For:
River training
Earth control and soil conservation
Retaining structures
Landscaping
Lining of canals and dams
Marine works
Rockfall protection
Gabion baskets
an ancient concept in a modern form...

Although it is known that gabions have been used from ancient times, it is only in the last few decades that their widespread use has led them to become an accepted construction material in civil engineering. Modern technology has made possible the manufacture of these reliable and sound products, using mild steel wire mesh. The wire is woven into an hexagonal pattern, with double twist joints which prevent the whole mesh from unravelling should a wire break or be cut.

...supported today by laboratory tests.

Research into the behavior of gabions and Reno mattresses has been carried out in both full and model scales at:

Fig. 1 - U.S.A. - Colorado
Hydraulic Laboratory at the Engineering Research Centre, Colorado State University.

Fig. 2 - FRANCE - Grenoble
SOGREAH Ingenieurs Conseils.

Fig. 3 - HOLLAND - Rotterdam
Delft Hydraulic Laboratory at Hartel-Kannel.

Fig. 4 - ITALY - Bologna
University of Bologna
Laboratorio di Scienza delle Costruzioni.

Fig. 5 - ITALY - Bologna
Officine Maccaferri SpA
Factory, in cooperation with Bologna University’s Laboratorio di Tecnica delle Costruzioni.
Advantages of Maccaferri gabion and Reno mattress structures

Flexibility
An outstanding advantage of the gabion is its flexibility. Its double-twist hexagonal mesh construction permits it to tolerate differential settlement without fracture, fig. 6. This property is especially important when a structure is on unstable ground or in an area where scour from waves or currents can undermine it.

Strength
The strength and flexibility of the steel wire hexagonal mesh from which gabions and mattresses are made is utilized to withstand and absorb the forces generated by retained earth or flowing water.

Permeability
Hydrostatic heads do not develop behind gabion structures because of their permeable nature. Their ability to combine drainage and retention functions make them ideal structures for slope stabilization, fig. 7.

Durability
A Maccaferri gabion or Reno mattress is a heavy monolithic gravity unit able to withstand earth thrust. Its efficiency increases instead of decreasing with age since further consolidation takes place as silt and soil collect in the voids and vegetation establishes itself (fig. 8-9).

Economy
Gabion installations are more economical than rigid or semi-rigid structures for a number of reasons. The following are the most important ones:
- Little maintenance is required.
- Gabion construction is simple, does not require skilled labour.
- Suitable stone fill is available normally on site or from nearby quarries.
- Minimum foundation preparation is required, the surface needs to be only reasonably plane.
- No costly drainage provision is required, as gabions are permeable.

Ecology
Because gabions permit the growth of vegetation and maintain the existing environment, they provide attractive and natural building blocks for decorative landscaping.
Description of the Maccaferri box gabion

Zinc coated box gabions
Box gabions consist of rectangular units, fabricated from a double-twist, hexagonal mesh of soft annealed, heavily zinc coated wire. The wire quality and the zinc coating meet all international specifications. The mesh panels are reinforced at all edges with wires of a larger diameter than that used for manufacturing the mesh, to strengthen them and to facilitate construction. Gabions may be divided into cells by fitting diaphragms which have the function of reinforcing the structure and making assembly and erection easier.

Zinc coated box gabions with PVC sleeve
The characteristics of these products are similar to those of the zinc-coated gabions; however the wire, prior to manufacturing the mesh, is coated with a 0.4 to 0.6 mm thick special PVC (polyvinyl chloride) continuous sheath. A complete protection against possible corrosion is thus obtained making the gabions suitable for use in marine or polluted environments.

diaphragms are always recommended when gabions are subject to continuous stress caused by wave motion, or high water velocity, etc. Filled with stone, gabions become a large, flexible and permeable building block from which a broad range of structures may be built.

Applications

RIVER TRAINING

Fig. 11 - ITALY - Campania
Longitudinal walls on river Lete.

Fig. 12 - YUGOSLAVIA
Weir on the Vranja stream.

Fig. 13 - MALAWI
Groynes for the protection of the Salima-Benga Road.
Applications

**EARTH CONTROL AND SOIL CONSERVATION**

Fig. 14 - REPUBLIC OF CAPE VERDE
Series of structures for soil conservation in Santiago Island.

