GABIONS AND GABION STRUCTURES

JOHN P. WESCOTT, *Technical Advisor*

Webster defines "gabions" as follows:

> "gabion (ga bi an). (Fr. It. gabbia, cage L. cavea.) 1. a cyliner of wicker filled with earth or stones formerly used in building fortifications. 2. a similar cylinder of metal used in building dams, foundations, etc."

If we use this as the first part of a modern definition and if we then paraphrase and slightly change a famous Latin motto, *Flectar Non Frangar*, I bend but do not break; we will have the essence of the gabion principle—for this one feature accounts for one of the primary technical advtantages of a gabion structure over rigid and semi-rigid types.

Gabions come from Italy where for 68 years the Maccaferri Company has been transforming the ancient art of building with stone. Gabion wire baskets (the building blocks of gabion structures) have in eleven states including eight of our National Forests enabled men using local stone to erect structures protecting roads, bridges, streams, land, water supplies and now, most unexpectedly to our Company, benefiting fishing streams.

Workers handling gabions and building structures find their greatest asset is their simplicity. The largest 13-foot-long gabion basket weighs not quite 100 lbs. It is easily handled by one or two men. Shipped flat to the building site with the necessary connecting wire and wire ties, the baskets can be quickly assembled and wired together into structures. Only a leveling of the cite is necessary before placing the gabions. *It is important to first stretch the empty units.* Stretching makes for better aligned, better appearing and stronger structures. Devices like a crowbar or a regular fence stretcher have been used effectively.

With little supervision, men unskilled in gabion work can within a few hours be erecting excellent gabion structures. It is important the foreman sees to it that the recommended number of wire ties and connecting wires are being used and that the stones are of proper size. The engineering designs are easily understood, simplified by the constant length, width, height and rectangular shape of the baskets being used. Thus, a minimum of highly trained supervision is required. Work crews are effectively employed, since the several tasks of assembling, wiring together, stretching and filling the gabions and procuring stone can be carried on simultaneously in different work areas.

Gabions come now in nine sizes, lengths of 6'6", 9'9", and 13'1", depths of 3'3", 1'8" or 1' with the one width of 3'3". Thus they are adaptable when forming structures and meeting varying ground conditions. Corners and curves are formed by angling one empty gabion box more or less into its neighbor before wiring them together. Also, various shapes can be formed by cutting and folding a basket as is desired.

Clean stone, quarry rock or such suitable fill is necessary for gabion work. Coral rock and broken concrete have been used in places without stone. The aim when filling is to build a structure which is flexible, permeable, without large voids, strong and long-lasting. Foreign matter should be kept out; only clean rock used. Stones between 4 to 15 inches are recommended; and for aprons, where maximum flexibility and strength are needed, the use of smaller, rounder stones of 5 to 8 inches in size is ideal. Since the apron folds down protecting the structure fully as it counteracts the undercutting, erosive action of water, it must be highly flexible. To fill only with clean stone, various devices have been used including rock forks, scoops and buckets modified to drain out gravel and dirt. The ⅜ cubic yard clam shell and dragline can also be used. Hand placement of rock along all visible faces is usually the best procedure, completing the fill by hand or by machine.

The use of gabions in Italy has become so commonplace and popular that gabion construction is frequently mentioned in the technical books of their engineering colleges. Remarkable technical achievement there includes the construction of dams and extensive works of protection and river training in the Po River Valley and Alpine regions, and many other structures all over Italy. Groynes, weirs and retaining walls are extensively used. One magnificent example is an 82-foot-high retaining wall

protecting an Italian highway. Nearly 20 feet thick at its top, over 32 feet at its base, this wall contains about 5,000 gabion baskets. Each square yard of its base withstands a pressure of approximately 36 tons, road weight not included. Gabion baskets are also much used there in drainage works.

The Maccaferri Organization has now made possible the use of gabions in many parts of the Western World. People in countries as far apart as Indonesia, Canada, Venezuela and Sweden now have in common this reliable method of controlling the forces of water.

Gabion structures are planned as permanent structures. The heavy zinc-coated, triple-twisted hexagonal mesh wire (also plastic-coated for use in sea water or in polluted water or air) is designed for long wear. If a wire should break, the break is contained, and it can be readily mended. Fast-moving water, with abrasion, causes the greatest wear, but even here in most cases only the outer faces of the gabion structure are exposed to abrasion. In Italy, where the Maccaferri Company first introduced the gabion method, there are several river structures built over 50 years ago which are still in perfect condition.

Such structures usually become covered with a protective mantle of gravel, silt, leaves and in some places, sod. Effective as ever, they have become permanent parts of the stream or stream bank.

Gabion structures in the United States while not yet including an 82 foot-high wall are, indeed, already quite impressive. On the North River in the George Washington National Forest of Virginia many of the planned 79 retaining walls, 33 groins and 6 weirs are in place. Likewise in the White Mountain National Forest of New Hampshire, extensive gabion construction continues on the Zealand River. Many other jobs on highways and streams can now be seen in our eastern states and shortly on the West Coast, where construction is now underway.

A development surprising to the Maccaferri Company, but probably not so to some of you, is the interest and use of gabions for fish stream improvement. Deeper pools, rapid aerated waters, silt removal with improved feeding and spawning areas are some benefits obtained using gabions. One or more gabions as deflectors, as V-shaped devices or as cross-channel weirs are excellent for these purposes. Examples of these structures can be viewed on fish streams in the Monongahela National Forest of West Virginia, where they were erected by the Division of Fish Management of West Virginia. It seems that the top national authorities on trout have found that the main limiting factor for trout reproduction is the water temperature of June through September. By improving the streams and providing cover, the gabion structures are helping fishermen to more and bigger fish.

The cost of gabion structures built in the United States has been found to be from $10-15 per linear foot of apron plus first tier of super-structure, and $8-10 per linear foot of the second tier of super-structure. Where the stones are available, two to three man-hours of work will fill one cubic yard of basket.

Gabions are a big and practical step ahead in the management of soil, water and fish stream problems. Added to the force-resisting ability of solid structures and the absorptive ability of stone rip rap, the filled gabion offers flexibility, greatly increased permeability (for drainage and absorptive power) and structural form without the need for erecting expensive forms. Furthermore, when bound together into gabion structures of from a few to many units, there is an important increase in the qualities of mass weight, stability, tensile strength, and in the self-deforming or correcting habit which makes the gabion structure a most natural, one can almost say intelligent form of protective device against the forces of nature.