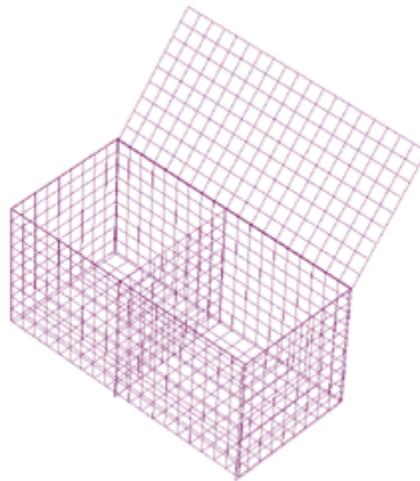


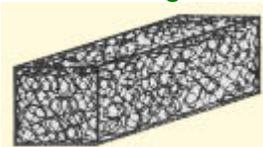
Gabions



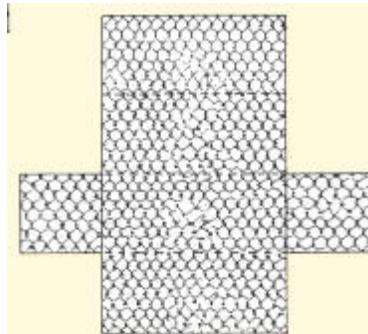
Introduction

1. A gabion is a **wire mesh cage or basket filled with stones**. Gabions are useful in construction works, for example to protect earth embankments, to line channels, to manage or divert river or stream flow and to protect river banks or coastlines.
2. We can buy wire mesh baskets and make our own gabions. The standard gabion basket consists of a single piece of wire mesh that can be assembled to form a rectangular box with a lid.

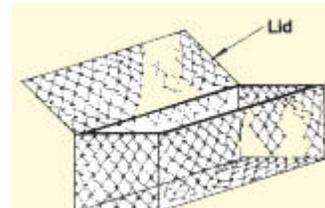
Stone-filled gabion



Galvanized wire mesh ready to be assembled



Wire mesh basket assembled

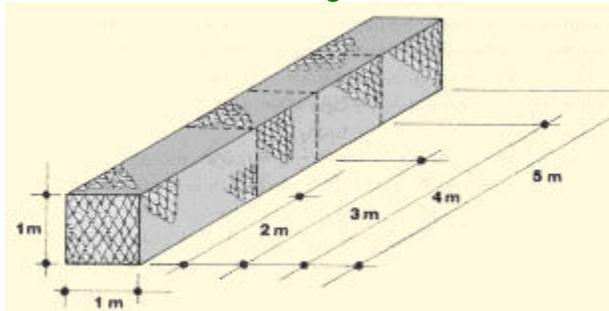


3. Wire mesh baskets for gabions can usually be found in two standard sizes. They are for:

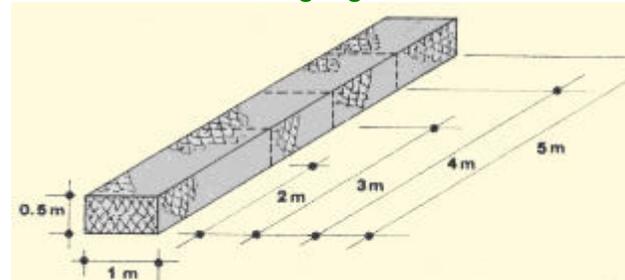
- full-height (standard) one-metre gabions;
- half-height half-metre gabions.

4. The width of a standard basket is usually 1 m, and the length varies from 2 to 5 m or more.

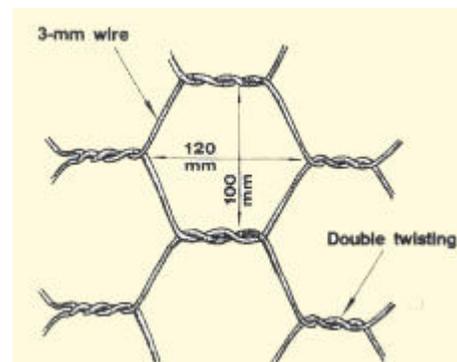
Standard gabion



Half-height gabion



5. Galvanized steel wire is used for making baskets for gabions. The wire is usually 3 mm in diameter and is twisted to form a mesh opening from 100 to 120 mm wide. Both single and double twist mesh are available, although double twist is better.

