

भारतीय मानक

नदी घाटी परियोजना के प्रवाचलन और  
रख-रखाव की सुरक्षा संहिता

भाग 9 नहर तथा आर-पार जल निकास कार्य

*Indian Standard*

**SAFETY CODE FOR OPERATION AND  
MAINTENANCE OF RIVER VALLEY PROJECTS**

**PART 9 CANALS AND CROSS DRAINAGE WORKS**

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**BUREAU OF INDIAN STANDARDS**  
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## FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Safety in Construction, Operation and Maintenance of River Valley Projects Sectional Committee had been approved by the River Valley Division Council.

Structures for conveyance of water at depths more than 0.6 m and velocity greater than 0.9 m/sec, constitute safety hazards, both to the public and to construction and operating personnel, which require to be considered by the designer. The many variable factors to be considered in determining the requirements for safety make it impossible to establish exact predetermined standards for all features; the best that can be done is to set up general guidelines to serve as technical guides in the final determination of proper safety facilities. Such guidelines are presented in this standard.

The importance of adequate and safe equipment as a factor in preventing accidents shall not be overlooked. Only machinery, equipment, tools, and supplies which are standard, so far as safety provisions are concerned shall be considered in design and in purchases made. All specifications for the purchase of power driven machinery and equipment shall include provisions for built-in shields or guards and safety devices. The necessary safety and first-aid equipment and fire extinguishers shall also be provided for the safety of employees.

The climatic conditions and the weather in an area have a major influence on the safety facilities to be provided at a given structure. These shall be considered in all designs from the safety point of view, whether the structure is large or small.

Indian Standard

SAFETY CODE FOR OPERATION AND  
MAINTENANCE OF RIVER VALLEY PROJECTS

PART 9 CANALS AND CROSS DRAINAGE WORKS

1 SCOPE

This standard (Part 9) lays down guidelines for safety measures to be adopted during operation of a canal/ cross drainage work.

2 CLASSES OF HAZARD

In evaluating the need for safety facilities at a particular structure, one of the most important things to be considered is the size of canal and the frequency of visits of the general public to the site, which has a direct bearing upon the likelihood of accidents occurring there. The following classification of accident/hazard may be considered:

**Class A**—Canals adjacent to schools and recreational areas, such as playgrounds, subject to frequent visits by children.

**Class B**—Canals nearby or adjacent to such areas which are subject to frequent visits by the public.

**Class C**—Canals nearby or adjacent to farms or highways which could be subject to visits by children seeking recreation, such as swimming.

**Class D**—Canals far removed from any dwelling and subject to infrequent visits by operating personnel and a occasional sportsman.

**Class E**—Canals that would be a hazard to domestic animals.

**Class F**—Canals that would be an extreme hazard to big game animals.

NOTE — For the purpose of the above clause the canal is deemed to include all types of canal and their appurtenant structures.

