Enka® Solutions

Earthquake-proof embankments Mediterranean Bypass

Kingdom of Morocco

Project owner
Kingdom of Morocco

Products
EnkaGrid® PRO 40 to 180
EnkaDrain® 5004C/T110PP

Functions
Reinforcement, drainage and separation

Contractors
Arab Contractors
Houar
El Hajji
LRN
Seprob

Volume
Geogrid: 800,000 m²
Drainage: 70,000 m²
Geotextile: 100,000 m²

The construction of the Mediterranean Bypass is a major infrastructure project in the northern part of Morocco and of vital importance for the development of the region. The bypass crosses the Rif region which is known for its high seismic activity and many earthquakes.

Challenge
Seismicity is considered to be one of the primary causes of instability of embankments, slopes and mountainsides and demands the selection of highly flexible support technique with high inertia to withstand its effects. Moreover, the load applied by the structure on the slope should be as low as possible.

Solution
The use of earth walls reinforced with EnkaGrid PRO geogrids fulfilled these two requirements. In this instance the design called for 35 earth walls with a maximum height of 31 m on Pk 4 (see graph). All walls have an inclination of 1H/2V and their facing consists of 1m x 1m x 1m gabions filled on site, with a nonwoven geotextile ensuring separation & filtration functions between gabions and embankment materials. A drainage composite EnkaDrain Wide was also installed to ensure the drainage of the excavated embankments behind the walls.

Benefits of the solution
To ensure the earth walls are earthquake-proof, the wall constructions were designed in accordance with the French design standard NF P 94-270 which follows the European regulation Eurocodes. Eurocodes establish a semi-probabilistic approach to safety while applying the principles of limit state calculation with partial factors for the justification of the reinforcing elements. In brief, the effects of loads on internal and external stability are determined through combinations of different permanent or temporary loads in different seismicity- or accident-related scenarios, to ensure stability under the most challenging circumstances.

Levelling/compaction of the filling, gabions being used as well as temporary formwork, geotextile pending layer on the gabions
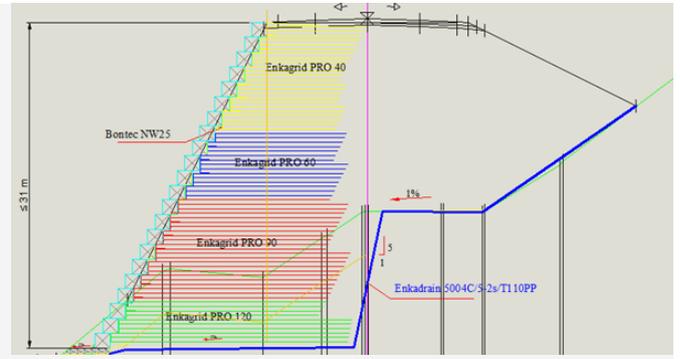
Typical cross section with decreasing tensile strengths depending on the height

EnkaGrid layers pending the levelling and compaction of soil layer

EnkaDrain in very aggressive conditions of use (tensile strength and puncture resistance)

EnkaGrid retaining solution minimised the load on top of the existing slopes

Installation benefits

Due to its large nominal aperture size (50 x 120 mm), the geogrids EnkaGrid PRO can be installed in all weather condition, particularly in windy conditions, which was often the case in this coastal environment.

Result

Project's context (e.g. presence of house at the toe of the wall PK4) and walls geometry (heights up to 31 m) led to demanding requirements on long term behaviour of the reinforcing material: EnkaGrid PRO geogrid offers a post-construction elongation (from t_0 = 10 h to t = 120 years) limited to 1%. This means that the geogrid elongation during the wall service life will not exceed 1%.

Products used

EnkaGrid® PRO
Uniaxial geogrid with laser welded straps for soil reinforcement

EnkaDrain® Wide
Drainage geocomposite with V-shape monofilament structure

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