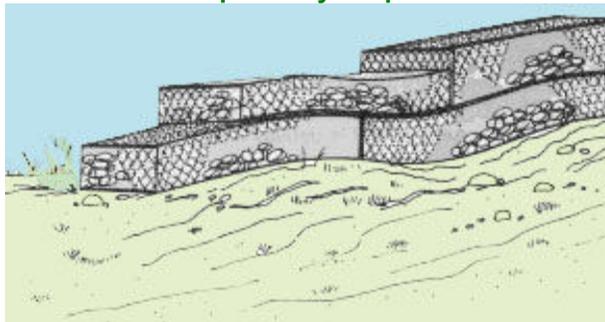


Advantages of gabions

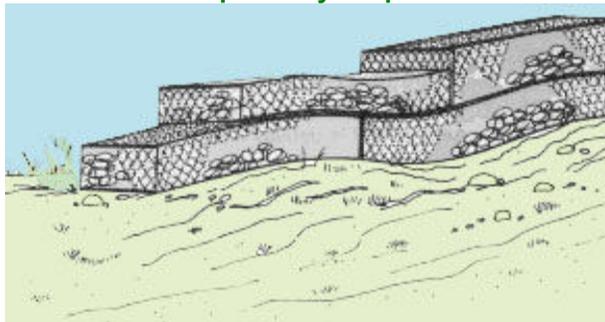
6. Gabions have a number of important advantages in construction:

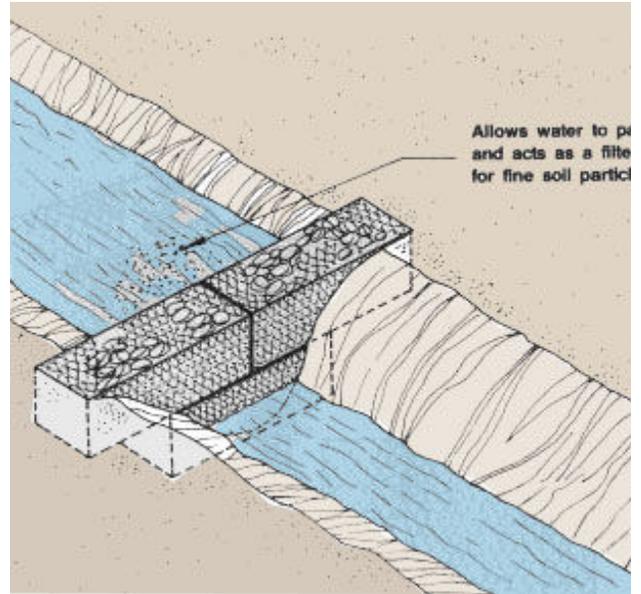
- **homogeneity and stability**, holding together and maintaining strong resistance to water current. Although containing small units (rocks, stones), each basket acts like a single large unit;
- **pliability**, adapting their shape easily to the ground contours even as these change gradually;
- **permeability**, allowing water to run through and act as filters for finer soil particles, thus giving protection to less stable materials;
- **simplicity** of design and easy, rapid construction;
- **economy**, using locally available stones that cost nothing.

Shape easily adapted



A three-gabion barrage

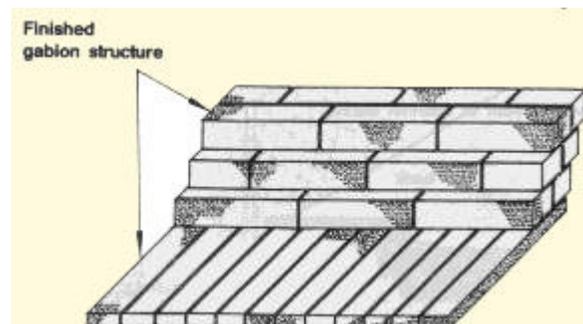
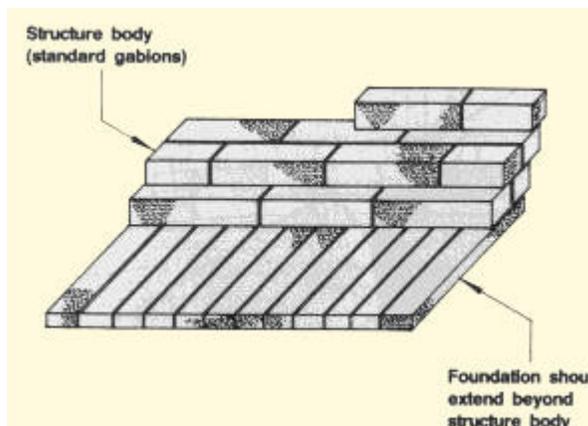
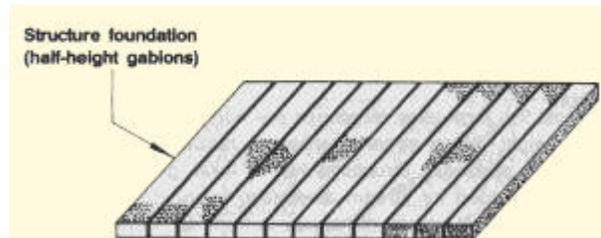




Designing gabion structures

7. Gabion structures normally consist of two parts:

- **the foundation**, which must protect the structure against undermining. It is usually made of half-height baskets and should extend well beyond the main structure body;
- **the body**, which should resist the forces present. It is made of standard baskets of various sizes that are piled up in one or more rows according to the total height required.