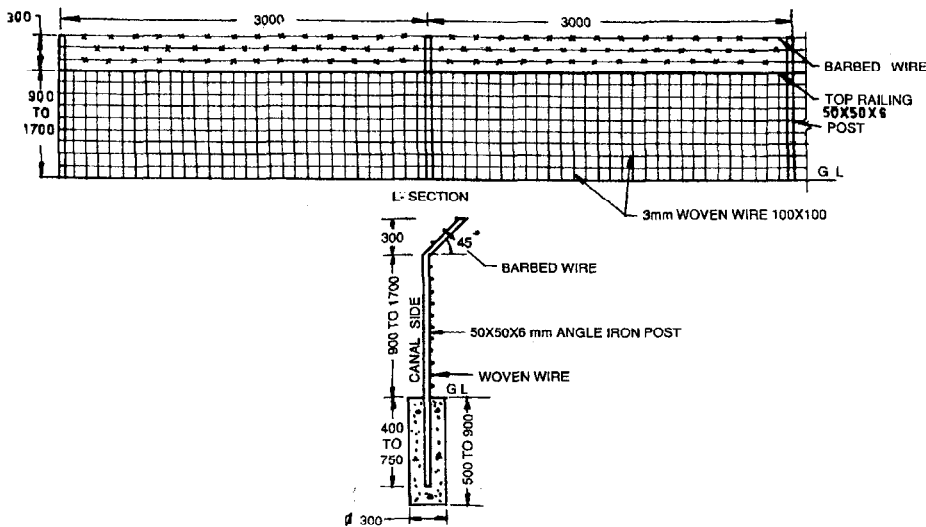
3 TYPES OF SAFETY DEVICES

3.1 Fences

Fences are one of the most common protective devices used to keep unauthorized persons and domestic and wild animals from getting into places where they might be hurt or where they might damage installed equipment. Fence designs vary from four strands of barbed wire on wood posts to a high-quality link mesh fence supported by steel posts set in concrete. Special attention shall be given to make it very difficult for a person to squeeze around the end of a fence and enter restricted areas. In any event the design data transmitted by the field must include information regarding the fencing needed.

3.1.1 Types of Fences

- a) *School Safety Fence*—Fence 2 m high with 1.7 m of woven wire and three strands of barbed wire. Steel posts at 3 m centre to centre with toprail (see Fig. 1).



All dimensions in millimetres.  
FIG. 1 WOVEN WIRE TYPE FENCE

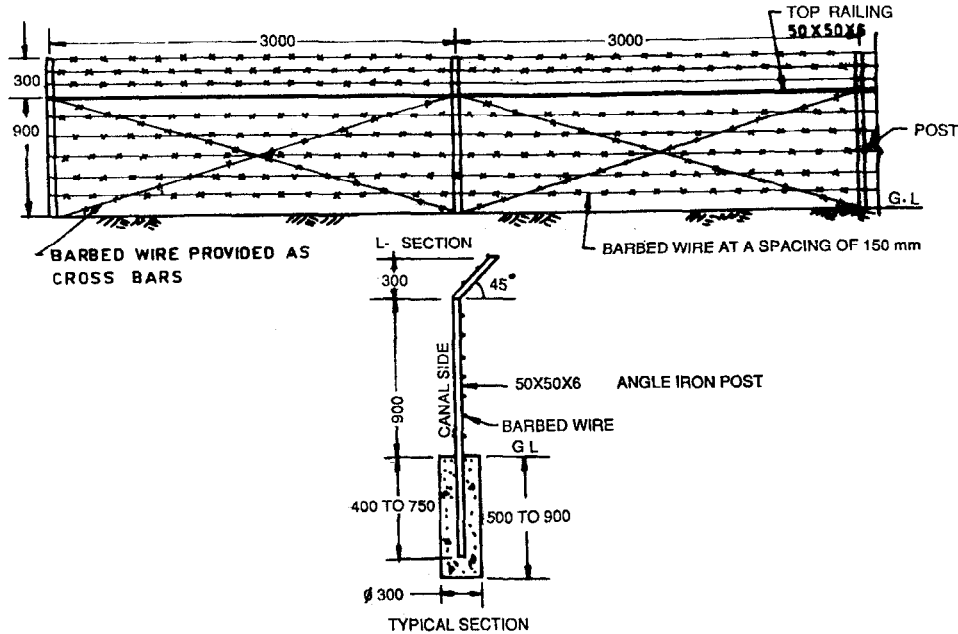
- b)

Urban and Rural Safety Fence—Fence 1.5 m high with 1.2 m of woven wire and three strands of barbed wire. Steel posts at 3 m center to center with top rail (see Fig. 1).
- c)