**RETAINING STRUCTURES**

Fig. 15 - SAUDI ARABIA
PVC coated gabion wall near Dahran

**RETAINING STRUCTURES**

Fig. 16 - SWITZERLAND
Retaining wall for the protection of the railway near Alpnach.

**BRIDGE AND CULVERT PROTECTIONS**

Fig. 17 - BRAZIL - S. Paulo
Bridge abutments on Turvo river, near S. Jose dos Campos.

**LANDSCAPING**

Fig. 18 - CANADA - Quebec
River wall to a city park along the St. Lawrence in Candiac.

**MARINAS AND SEASHORE PROTECTION**

Fig. 19 - CANADA - Quebec
Marina walls at Matane; the work was carried out using PVC coated gabions.
Description of the Maccaferri Reno mattress

Zinc coated Reno mattress
The Reno mattress is a special form of gabion with a large plan area/thickness ratio. It is fabricated from a similar but smaller double-twist hexagonal mesh to that used to manufacture the gabions. The wire characteristics are the same. Diaphragms are spaced usually at 1.00 m centres, and a continuous panel of mesh forms the base, the side and the end walls of the unit to obtain an open-topped multicell container.
The same is used for the base, diaphragms, and the separate lid (made up with mesh panels - fig. 21a or mesh rolls - fig. 21b). All panel edges are selvedged with a wire of larger diameter than that used for the mesh, so as to strengthen the structure.

Zinc coated Reno mattress with PVC sleeve
The wire of the Reno mattress can be coated with PVC in the same manner as that for gabions.

Applications

RIVER TRAINING

SOIL CONSERVATION

Fig. 22 - U.S.A. - New York
Gabion bank protection near Buffalo.

Fig. 23 - ITALY - Tuscany
Drainage channel to stabilize a slope near Florence.
Applications

**CHANNEL LINING**

Fig. 24 - ITALY
Canalization and lining of the Fella stream (Udine).

**LANDSCAPING**

Fig. 25 - U.S.A. - Maryland
Lining of a stream near Frederick, along highway A40.

**CULVERT PROTECTION**

Fig. 26 - CANADA - Ontario
Culvert protection near Cornwall.

**BRIDGE PROTECTIONS**

Fig. 27 - AUSTRALIA
Protection of abutments of the «Sheridan» Bridge, State Highway No. 2.

**IMPERMEABLE LINING OF DAMS**

Fig. 28 - ITALY - Sardegna
Lochene dam (Nuoro) Xero mattresses can be sealed by hot poured sand asphalt mastic, in order to provide an impermeable revetment.

**MARINAS AND SEASHORE PROTECTION**

Fig. 29 - BRAZIL - Paraná
Protection of the Praia Mansa at Calicó.
Terramesh® System

The Terramesh® System is a soil reinforcement which consists of panels of double-twist hexagonal woven heavy zinc and PVC coated wire mesh. In order to strengthen the structure, the external face is provided with steel zinc and PVC coated reinforcing wires, int. Ø 3.4 - ext. Ø 4.4 mechanically inserted into the double twist. The external face, 0.50-1.00 m thick can consist either of stones (Terramesh® System) or vegetative soil (Reinforced Green Terramesh®).

The Terramesh® units are supplied already cut to measure without requiring to be cut on site. The Reinforced Green Terramesh® units are provided with a geofabric to retain the fines connected to the wire mesh during the manufacturing process: the external face is provided with an additional mesh panel and two triangular steel brackets, Ø 10 mm, to increase the unit strength and for an easier erection of the unit.

The Reinforced Green Terramesh® «soil type» units are provided with a geomat whereas the water type ones are reinforced with a polypropylene geogrid. A complete «greening» of the external face can be achieved by hydroseeding according to the real environmental local situation.

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Fig. 31 - AUSTRALIA - N.S.W.
Reconstruction of the Lawrence Margrove Drive at Clifton.

Fig. 32 - ITALY - Sardinia
Retaining works carried out with Green Terramesh® units along the road Bitti-Lula which connects the SS131 to the SS389.
Description of the Maccaferri sack gabion

The Maccaferri sack gabions are mainly used for river and stream training works. They are made up of a single sheet of mesh and are supplied with steel wire spirals \( a \) inserted during production to facilitate closing during the installation procedure. \( b \) The characteristics of mesh, wire, zinc and PVC coating are identical to those of box gabions.