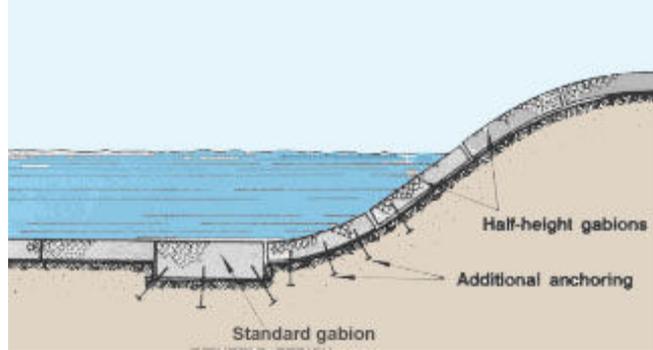


8. Half-height gabions may also be placed on sloping river or stream banks or terraces.

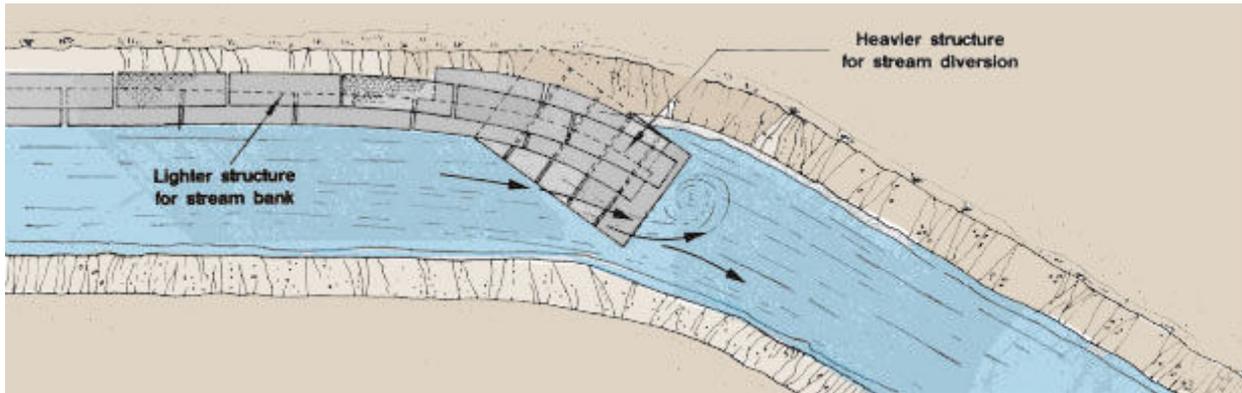
River or stream banks

The gabions must be well supported at their base.

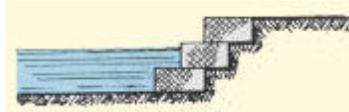
9. For most fish farm uses, structures are not more than two or three gabions in height. Along stream banks or channels, a single gabion width is usually adequate. Structures two or three gabions or more in width may be needed for stream diversions in rapidly flowing water. Normally, the slope of gabion structures is from 45° to near vertical.