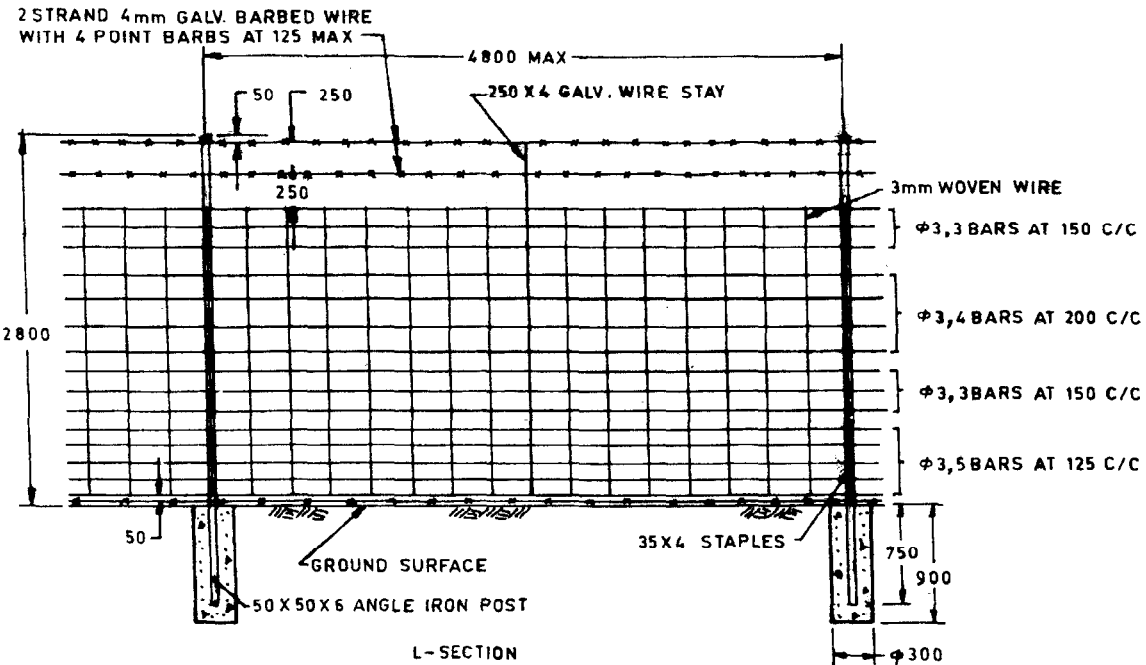
Woven-Wire Stock Fence—Fence 1.2 m high with 0.9 m of woven wire and three strands of barbed wire. Steel posts may be provided at 3.0 m intervals (see Fig. 1).
- d)

Barbed-Wire Stock Fence—Fence 1.2 m high with strands of barbed wire. Posts may be either steel or other suitable materials (see Fig. 2).
- e)

Deerproof Fence—Fence 2.8 m high with 2.2 m of woven wire and two strands barbed wire above and one strand below the woven wire. Fencing is supported by steel posts (see Fig. 3).



All dimensions in millimetres.  
FIG. 2 BARBED WIRE TYPE FENCE



All dimensions in millimetres.  
FIG. 3 DEERPROOF FENCING

3.1.2 Fencing Utilization Requirement

Class of Hazard	Fencing Requirement
A	School Safety Fence
B	Urban and Rural Safety Fence
C	Urban and Rural Safety Fence
D	None unless required by Right-of-way Agreement
E	Barbed-or Woven-wire Stock Fence
F	Deerproof Fence

3.2 Guardrails

Guardrails are classified into two general types, those used to protect vehicles and those used to protect pedestains. Guardrails are often used to serve both purposes. Guardrails installed to protect vehicles, such as those at dangerous turns on a canal bank road, usually consist of short heavy posts set in the ground along the smaller of the rod supporting a cable or sheet steel deflector on the traffic side of the rail. The function of the guardrail is two fold. It marks the safe limit of the roadway and also tends to deflect vehicles which may contact it. Since the guardrail serves as a marker, it is important that guard rails along roadways be made and kept clearly visible. Reflectors may be installed on the posts to make them more visible at nights. Guardrails to protect pedestains may be made of planks and wood posts or pipe rails and metal posts set in concrete. For the protection of children it is desirable to place wire mesh on the pipe guardrail to prevent passage between the pipes. As in the case of other safety devices, the selection of the type of guardrail to be used will depend upon what is to be accomplished and the class of hazard.

