Important Considerations for Geosynthetic-Reinforced Concrete Mats (GRCMs)

By GNA Editor

Concrete mats represent a unique marriage of materials, combining the tensile strength and flexibility of polymer geogrids with the rigidity and durability of concrete. This combination enables concrete mats to be delivered on rolls and conveniently unrolled on-site for practical applications such as erosion control on spillways and embankments. However, an important consideration when designing these systems lies in the selection of geogrid materials, as their performance and durability can vary significantly under alkaline conditions.

The Role of Geogrids in Concrete Mats

The geogrid reinforcements used in concrete mats are typically made of **polypropylene (PP)** or **polyester (PET)**. Both materials provide strength and structural reinforcement, but their long-term performance differs depending on the environment.

While PET geogrids can generally achieve higher strength values than their PP counterparts, they are particularly vulnerable to **alkaline hydrolysis**—a significant issue when they are in direct contact with concrete.

What is Alkaline Hydrolysis?

Concrete is inherently alkaline due to the presence of lime, which raises its pH to levels greater than 11 (high alkalinity). This environment, coupled with moisture, creates conditions conducive to **hydrolysis**—a process where polymer chains break down in the presence of water. When moisture and alkalinity combine, as is the case with concrete, **alkaline hydrolysis** occurs, leading to the breakdown of polyester polymers over time and a concomitant decline in their mechanical properties.

Simply put:

- **Hydrolysis** = breakdown of polymer chains in presence of water or moisture.
- **Alkaline Hydrolysis** = breakdown under both moist and alkaline conditions.

Why PET Geogrids are a Concern in Concrete Applications

Although PET-based geogrids often demonstrate impressive initial strength properties, their long-term durability is compromised in concrete due to the presence of moisture and high pH levels. Over time, the mechanical properties of PET geogrids degrade as the polyester structure undergoes chemical breakdown. Research indicates that PET fibres in alkaline environments face significant uncertainties in terms of stability and performance (Rostami, 2019). This susceptibility has limited the application of PET geogrids in cementitious materials.

Advantages of PP-Reinforced Concrete Mats

Polypropylene (PP) geogrids, on the other hand, exhibit superior resistance to alkaline environments. PP-reinforced concrete mats offer:

1. **Long-Term Stability**: PP maintains its structural integrity under alkaline conditions, both in concrete and in contact with alkaline soils.
2. **Enhanced Durability**: PP can be fortified with antioxidants and stabilizers, providing excellent resistance to heat and UV light degradation.

This durability makes PP-reinforced geosynthetic concrete mats a more reliable and stable option for applications requiring long-term performance in alkaline environments.

Conclusions

When selecting materials for geosynthetic-reinforced concrete mats, it is essential to consider the long-term effects of alkaline hydrolysis. While PET-based geogrids may initially provide high tensile strength, their vulnerability to alkaline conditions in concrete makes them less suitable for long-term applications. In contrast, PP-reinforced mats offer durability, stability, and resistance to environmental factors, ensuring reliable performance over time. For projects involving concrete mats in alkaline or moist environments, **polypropylene geogrids** are the preferred choice to mitigate the risks of material degradation.

Therefore the use of PET fibres/grids in an alkaline environment such as concrete is faced with uncertainties (Rostami, 2019).

Hence the degradation of PET fibres and grids in alkaline environments has hindered their use in cement and cementitious composites (Rostami, 2019).

References

Rostami, R. et. al. Cement and Concrete Composites, Vol. 97, 118-124 (2019). https://www.sciencedirect.com/science/article/abs/pii/S0958946518308175#:~:text=Moisture%20absorption%20of%20PET%20fibers,parameters%20%5B13%2C14%5D

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