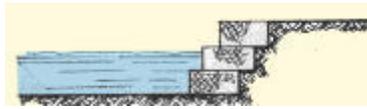
River or stream diversion



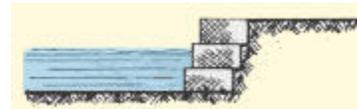
River, stream or channel banks
45° bank



30° bank



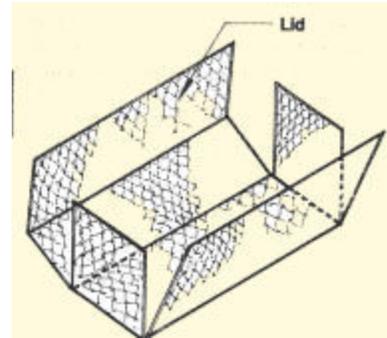
Nearly vertical bank



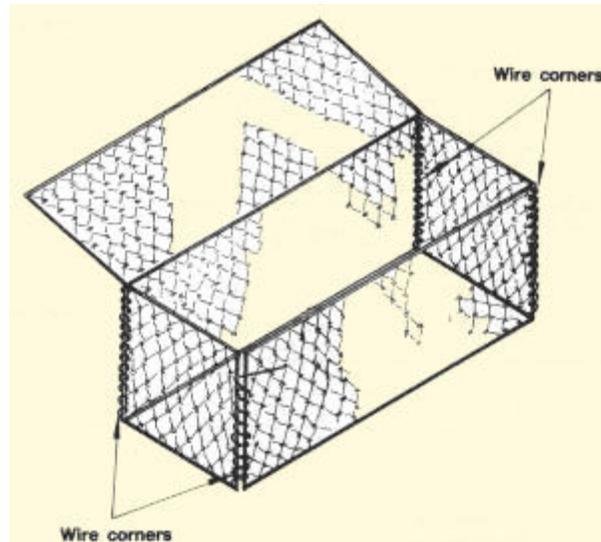
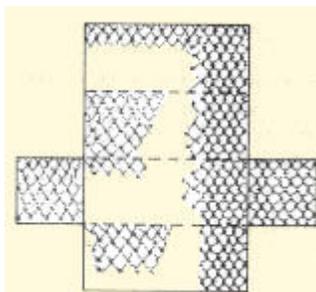
Building a gabion structure

10. Wire mesh baskets are built one at a time, put in place according to the design of the structure and then filled with stones. The following steps will tell you what to do.

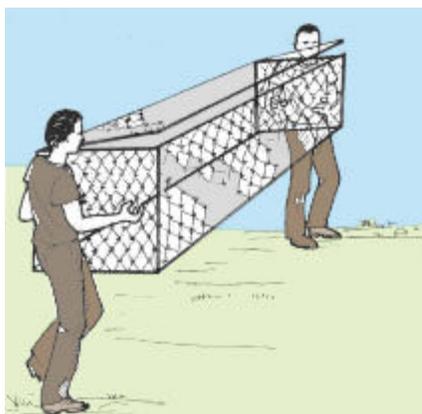
- (a) Begin the first basket by unfolding a section of wire mesh and stretching it the lid open.
- (b) Fold the front, back and sides to form a box with out flat on the ground.



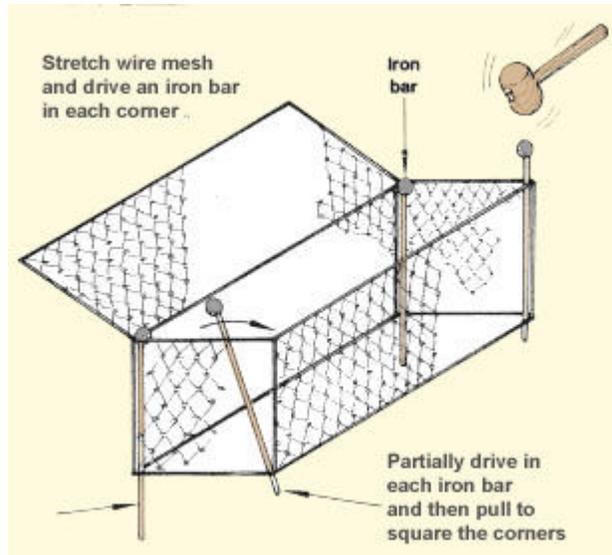
(c) Securely wire the four corners of the mesh box together as shown. This should be done very carefully using galvanized steel wire of the same quality and diameter as the mesh wire. Do not pull the wire with pliers, because you may tear and weaken the box.



(d) After you have wired the four corners together, carry the basket to straight and square where you will use it.



(e) When a basket is in position, make sure that it is straight and square. To do this, stretch the front, back and side, driving a 1.5-m iron bar into each corner as shown. As each corner becomes straight and square, drive the bar into the ground to hold it in place.

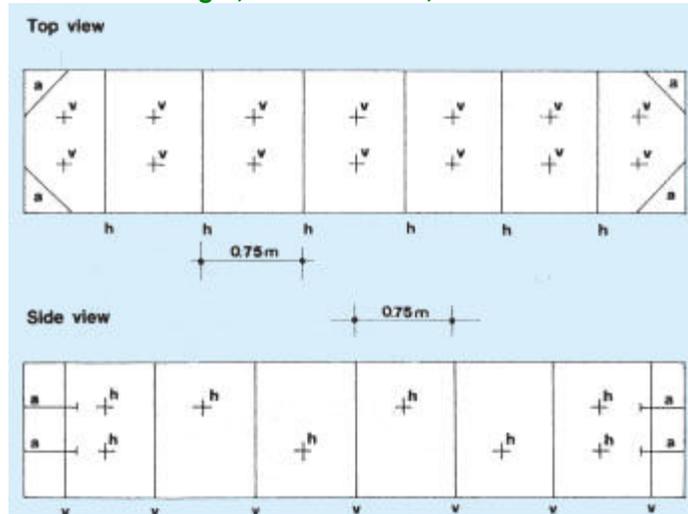


11. Each mesh basket must also have **extra wire bracing** to help support the weight of the stones when the basket is filled. As braces, you can use the same wire you used to secure the four corners of the box.

