SECTION 130 – CULVERTS

2811. The area of waterway to be provided can be estimated from table 5.2.

2812. Common types of culvert are summarized in table 28.2.

2813. **Parts of a Culvert.** The simplest form of culvert consists solely of a barrel which is the correct name for the channel through which the water flows. When, however, the volume of water to be released is considerable and the culvert is in constant use, refinements are necessary to prevent damage to the barrel and the carriageway under which it passes. The main parts of a culvert are (see Figure 28.5):

a. **Barrel.** The channel through which the water flows.

b. **Headwalls.** The walls supporting the shoulders over the end of the culvert.

c. **Wing Walls.** Retaining walls set at an angle to the headwalls, to support the shoulders and inner slope of the side drain.

d. **Apron.** A hard floor, either concreted or stone pitched, to prevent scour at the exit end (not shown).

e. **Silt Trap.** A catchpit or sunken box at the entrance to the culvert, to trap material washed down from the side drains which might block the barrel. An apron may also be needed at the inlet, with a catch pit to trap debris.

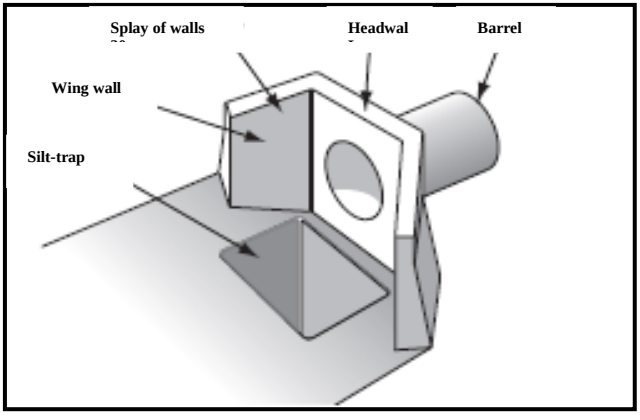


Figure 28-5: Culvert Inlet with Silt Trap

2814. Permanent Culverts.

a. Spans less than 5 ft.- pipe or box culverts are normally used.

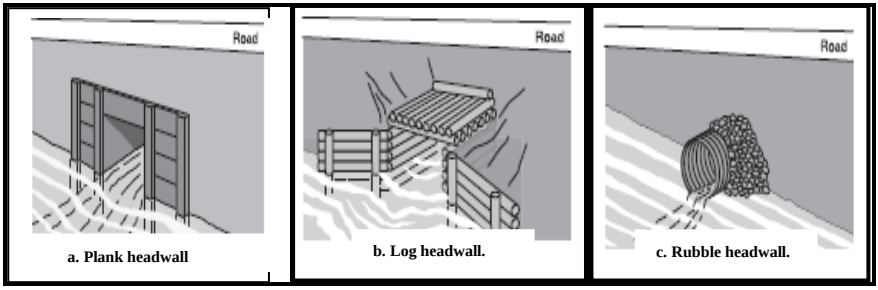
b. Spans exceeding 5 ft.- on operational routes, a series of pipe culverts may be satisfactory, for more permanent work, culverts of reinforced concrete, brickwork, or masonry are advisable. Reinforced concrete box or slab culverts are recommended unless skilled masons are available.

c. Arch culverts (5 to 10 ft.)- A typical design is shown in Figure 28.10, and recommended dimensions are given in Table 28.3.

d. Spans exceeding 10 ft.- a single span bridge is recommended.

Culvert Construction

2815. Culverts can be constructed of many kinds of material or prefabricated pipes. Types and designs of culvert are given in Table 28.2. For tasks within the scope of this book, pipe or box culverts are likely to be used as they have the merit of being quick and simple to lay. Arch culverts in brick work or masonry may sometimes be used, but their construction is slow. Examples of pipe and box culverts are illustrated in Figures.



a. Plank headwall

b. Log headwall.

c. Rubble headwall.

Figure 28-6: Some Methods of Culvert Construction

2816. The Service-supplied culvert (Armco) is shown in Figure. It is laiddirect on soil with end lapped joints staggered top and bottom. The soilmust be well compacted around it. The minimum cover required is 300mm for up to 0.6 m diameter pipe and thereafter half the diameter of thepipe. Sizes exist up to 2.20 m diameter.