Design shall provide for suitable guardrails, fences, walls, and enclosures, where needed, to be constructed as an integral part of the structure. Guardrails are needed on both sides of all bridges, on the open side of all stairways, ramps, walkways and similar places where the vertical height above the surrounding area is 1.0 m or more.

Guardrails are required around all uncovered hatchways and openings in floors and platforms, and all windows and other wall openings if the bottom of the opening is less than 1.0 m above the floor, or if the design of the opening makes such a guard necessary.

3.3 Handrails

Handrails may be used along the sides of stairways or ramps to lend a person support and to guard against his

falling in case of a miss-step. Handrails are sometimes modified to perform the functions of a guardrail as well; for instance, the handrail along the side of a stairway might be covered with wire mesh to prevent children from getting between the rails. Handrails may be made of steel, aluminium, or wood depending upon their location and their function.

3.4 Signs

The proper use of signs to point out particular hazards to operating personnel, or to the public, is very important. A well-worded sign advising of the specific danger will warn persons and may prevent danger to life and property. Signs pointing out specific dangers are much to be preferred over signs which merely threaten dire consequences to trespassers, although 'No Trespassing' signs do serve a useful purpose. Signs which might serve to call the attention of trapped person to escape devices shall be considered. In case areas are likely to be frequented by persons not familiar with the English language the warning signs shall be worded in Hindi/regional language.

Information signs, dedication plaques, etc, shall be located away from roadways so that traffic shall not effect the visibiliy of the sign boards and thus eliminate a traffic hazard. Road signs of the conventional type shall be installed along principal access roads where needed.

4 SAFETY DEVICES REQUIRED FOR CANALS AND THEIR STRUCTURES

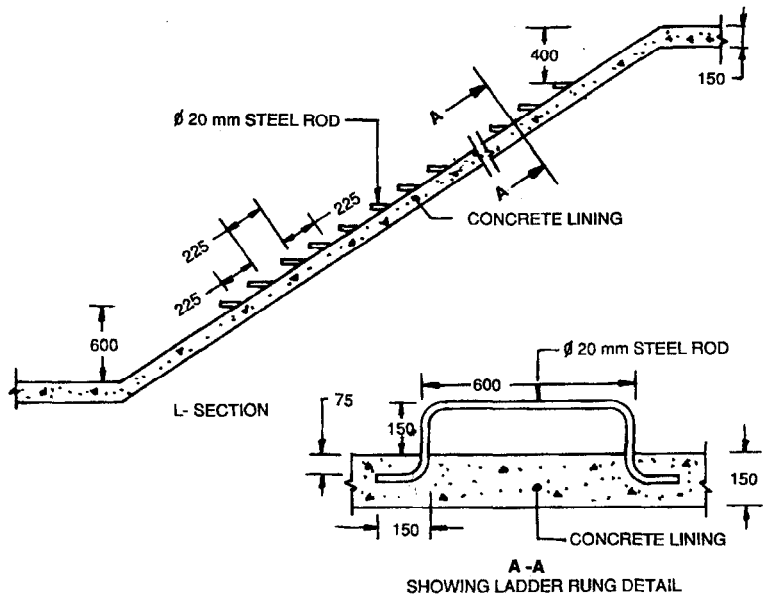
4.1 General

Sharp turns in canal bank roads shall be protected with guardrails, and signs shall be posted along the roads warning drivers that the road is private and that they travel at their own risk. Signs shall also be posted to warn 'would be' swimmers of deep water or other hazards.