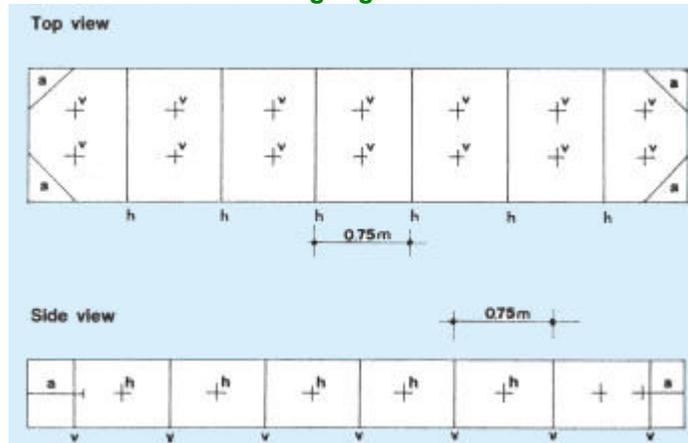
12. The vertical braces are attached as soon as the basket is in place. The horizontal and angle braces are added as the baskets are filled with stones.

13. The drawings show you where to put vertical, horizontal and angle braces, both for a full-height gabion and for a half-height gabion.

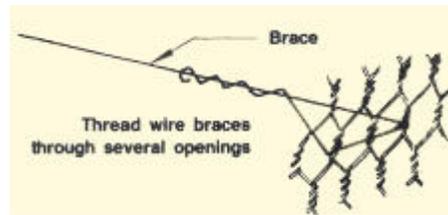
Braces for full-height gabion - 1 x 1 x 5 m
a = angle; h = horizontal; v = vertical



Braces for half-height gabion - 0.5 x 1 x 5 m



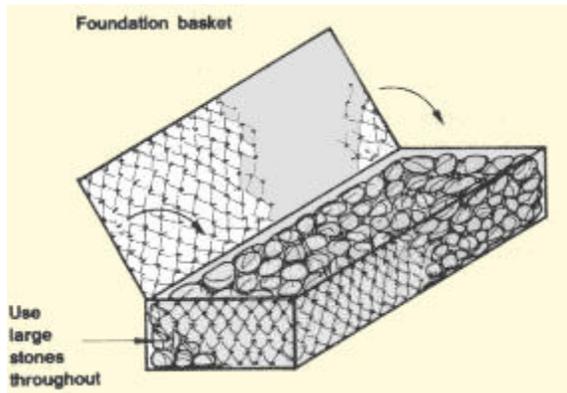
14. Each brace is attached by threading it through several of the wire mesh openings.



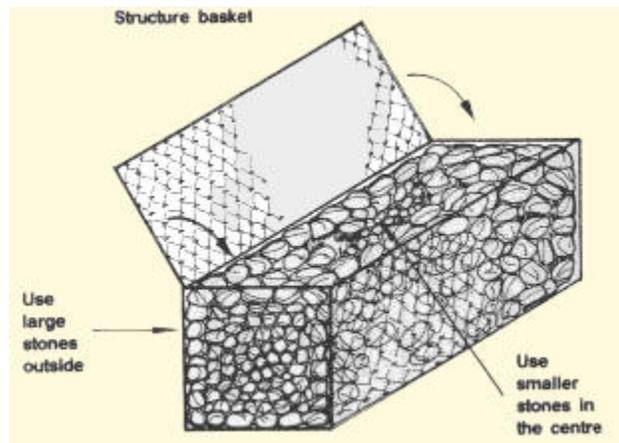
15. Now you are ready to start filling the basket with stones.

16. A **foundation basket** is best filled with round or rounded stones at least one-and-a-half times as large as the openings in the wire mesh. Avoid using stones larger than this. If the stones are too large, you cannot easily deform the basket to fit irregular or curved sites such as stream banks.

Note: try to choose stones that fit closely together so that there will be no large empty spaces in the basket.