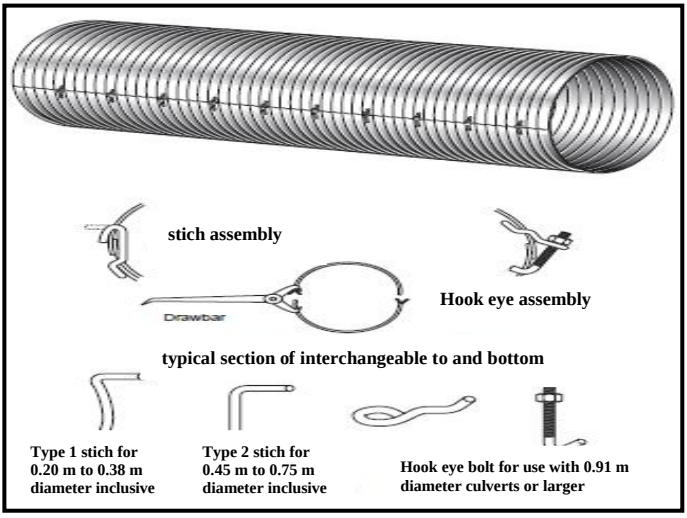


Figure 28-7: Armco Culvert

Figure 28-8: Aquapiping

2817. Improvised culverts are sometimes necessary and may prove satisfactory for a short time. However, they should be replaced as soon as possible by more permanent types, particularly if continued use of the road is envisaged. Various designs are shown in Figure 28.9 and are described below:

a. A form of pipe can be made up from oil drums with the ends cut off as illustrated in Figure 28.9a, or it can be built from spars or planks, forming a box culvert (*see* Figures 28.9b and 28.9c).

b. Box culverts, though not strictly improvisations, are very simple to construct. The opening should be approximately 300 mm wide by 150 mm high. If suitable spikes are not available for fixing the short cross timbers to the longitudinal ones, spreading outwards that occurs under load can be prevented temporarily by driving in stakes at each end of the culvert or lashing together a number of the short timbers at each end before the earth covering is added.

c. The thickness of the timber in the timber box culvert shown in Figure 28.9c should equal the overall width of the culvert, measured in mm, divided by 5: thus in the example shown it amounts to 60 mm. Small timber may be used, but this would reduce the size of the opening, resulting possibly in more than one culvert being necessary.

d. Figure 28.9d shows an open culvert in which 150 mm timbers, with a 100 mm gap between them, are laid across a road; they are supported on bearers to which they are fixed with spikes. When round timbers are used, notching is necessary to provide proper bearings. If, in addition to fixing by spikes, dogs can be used as spacers, a stronger job results and the likelihood of the timbers being pushed together by the impact of wheels is reduced.

e. Hollow blocks, which are now used extensively in building, can be used effectively, but whatever method of construction is adopted, improvised culverts must be regarded as temporary measures. With the possible exception of the examples shown in Figure 28.9b and c, they should be replaced by properly designed and constructed culverts at the earliest opportunity.

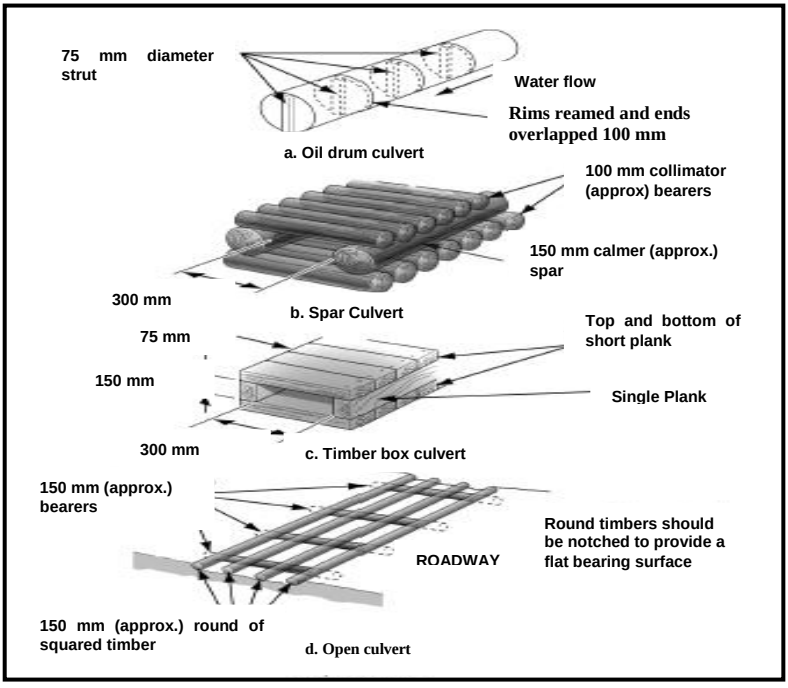


Figure 28-9: Improvised Culverts

TABLE 28.2 – TYPES AND DESIGNS OF CULVERT

Ser No	Types	Sizes	Construction	Remarks
(a)	(b)	(c)	(d)	(e)
1	Pipe culverts-Stoneware	Up to 24-in dia	Spigot and socket joint. Over 18-in dia bedded in concrete. Minimum cover; 2ft	Pipes with over 20ft or under 3 ft cover surrounded by 6-in concrete
2	Concrete tubes	Up to 5-ft dia	Ogee joint. Concrete bed and surround desirable	Liable to damage
3	CI pipes	Up to 4-ft dia	Cement mortar jointing. Concrete bed not necessary	Strong, Suitable where cover is small
4	Armco	8-in, 12-in, 18-in, 24-in, 30-in, 36-in, 50-in, 84-in	Lap joints, staggered top and bottom. No concrete require	Engineer stones. Usual sizes available: 8-in and 12-in
5	Drums, 40-gal	Approx 2-ft dia	Surround necessary for protection (6ins concrete preferable)	Improvisation. Ends cut out of bitumen or fuel drums
6	Box culverts-RC slab	Spans of 4-ft and upwards	Brick walls, 9 ins to 1 ft 6 ins thick	Slow, Expensive in materials. Shuttering required
7	Stone slab	Up to 4-ft span	Foundation: concrete or header stones. Invert: pitched stone jointed in cement	Suitable only when good stone is available locally

