diversion and care of the river during construction should be collected for proper planning and design of temporary diversion works. Model study is a very useful tool in the design and construction of river training works. All requisite data for model studies, design and construction of river training works to guide the river to flow axially through the barrage or weir and to check the outflanking should be collected.

3.2.10 *Construction Materials and Borrow Areas Survey*

Survey of construction materials, like building stone, limestone, brick, sand, gravel, suitable earth, etc, their availability with leads and lifts is necessary for determining the type of construction for perparing comparative estimates. Availability of hard and durable stone may make masonry preferable to concrete. If limestone is available, its hydraulicity, strength and durability should be investigated. Laboratory and field tests should be carried out for determining the quality of aggregates and earth materials. The borrow area survey should be made for availability of suitable construction materials and their distances from the barrage site.

3.2.11 *Communication System*

Detailed assessment should be made of the following facilities required during construction and implementation phase of the project.

a) Existing and proposed roads, rail and water routes with information on load and size limitation;

b) Telephone and telegraph lines; and

c) Sources for obtaining power with transmission line routes.

Investigation should include dislocation of the existing facilities and their relocation and additional facilities required during construction and operation of the barrage.

3.2.12 *Other Miscellaneous Studies*

3.2.12.1 *Pond survey*

The area submerged up to normal pond level or within the afflux bunds that shall be acquired to be surveyed and all movable and immovable properties coming within it should be recorded and values worked out before the works are started to avoid disputes and delay at a later stage. Forest land coming under the pond area should be specifically demarcated so that necessary arrangements may be made to obtain permission from Government of India and land transfer from the Forest Department.

3.2.12.2 *Fish pass*

These are required for migratory fish and should be provided in consultation with the experts of Fisheries department and Central Inland Fisheries Research Institute. Necessary data as may be advised, should be collected for assessing the need for provision of a fish pass and its design.

3.2.12.3 *Navigation*

This study is necessary to assess the effect of barrage on the existing navigation facilities. If the barrage is to obstruct the passage of the boats, small navigation locks will be necessary. For this purposes, size of boats, frequency, draft, load, etc, are to be assessed. If a new navigation route can be established due to

the pondage of the barrage, the same can also be investigated.

3.2.12.4 *Possible generation of power*

All barrages have got the potential of generating a differential head throughout the non-monsoon season, between the upstream pond and tail water. With the development of bulb turbines which can cater for heads varying between one metre to fifteen metres, excellent power can be generated in the barrages proper, provided some excess water is available for this purpose. The investigation should include minimum available 10-daily flow in 50%, 75% and 90% of the year and the normal differential head available in different months. Exclusion of sediment bed load and in suspension to be investigated, keeping in mind the abrasion of turbine blades.

3.2.12.5 *Passage of migratory wild life for example, elephants*

If by construction of a barrage or weir the mobility of migratory wild life is hampered due to construction of afflux bund and creation of pond, necessary provision of passage or pass is to be made at downstream of the barrage or upstream of the pond area for safe and smooth migration of wild life from one bank to the other bank of the river. All necessary and relevant data such as number of wild animals in a herd, number of herds moving across the river, period in which they migrate, their usual path, steps to be taken to make them follow new passage, etc, are to be collected so that necessary and suitable safe passage can be provided for their migration.

3.2.12.6 *Rail/road bridge across the barrage*

Sometimes a road bridge may be provided along a barrage or weir for providing communication facilities between two banks of the river. In such a case, data regarding the size of the bridge, type of the bridge, footpaths, class of loading needed, present and projected traffic volume, etc, should be collected. If railway bridge is also required, the data should be collected in consultation with the railway authorities.

3.2.12.7 *Data relating to ice problems*

In high altitudes where the problem of formation of ice exists, data regarding the ice thickness, maximum and minimum temperatures and rate of variation of temperature should be collected. These are necessary for designing the structure and de-icing facilities as well.

3.2.12.8 *Problem of land slide and erosion of banks near the barrage*

Specially for barrages for generating electricity in upper reaches of the river the hills on both the banks should be properly studied against any possibility of landslide, etc. The selection of site should be suitably modified on the basis.