Lined canals having a vertical lining height of 0.9 m or more shall be equipped with escape ladders (see Fig. 4) installed opposite each other at intervals of not more than 500 m, on each side of the canal, and immediately upstream of siphons, falls and similar structures. The canals shall be fenced where justified by the degree of hazard.

4.2 Escape Devices at Canal Structure

In addition to ladders in canals, other escape devices may be provided to assist persons in extricating themselves from a canal or other canal structures that are particularly hazardous. Among these facilities are suspended cables with drop lines, floats or booms across channels, escape nets, and trashracks. The devices are designed to provide a person trapped in the



All dimensions in millimetres.  
FIG. 4 SAFETY LADDER FOR CONCRETE LINED CANALS

deep water a chance to save himself by catching hold of the device and working his way to a ladder on the bank. The device shall be located far enough above the structure that the drawdown into the structure, does not make it impossible for a person to extricate himself.

Suspended cables are usually installed so that the drop lines which may be either chains or knotted ropes, reach the minimum operating water surface. Floats or booms across channels, if properly made, offer a trapped person something that he can get an arm or leg over and possibly get upon and work his way to the bank. Escape nets are usually hung from cables stretched across the channel or from a light steel truss structure. The net is installed so that it reaches below the normal minimum operating water surface; a person being carried down the canal is swept against it and if he is conscious he has a good chance to save himself. In designing a boom, the individual floats shall be large enough to support the weight of a person.

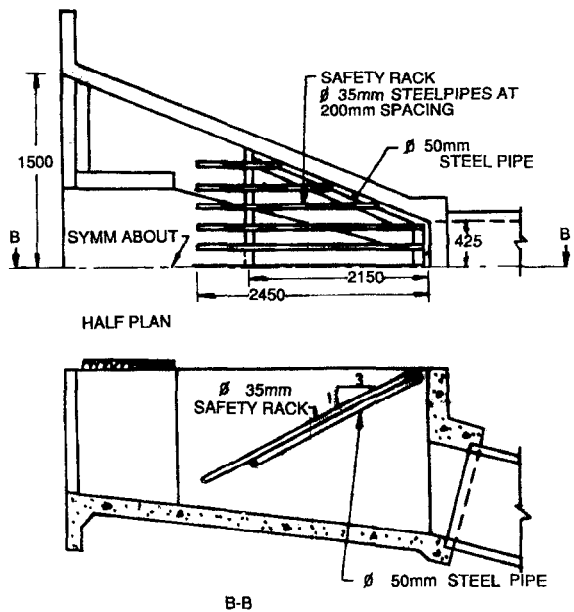
While trashracks are not necessarily classed as escape devices or safety facilities, they do perform that function at times. With slight modification, a trashrack designed to strain weeds out of the water entering a structure could be adopted to keep humans or animals from being drawn into the structure. The modification required would probably be no more than flattening the slope of the trashrack and providing an escape ladder at one end of the rack.

4.2.1 Syphons

All siphons over 0.9 m in diameter shall be protected as specified below :

Class of Hazard	Safety Device at Inlet	Transition Enclosures	
		Inlet	Outlet
A, B or C	Rack	Guardrail	Guardrail
	Net	Fence	Guardrail
	Cable	Fence	Guardrail
D	None	Guardrail	None

**Safety Rack**—Safety pipe racks (see Fig. 5) shall have 20 cm clear spacing between pipes and be installed on 3 : 1 or flatter slope. This device shall be used in small



All dimensions in millimetres.  
FIG. 5 SAFETY PIPE RACKS

canals and where maintenance problems associated with weeds are not severe.

**Safety Net**—Safety nets (*see* Fig. 6) shall be used in small canals where safety rack installations are not deemed advisable.

**Safety Cable**—Floated cables (see Fig. 7) shall be used in large canals where excessive spans limit the use of the safety rack or safety net.

