Geogrids are planar, polymeric structures consisting of a regular open network of integrally connected tensile elements, which may be linked by extrusion, bonding or interlacing, whose openings are larger than the constituents, used in contact with soil/rock and/or any other geotechnical material in civil engineering applications. They can be made of high-tensile strength plastics or woven polyester yarns and are typically packaged at the factory in rolls. The first Geogrid was produced in the early 1980’s by extruding a sheet of polyethylene or polypropylene, punching a regular pattern of holes and then stretching the sheets. Such extruded and oriented Geogrids are called as stiff Geogrids. Another class of Geogrids—the flexible or textile grids – comprising a woven or knitted structure of high tenacity polyester filament yarn coated with a polymeric (mostly PVC) compound, were introduced in the mid 1980’s. Today a large number of companies worldwide manufacture coated polyester Geogrids. Thus, PVC coated polyester Geogrids have a successful history of almost 25 years.

Geogrid Reinforced Soil Wall:

Geogrid Reinforced soil retaining walls are internally stabilized systems wherein the fill reinforced with multiple layers of reinforcement behaves as a coherent composite mass and resists earth pressures from the retained fill and other externally imposed loads. Hence the fill material plays an equally important role as the reinforcement and due care has to be exercised in the selection of appropriate type of fill and determination of the properties for design.
The following properties of fill are important:
- Effective cohesion ($c'$): Normally taken as zero for most soils
- Peak effective angle of shearing resistance
- Particle size and gradation
- Unit weight
- Compaction characteristics
- Chemical properties

Generally a free-draining granular fill without excessive fines and having high angle of shearing resistance and free-from organic and other deleterious materials is ideal for use as reinforced fill.

Evolution of Geogrid Reinforced Soil Retaining Wall

Soil reinforced retaining wall is the latest fleet of retaining walls. Retaining walls started from gravity type walls, which were very bulky in size and shape, and then reinforced cement concrete type wall came, which offered a saving of space. After that, buttressed walls came into picture which found a lot of applications, especially where space was a real constraint. The Figure 1 for evolution of Geogrid reinforced soil retaining walls.

Construction Methodology of Geogrid Reinforced Soil Retaining Walls

Construction of reinforced soil structures involves a repetitive sequence of fairly simple operations, which can be easily and quickly mastered in a short time. Nevertheless, it is important to take all necessary precautions and checks at each stage to ensure that the construction is strictly in accordance with the approved design and drawings.

Step 1: Excavation and site preparation

The foundation for the wall shall be excavated to the lines and grades as shown in the drawings and graded level for a width equal to the length of the reinforcement plus 300 mm or as shown on the drawings. Any foundation soils found to be unsuitable shall be removed and replaced with approved fill. Before the start of wall construction, the foundation (except in the case of rocks) shall be compacted with a smooth wheel vibratory roll.

Step 2: Casting of Foundation leveling pad

Mark the center-line of the facing at the foundling level, excavate trench of required dimensions, place side forms and cast foundation leveling pad to the lines and grades as shown on the drawings. The leveling pad should be finished to a tolerance of ± 3 mm and cured for 24 hours prior to commencement of placement of facing units.

Step 3: Erection of facing units

The first row of facing panels will normally consist of an alternating sequence of full and half height panels (or special bottom panels appropriate height to accommodate grade differences in leveling pad due to ground level variations), set to the required batter to compensate for panel rotations during fill placement and compaction. It will be required to prop the first row of panels. Subsequent rows of panels are fixed to the lower raw using clamps. A uniform vertical gap of 20 mm (or as shown on the drawings) is maintained between adjacent panels. Geotextile strips fixed to the rear face of the panels or polyurethane foam inserted to the joints are used to prevent loss of fill through the joints. Segmental blocks are placed in a running bond configuration, with any hollow cavities or spaces in between filled with crushed stone / granular drainage media as per specifications.

Step 4: Placement and compaction of fill to the first layer of reinforcement

Fill should be placed and compacted in lifts with appropriate thickness consistent with vertical spacing of reinforcement and compaction requirements. The uniform loose lift thickness of reinforced fill should not exceed 300 mm. The fill should be compacted to the specified density – 95% of maximum Proctor density for normal fill, 98% for pavement subgrades and 100% for fill supporting structural footings. No plant or equipment with a weight more than 1500 Kg, should not be permitted to operate within a distance of 1.5m from the facing. A light weight (< 1500 kg) walk behind vibratory roller or vibratory plate compactor may be used in this zone. Beyond a distance of 1.5 m from the facing, static/vibratory rollers of 8 – 10 T weight may be used for compaction.