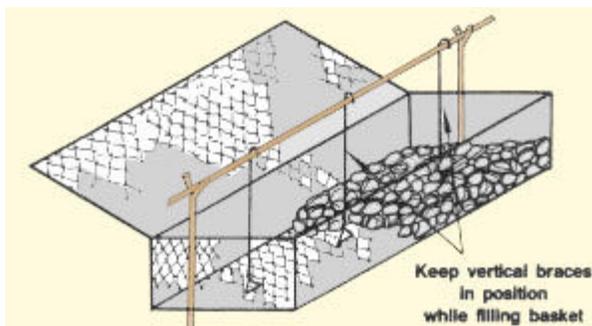


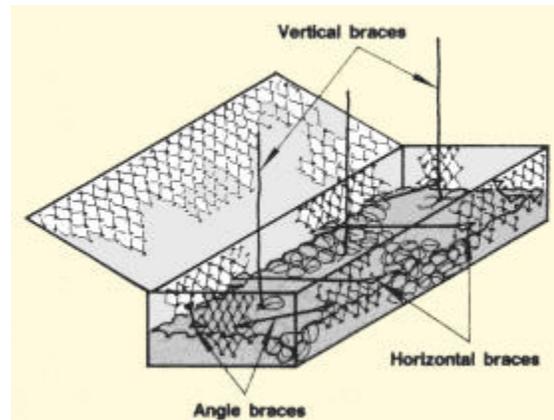
17. A **structure basket** is also best filled with stones, at least one-and-a-half times as large as the openings in the wire mesh. However, if you do not have enough large stones, you can use smaller stones in the centre of the basket if they are at least 8 cm in diameter. If you use smaller stones, first line the bottom and sides with large stones, then fill the centre with smaller stones and finally cover the top with a layer of large stones.



18. When you are filling baskets with stones, **make sure that the vertical wire braces stay vertical.**

19. Attach the **horizontal braces** and **angle braces** from time to time as you put in the stones.

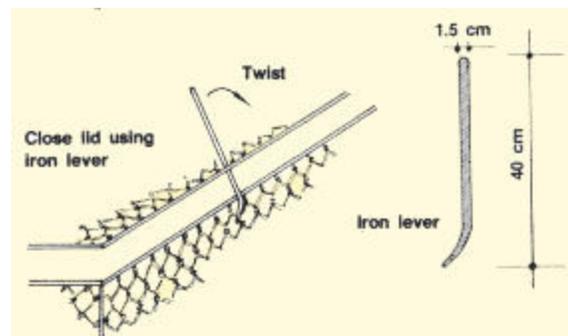
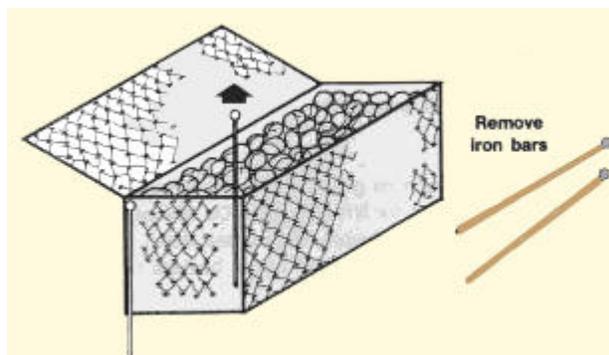




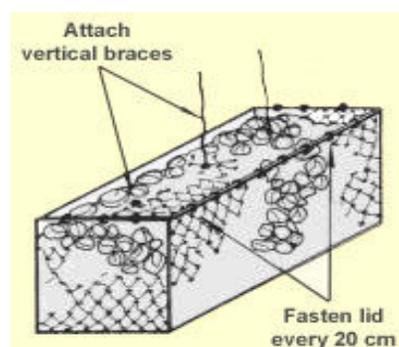
Note: use hard stones such as granites, quartzites, sandstones, laterite and hard calcareous stones for filling baskets. Do not use schists, gneiss or serpentine, which are too friable, may break down in strong water currents and may eventually wash out of the baskets causing them to collapse.

20. When the basket is filled with stones, you can remove the iron bars from each corner.

21. Close the lid of the basket, pull the edges tight and fasten them every 20 cm with galvanized steel wire, using a short piece of iron for a lever as shown.