Application

**Fig. 33 - ITALY - Lombardy**
Assembly of a sack gabion using a special machine.

**Fig. 34 - BRAZIL - S. Paulo**
Sack gabion foundation for a bank protection wall on the Tamanuatué river.

**Fig. 35 - ITALY - Emilia-Romagna**
Closing a breach of the Po river, near Ferrara.

**Fig. 36 - BRAZIL - São Paulo**
Construction of a longitudinal gabion wall founded on sack gabions along the Campesêre river at Linha.
Description of the Maccaferri rockfall protection netting

Wire mesh netting is often used to prevent rocks and debris from falling on to roads and railways. This solution can also help to establish vegetation.

Maccaferri rockfall mesh has the same characteristic as that used for gabions and Reno mattresses.

Thanks to the double-twist weaving, it is strong enough to withstand the force of the falling rocks and unlike chain-link mesh, does not unravel should some of the wires break.

Fig. 37 - ITALY - Liguria
Erection of netting by means of a helicopter, near Aremzian.
Fig. 40 - ITALY - Valle D’Aosta
Erection of netting carried out manually.

Fig. 41 - U.S.A. - Tennessee
Erection of netting by means of a crane, along Interstate 40.

Fig. 42 - ITALY
Lacing the netting.
Gabions and Reno mattresses installation procedures

Assembly
Gabions and mattresses are shipped folded and packed together in bundles, in order to occupy less space and make transportation to sites economical and easy (fig. 43). On site, they are opened and assembled as follows: corners are wired together and diaphragms are fixed to the side panels (fig. 44). Empty units are subsequently joined together along all adjacent edges, both horizontally and vertically (fig. 44).

Filling
This is usually carried out by mechanical means (fig. 45, 46) using rounded river shingle or quarry stone having a size slightly larger than that of the mesh, so as to have minimum percentage of voids. The use of hard material of high specific gravity is recommended.

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Fig. 43
Bundles of gabions ready for shipment.

Fig. 44
Assembly of a gabion structure.

Fig. 45
Gabion filling operation.

Fig. 46
Reno® mattresses filling and closing operation.

Fig. 47
New lacing tool for the installation of gabions, Reno® mattress and Terrameesh® units.
Example of works carried out in Far East territories

Fig. 48/49 - MALAYSIA. Pulau Langkawi Jetty with P. V. C. coated gabions. The figures show the work after the construction and some years later.

Fig. 50 - PHILIPPINES. Longitudinal River Flood Protection wall.

Fig. 51 - INDONESIA - Java. Gabion weir and counter weir on Bagor river.

Fig. 52 - MALAYSIA. Bed control weir at Parit Putih, Kelantan.
Fig. 53/54 - THAILAND
Huil Bua Weir: stepped weir, with downstream apron and lined banks.

Fig. 55 - BRUNEI
A slope susceptible to weathering at Goldhill has been stabilised with a gabion revetment.

Fig. 56 - BRUNEI
PVC coated Reno mattress apron for coast protection of the Brunei Shell Oil Company plant, Penaga.

Fig. 57/58 - MALAYSIA - Sabah
Gabion faced reinforced earth wall on Kota Kinabalu - Singuran Road, Mile 26.
A detail of the wall is shown in fig. 58.
Fig. 59 - MALAYSIA
Country: Sabah
Kota Belud Bridge Pier Protection.

Fig. 60 - MALAYSIA - Sarawak.
Reno mattress revetment at Kuching, constructed for the Sarawak Electricity Corporation.

Fig. 61 - BRUNEI
Culvert crossing on Benut Dam access Road.

Fig. 62/63 - BRUNEI
Sungai Lumut Flood relief channel.
Fig. 64 - MALAYSIA
Main drainage canal lining at Paka Power Station.

Fig. 65 - MALAYSIA
Reno mattress slope protection to sludge lagoons on Johore River Booster Water Supply Station.

Fig. 66 - BRUNEI
River longitudinal wall protecting the bank at Tutong.

Fig. 67 - MALAYSIA - Sarawak
River wall at Holiday Inn Hotel, Kuching.

Fig. 68 - BRUNEI
FUT gravity retaining wall for land terracing at Serasa school.
Fig. 69 - HONG KONG
Stepped revetment on unstable hillside above housing estate at Junk Bay.

Fig. 70 - BRUNEI
Reno mattress flood protection, revetment at Shell Oil Co. Generation plant, Lumut.

Fig. 71 - MALAYSIA
Gabion stepped weir on Saga River near Langkawi.

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