**Guardrails**—Guardrails in conjunction with pipe racks, for Class A, B, or C exposure, shall cross the siphon transition headwall and extend the length of the

transition on both sides of the canal. The railing shall be 1 m high and consist of either pipe, cable or chain with metal posts embedded in concrete.

**Fences**—Safety fencing in conjunction with safety nets or cables shall be a chain link fence of minimum height 1.2 m, with three strands of barbed wire vertically above it and shall be provided across the transition headwall, extending to the anchor posts of the safety net or cable; except that where connection is made to an existing fence higher than 1.2 m a fence of equal height shall be provided.

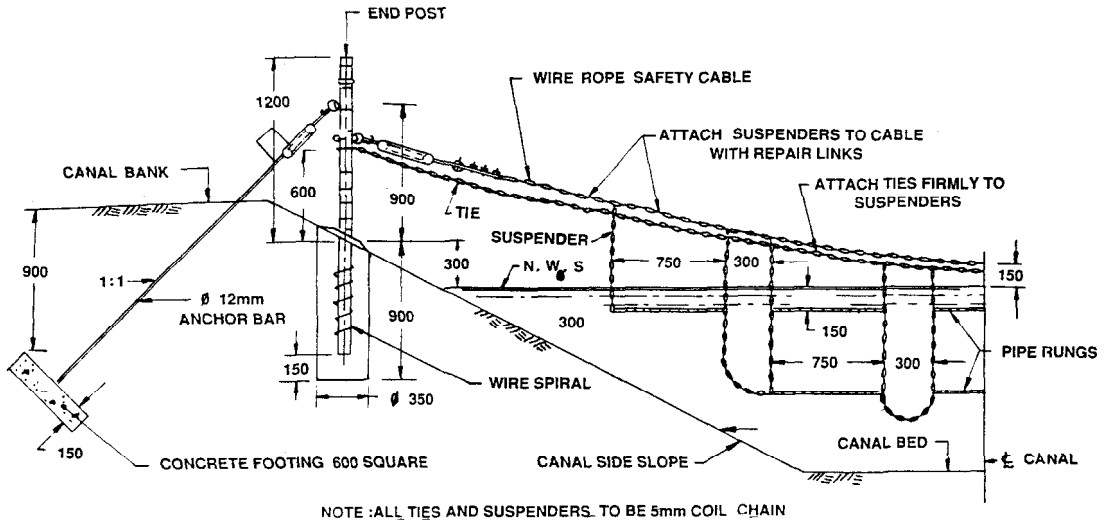


FIG. 6 TYPICAL SAFETY NET AND CABLE DETAILS

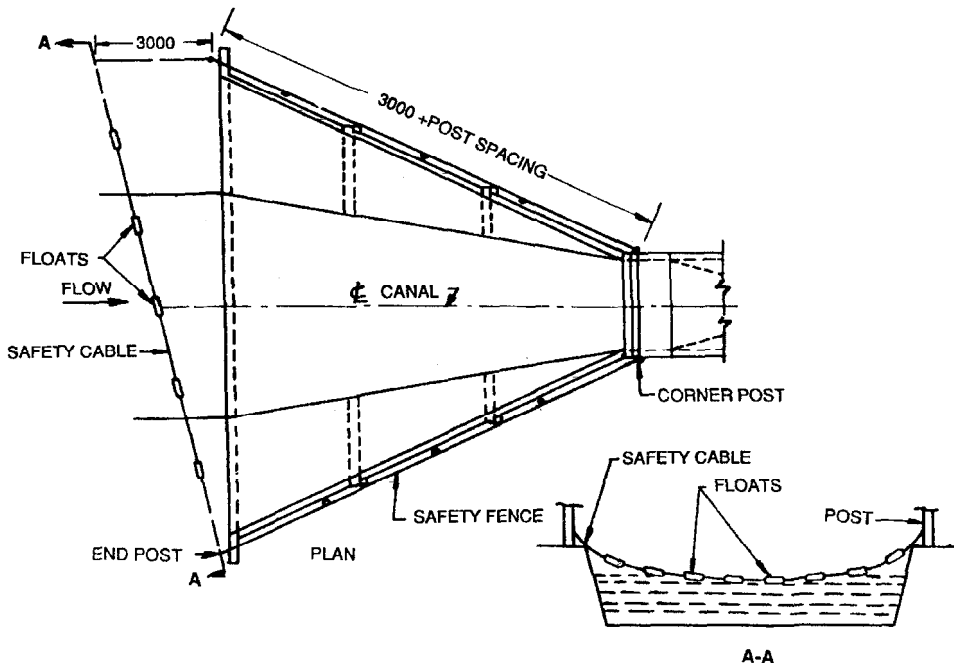


FIG. 7 SIPHON SAFETY FENCE AND SAFETY CABLE

**4.2.2 Tunnels**

Tunnel reaches shall be protected in the same way as those of siphons since the hazards are similar.

**4.2.3 Bridges**

Foot and vehicular bridges shall be well guarded with guardrails. The type of railing used shall give the protection needed under the class of hazard existing (see 2 and 3.2). For combination of pedestrian and vehicular bridges located within thickly populated areas, and which have guardrails separating the vehicular and pedestrian traffic lanes, consideration shall be given to making the separating guardrail splashproof to protect pedestrians.

Operating bridges shall be provided with suitable railing. Public entry shall be banned on operating bridges by a suitable barrier.

**4.2.4 Falls and Chutes**

Rectangular section falls and chutes of 1.5 m depth or more and under Class A, B, or C hazard, shall be fenced or have guardrailing constructed along each side of the structure. In those cases where a canal fall or escape carries more than a 1.2 m depth of water into the structure, the need for a safety net or cable and drop-line device across the water prism upstream from the intake of the structure to facilitate escape from the water shall be considered.