8	Timber box culvert	12-ins x 12-ins 18-ins x 18-ins 24-ins x 24-ins 30-ins x 30-ins 36-ins x 36-ins	Legs and sills framed and dogged together. Longitudinal lining of squared or round timber blended with brushwood or gravel	Local timber suitable squared or log. Creosote before laying
9	Arch culverts-Brick or masonry arch	Spans of 5-ft and upwards	Brick wall battered 6/1. Rise of arch: ½ span. Minimum cover: 1 ft 6 ins	Slow, Skilled work, Centering required

TABLE 28.3: DEMENSIONS OF ARCH CULVERTS

(seeFigure28.10)

Suitable for ordinary road loads. Rise of arch $=\frac{1}{4}$ span*

External batter of abutments: 6 in 1

Serial No	Item	Span of culvert			
		4ft	5ft	6ft	10ft
1	Rise of arch ring (H)				
2	Internal radius of arch ring ®				
3	Thickness of arch ring (t) – Best PC concrete or best ashlar masonry				
4	Fair PC concrete or second class masonry				
5	Good brick or rough masonry, in cement or best lime mortar				
6	Thickness of abutment at springing (A)				
7	Height of abutment at springing (B)				
8	Inside height to springing (C)				
9	Over-all width at top (D)				
10	Over-all width at bottom (E)				
11	Load for pier (tons) foundations #				
12	Load for abutment (tons) foundation #				

*The thickness o fill over the crown of the arch, from top of arch ring to road surface, should be not less than 1 ft 6 ins.

#Foundation loads given are per foot width of arch and are calculated for minimum (18-in) cover. Greater thickness of cover will increase the load on foundations.

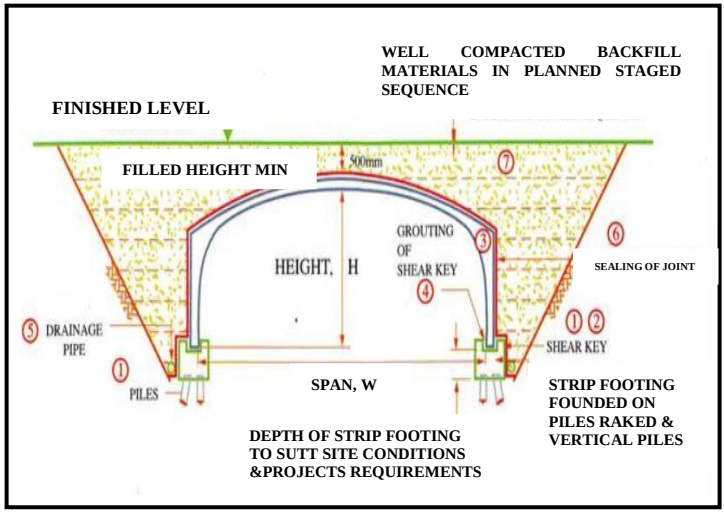


Figure 28-10: Typical Design of Arch Culv ert

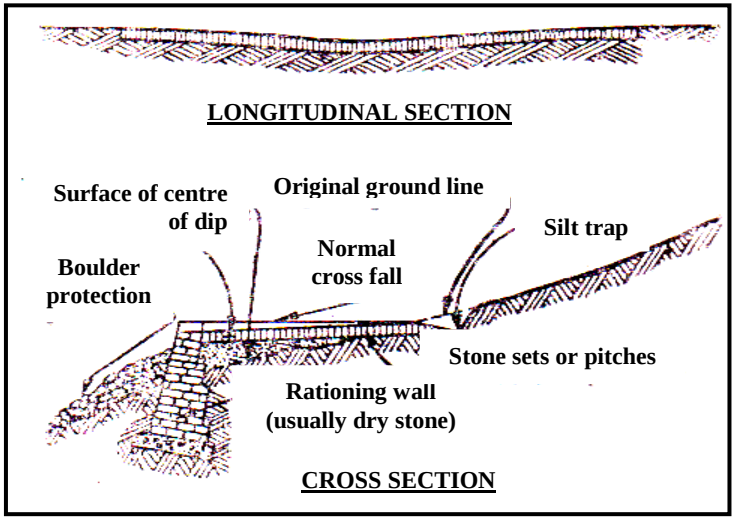


Figure 28-11: Diagrammatic Sketch of An Irish Bridge