4 PLANNING AND LAYOUT

4.1 General Arrangement

A barrage or weir normally comprises a deep pocket of undersluice portion in front of the canal head regulator on one or both the sides and the remaining river bays or spillway bays separated from the undersluice bays by divide walls. In addition guide bunds on the upstream and downstream of the barrage or the weir and sediment excluding devices such as silt excluders in the barrage and silt ejectors in the canal are provided. Detailed model studies should be carried out to decide the location, levels and layout of the barrage and appurtenant structures.

4.2 Location

4.2.1 Location for a barrage or weir should be decided on considerations of suitability for the barrage or weir proper, the undersluices and the canal head regulators. An ideal location is that which satisfies the requirements for all the three. For irrigation purposes, the head works shall be so planned that full command may be achieved by a barrage or weir of reasonable height. The combined cost of the construction of headworks and the canal from the barrage or weir to the point where irrigation commences should be as small as is consistent with the efficiency of the project. Sometimes a most favourable site for a barrage or a weir may have to be discarded due to large quantity of rock excavation involved in the construction of the works. The points given in **4.2.2** to **4.2.5** need careful considerations while deciding the proper location of the barrage or weir.

4.2.2 The river reach should, as far as possible, be straight so that velocities may be uniform and the sectional area of the river fairly constant. The banks should preferably be high, well defined and inerodible. This will obviate oblique approach as well as non-uniform distribution of flow on to the barrage. If such a site is available, it may need very small or practically no guide bunds. In case of high banks, the country side will not be submerged during high floods and a considerable saving in the cost of flood protection embankments can be effected. In the case of a meandering river the barrage or weir should be located at the nodal point.

4.2.3 A slight curvature at the site may be advantageous from point of view off-taking canal, which when located on the downstream end of the outer curvature will have the advantage of drawing less sediment. However cross currents may be produced due to curvature and may endanger the foundation. Moreover, if canals take of from both the banks, the canal taking off from the inner side of the curve will draw comparatively more sediment. Therefore, proper judgement should be exercised while deciding the location of a barrage or weir in a curvature reach of the river.

4.2.4 The undersluices should be sited in the deep channel in order to ensure adequate supply to the canal head at all times; when canals take off from both banks, a site with deep channels on both the banks and low water in the central portion is the most suitable.

4.2.5 While deciding the layout, due consideration should be given for all possible locations of the sediment ejector and availability of levels for effecting proper functioning of escape channel.

4.3 River Diversion Scheme

While deciding the location and layout of the barrages, due consideration should be given to the river diversion and flood handling scheme during construction. At times the hydraulic requirements may have to be compromised to obtained a workable diversion scheme or the barrage constructed in a spill of the river and the river diverted on to it by providing suitable river training works. Such decision should be supported by adequate model studies.

4.4 Alignment of Barrage or Weir

The alignment of a barrage or weir should be such as to ensure normal and uniform flow through all the barrage or weir bays, as far as possible. A barrage or weir aligned at right angles to the river course will have the minimum length and normal flow thereby minimizing the chances of shoal formation and shrouding of a portion of the barrage specially the undersluice pocket. A skew alignment should be avoided unless otherwise necessitated by site conditions. The alignment should, as far as possible, be finalised after detailed model studies.

4.5 Alignment of the Head Regulator

The upstream abutment of the head regulator should be set back from the line at right angles to the barrage axis. The head regulator is usually aligned at an angle of 90° to 110° to the barrage axis for minimizing sediment entry into the canal (*see* IS 6531 : 1972).

4.6 Upstream Floor and Crest Levels

4.6.1 The crest and upstream floor levels in the undersluice bays may be kept at the general lowest bed level of the deep channel of the river, subject to the cost of foundation and the difficulty in dewatering.

4.6.2 The upstream floor of the remaining bays, that is spillway bays should be kept normally 0.5 to 1.0 m above the upstream floor level of the undersluice bays or the general river bed level. The crest of the spillway bays should be kept high by 1.0 to 1.5 m than the crest level of the undersluice bays.

4.7 Position and Length of Divide Wall

4.7.1 A divide wall is normally constructed at right angles to the barrage or weir axis to separate the undersluice bays from the barrage or weir bays. Under adverse flow conditions additional divide walls may be required in barrage or weir bays.