22. Finish the basket by attaching the vertical braces to the lid.



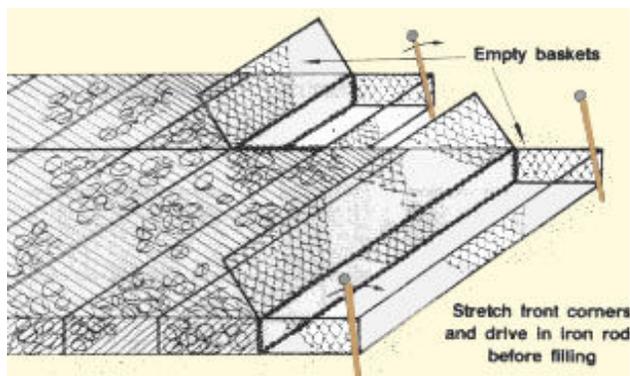
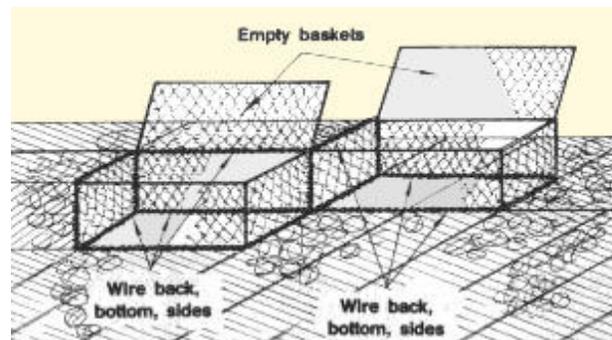
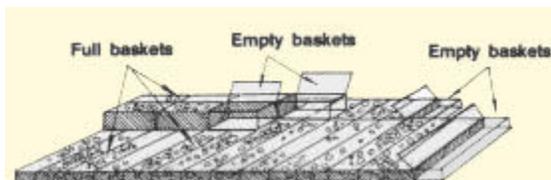
23. After the first basket is in place and filled, **add empty baskets** one by one according to the design of the gabion structure.

(a) Wire the back and sides of each new basket to the filled baskets already in position.

(b) Stretch the front corners of each empty basket using a 1.5-m iron bar until the basket is straight and square. Then hold it in place by driving the iron bar into the ground or into the gabion below.

(c) Attach the braces and fill the basket with stones as before. Remove the iron bars. Fasten the lid and attach the vertical braces.

24. Continue to add more empty baskets until the gabion structure is finished.



Gabion barrier

5. These baskets can be used very effectively in small streams with **a maximum flow of less than 100 l/s** to divert part of the water and to act as a spillway when floods occur. They are particularly suitable when gravel is found on the streambed and when the stones can be found locally.

6. Proceed as follows:

- (a) When the water flow is minimum, **divert the stream** around the construction site.
- (b) Stake out the base of the barrier you wish to build, for example, a rectangular area 3 m wide across the streambed, at a **right angle to the flow direction**.
- (c) Across this area, prepare a **horizontal platform** at a depth of about 0.5 m below the streambed level.
- (d) **Build the foundation of the barrier** on the horizontal platform, using one layer of **thin gabions** (2 m x 1 m x 0.5 m), as shown in Section 3.7.
- (e) On top of this foundation build **the body of the weir** using two layers of **thin gabions** placed across and on the upstream part of the foundation. Anchor these baskets well into the stream banks and into each other.
- (f) If necessary, **protect the banks** above the second layer with additional lateral layers of **thin gabions**. Fill in the gaps with compacted clayey soil.

Gabion barrier in a stream

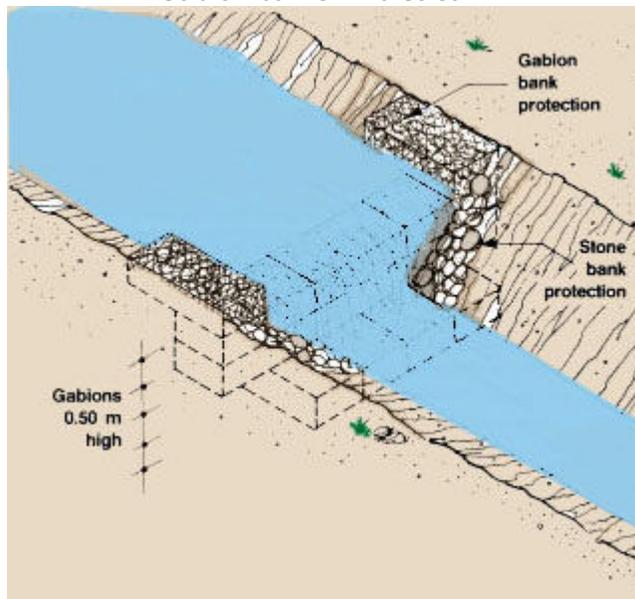
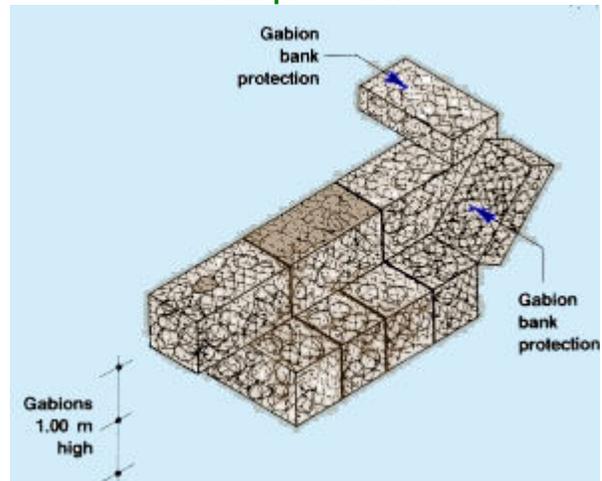


Diagram of a gabion barrier with additional bank protection



Installation

After the number, size and location of drops have been determined, installation may proceed as follows.