Step 5: Placement of the first layer of Geogrid reinforcements

Geogrid reinforcement of the required strength and length are installed at the levels shown in the drawings. The Geogrid shall be laid with its principal strength direction (normally the machine direction) perpendicular to the wall face. The Geogrid shall be connected to the facing elements (panels,
blocks etc.) as shown on the drawings. The Geogrid shall be laid smooth without folds and wrinkles. A light tension is applied to the Geogrid to remove any slackness and it is held in this position by driving U-pins or placing small heaps of fill. Adjacent panels/sheets of Geogrid are simply but-jointed without any overlap.

**Step 6: Placement of next and subsequent lifts of fill**

No equipment shall be allowed to operate directly on the Geogrid. It is recommended to maintain a minimum loose lift thickness of 200 mm between Geogrid and the wheels/tracks of any construction plant. Fill should be dumped near the rear or middle of the Geogrid and bladed towards the front face. Fill placement behind the reinforced zone should also proceed simultaneously. Compaction of the fill should be carried out as described above.

**Step 7: Erection of subsequent rows of facing units and reinforcements**

Top of the installed facing units should be cleaned of any debris, gravel, fill etc. In the case of discrete panels bearing pads should be provided on the horizontal bedding joints. Erect the next row of panels to the required batter using wooden wedges and fix to the lower row of panels with wooden clamps. Fix geotextile/foam strips. Segmental block units are normally placed in running bond configuration. Blocks normally have a built in arrangement in the form of locator pins/lips/down-stand etc. which automatically ensures the correct setback between successive courses of units. Ensure that each unit is pushes forward to engage the shear key / pins etc. of the course below. At each level ensure that the horizontal and vertical alignment of the facing and bedding between successive rows/courses of panels/blocks are correct and as per the drawings and any deviations within the permissible limits. Install Geogrid reinforcements of the required strength and length at the required levels.

**Step 8: Placement of drainage layer**

Install the drainage system, simultaneously with the placing and compaction of fill. The drainage fill should be brought up at the same rate as reinforced and retained fill, taking care to prevent any mixing with other soils. Any perforated collection pipes should be installed with the required slope as shown on the drawings.

**Step 9: Coping**

At the top of the wall, provide cast in-situ coping to achieve the required longitudinal profile.

Construction details can be understood through various figures as shown below:
1. The Dubai Fujairah Freeway Project –

Tensar’s Reinforced Soil Retaining Wall (RSRW) systems were first introduced into major civil engineering projects in the United Arab Emirates (UAE) around 2000. The Dubai Fujairah Freeway Project for The Ministry of Public Works is latest to be completed (Refer Figure 8). The 10-lane road was aligned to navigate through the mountainous landscape. Intense rainfall which occurs typically once a year has formed deep gullies and valleys within the terrain. The new road had to bridge over the existing valleys and cut through existing severe gradients of the mountains. The original conforming design was the construction of major viaducts across the valleys. However, the construction of viaducts would have been incredibly costly and challenging due to the lack of access, water resources and difficulties of facilitating concrete curing in the extreme temperatures and the arid conditions. Finally it was decided to construct Geogrid reinforced soil retaining wall for the project with maximum height upto 60mtrs.

2. Forming, providing wet mix macadam & black topping to master plan road in between Brahmani & Indu project at IT SEZ Hardware Park, RR Dist, Andhra Pradesh. The client was Andhra Pradesh Industrial Infrastructure Corporation Ltd. The consultant and contractor were Shree Lakshmi Metal Industries & Constructions and Shree Lakshmi Metal Industries & Constructions respectively. Max. Height was 15.0 m. (Refer Figure 9)

Figure 6: Locking Geogrid between blocks

Figure 7: Examples of Finished Structures

Some Real Time Applications

Conclusion

Geogrid Reinforced soil retaining walls have evolved as viable technique and contributed to infrastructure in terms of speed, ease of construction, economy, aesthetics etc. The increased interaction with soil greatly improves the pull-out resistance of the Geogrid in a wide range of soils. However it is a technology that needs to be understood well in terms of its response, construction features etc. Failures of RE walls have also been noted in a few places due to lack of understanding of behaviour of RE walls so before beginning installation of Geogrid, a proper engineering analysis has to be carried out by experts.

Reference

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