4.7.2 The main function of the divide wall on the upstream side is to provide a comparatively still pocket in front of the canal head regulator resulting in deposition of the sediment in the pocket and entry of silt free clear water into the canal.

4.7.3 A divide wall of two thirds to full width of the head regulator normally gives satisfactory flow conditions when only one canal takes off from a barrage or a weir. In the case of more than one canal on the same bank, the divide wall should be taken up to the upstream end of the uppermost head regulator. Hydraulic model studies are to be made to determine the position and length of upstream divide wall for most effective action.

4.7.4 It is necessary to continue the divide wall on the downstream to ensure adequacy of tail water depth in the undersluice bays for the formation of jump and to avoid cross flow in the vicinity of the structure which may result in objectionable scours. The divide wall is generally extended to the end of impervious floor or to the end of loose apron on the downstream side. The exact length required is to be determined on the basis of model studies.

4.7.5 A second pocket of river sluice, adjoining the undersluices has been found to improve the flow conditions considerably where the river curvature is not favourable for silt free entry of water into the canal by inducing convex curvature opposite the head regulator. The provision of second pocket can also be adopted in case of wide rivers to guide the river to flow centrally, minimizing cross flow and inhibiting formation of shoals near the head regulator. The location and layout of river should be decided by model studies.

4.8 River Training Works

4.8.1 River training works for barrages and weirs are required to: (a) prevent out flanking of the structure, (b) minimize cross flows through the barrage or weir which may endanger the structure and protection works, (c) prevent flooding of the riverine lands upstream of the barrages and weirs, (d) provide favourable curvature of flow at the head regulator from the point of sediment entry into the canal, and (e) guide the river to flow axially through the barrage or weir.

4.8.2 A river generally flows in a wide alluvial belt and it is necessary to narrow down and restrict its course through the barrage or weir constructed across it. The guide buds are constructed to arrest the meandering tendency, obliquity of flow and to maintain deep channels through the undersluice bays adjacent to the canal offtakes. Proper alignment of guide bunds is essential to ensure satisfactory flow conditions on to the barrage. The most effective alignment, length and shape of guide bunds should be decided by model studies.

4.8.3 In case of wide alluvial banks the length and curvature of head of guide bunds should be kept such that worst meander loop is wide away from either the canal embankment or the approach embankment. If the alluvial bank is close to the barrage, the guide bunds may be tied to it by providing suitable curvature, if necessary. If there are any out-crop of hard strata on the banks it is advisable to tie the guide bunds to such control points.

4.8.4 While constructing barrages or weirs on rivers in alluvial plains, the natural waterway is restricted for economy as well as, for better flow conditions through the barrage or the weir and the unbridged width is blocked by means of approach embankments. The approach embankment on both sides should be aligned in line with the axis of barrage up to a point beyond the range of worst anticipated meander loop formed near the head of guide bunds.

4.8.5 Afflux embankments are earthen bunds extending from both the approach embankments and connected on upstream to the ground above affluxed highest flood level or to flood embankment, if existing. On the downstream the embankments have to be taken to such a length as would be necessary to protect the canal or approach embankments from high floods.

4.8.6 The alignment of afflux bunds on upstream generally follows the alluvial belt edge of the river, if the edges are not far off. If the edges are far off it can be aligned in alluvial belt but precaution should be taken to align it away from the zone of high velocity flow. If necessary proper river training works may be done along with construction of marginal bunds.

4.8.7 Gryones and spurs are structures constructed transverse to the river flow extending from bank into the river. These serve one or more of the following functions:

a) Training the river along the desired course to reduce concentration of flow and to direct the flow centrally through the barrage or weir,

b) Creating slack flow with the object of silting up the area in the vicinity.

c) Protecting the bank or afflux bund by keeping the flow away from it. Position, type and spacing of spurs, if needed are to be fixed by model studies. River training works are to be done in conformity with IS 8408 : 1976.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
4890 : 1968	Method for measurement of suspended sediment in open channels
6531 : 1972	Criteria for design of canal head regulators
6966 (Part 1) : 1989	Guidelines for hydraulic design of barrages and weirs : Part 1 Alluvial reaches
8408 : 1976	Criteria for river training works for barrages and weirs in alluvium

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