1. Determine the volume (m^3) of gabion rock (75-125 mm) required to fill all the baskets, and apron areas as required. The rock weighs approximately $1.8t/m^3$, and should be trucked from pits as close as possible to the gabion locations.
2. The wire gabion basket is transported flat, is very light (approx. 15 kg each) and several can be carried at once in the back of a pickup truck.

3. Filter cloth should be used liberally under the baskets, extending up the sides at least 1 m beyond the baskets, and at least 2 m up the waterway to help prevent 'tracking' of water downward, in front of the baskets. Filter cloth allows water to drain through it and the baskets, but holds the soil behind and under the baskets. Joints should be overlapped at least 0.5 m.
4. The waterway should be staked with reference heights to ensure that the gabions are installed at the correct elevation.
5. The gabion structure must be installed perpendicular to the waterway flow.
6. The gabions are installed as 'steps' with the top basket across the waterway sitting on 2 or 3 gabions running parallel to the waterway. A rock of 125 mm or larger beyond the exit apron gabions may be necessary to prevent undermining as the water exits from the drop. In most cases the total apron length will be 1–2 m.
7. The exit apron gabions need not be as wide as the entrance gabion to save on cost.
8. A 1 m length of riprap (125 mm rock or larger) 0.2 m in depth is required above the entrance apron to protect the structure from upstream erosion.
9. Baskets should extend well, i.e. 0.6 m (2 ft.) into the bottom and sides of the channel to prevent washouts underneath or around the sides.
10. The centre of the spillway should be as wide and flat as possible.
11. Bank walls can be made from heavy, treated lumber or rock to protect the entrance banks, and should extend 1 m minimum up the bank and up the waterway as far as the entrance apron.

Depth of Water Over Drop, Ft. (m)	Width of Exposed Entrance Apron Gabion, Feet (m)	
	4' (1.2)	8' (2.4)
	Discharge, ft³/s (m³/s)	
0.5 (.15)	4.5 (0.13)	9.1 (0.26)
1.0 (0.3)	23 (0.65)	25 (0.71)
1.5 (0.5)	36 (1.0)	47 (1.33)

It has been determined that about 0.75m³/s of runoff water must be transported down a steep slope, and that one gabion basket dropping the water 0.5 m (1.5') will be used to create a shallower sloped waterway both above and below the drop. Determine the gabion basket drop structure size and materials required to build the structure.

Solution

From Table 1 one practical alternative is to provide a 2.4 m (8 ft.) wide entrance apron, with an anticipated water depth of up to 0.3 m (1 ft.). Gabions are generally available in standard imperial sizes for drops of 1, 1.5, 2, and 3 ft. Widths are available for 6, 9, and 12 ft, with a depth of 3 ft being standard. This provides 12 gabions of various sizes. In this case use a 12 x 3 x 1.5 ft. gabion for the entrance gabion, sitting on 3–6 ft. x 3 ft. x 1ft. gabions running parallel to the waterway.

With a depth of 0.5 m of water expected (including freeboard), 125 mm rock should be provided up the sides of the waterway about 1.5 m, both above and below the drop at a depth of 0.2 m. A 1.0 m length of entrance and exit apron of rock should be provided, also to a depth of 0.2 m.

In order to be under all the rock and baskets, the filter cloth must be at least 8 m long by 8 m wide.

Assembly and Erection:

Gabion Boxes / Mattresses are packed in convenient numbers per bundle, in a folded, flat form. Normally top lids are packed separately as they are only secured after the bottoms have been filled. Sheets are laid flat, without creases to form the required boxes/mattresses. The sheets are then connected with lacing wires in a sequence.



The sheets are then systematically folded. Care is taken to ensure rectangular shapes maintained with exact distances between shapes.



Gabions should be filled with hard natural stones. The stones should be of a non-variable texture, weather of a high density. The size of the stones should be at the mesh. Stones are to be packed tightly, with a Care is taken to level the stones at different stages, to retain original size and shape. This prevents bulging.



natural or quarried resistant and preferably least twice the size of minimum of void space. connecting wires used

The bracing wires are used at regular intervals of 300mm in order to retain the original shape and prevent bulging. Where "Jumbo" boxes/mattress are used diaphragms are placed and connected with tie wire at regular one metre intervals.



At the time of erection large numbers of boxes/mattresses are used - it is necessary to tie and so as to form one intergrated structure. Tie wires are selvedge wires of adjoining Gabions at regular intervals. secured by triple loops.



connect them in series used to connect The loose ends are fully