**4.2.5 Trashracks**

Trashrack operating decks are hazardous primarily because the wet trash removed from the racks is often deposited on the deck, making it wet and slippery. It is desirable therefore to have a rough, nonslip surface on the operating deck floor and to have a guardrail, across the front of the deck, against which the operator can brace himself while removing debris from the racks.

**4.2.6 Stilling Basins**

Stilling basins constitute definite safety hazards and, depending upon the class of hazard, shall be guarded by adequate protective devices. Where the top of the walls are flush or nearly flush with the ground, guardrailing, possibility of a chain-link type, shall be installed on top of the wall in such a way that there is no room for a person to stand on top of the wall inside of the fence. Where the top of the walls extend as much as 1.2 m above the ground level, so that guardrailing is not necessary, the top of the wall shall be designed so that it is not possible for a person to stand upon it or to walk upon it. Wing walls at the inlets to spillways shall be protected in a similar manner. Guardrailing and fencing are discussed in 3.1 and 3.2.

**4.2.7 Inlet and Outlet Works**

In addition to the protection recommended in 4.2.6 for stilling basins constructed in connection with inlet and outlet works, log booms or safety nets shall be provided near tailraces and inlet and outlet works on bodies of water where boatsmen or swimmers may be endangered.

**4.2.8 Stop Logs and Bulkhead Gates**

For the temporary closing of openings such as penstock inlets or draft-tube outlets, it has been found that bulkheads are to be preferred over stop logs if suitable hoisting equipment is provided. Some projects have found that the use of bulkheads is preferable to the use of stop logs on canal structures. Where the former is used a truck-mounted crane is usually necessary to handle the bulkheads. Stop-log grooves shall be designed with this possibility in mind. In all the above mentioned cases the use of bulkheads is preferable so that the closing operation is simplified and is made safer as well as faster. Further, a tighter seal is usually obtained and better protection is afforded to the men working behind the bulkhead.



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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Handbook' and 'Standards: Monthly Additions'.

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