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Sustainability

The use of FRP/GRP in construction

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Introduction:

The construction industry consumes more of the earths resources (up to 50%) than any other industry. Construction, operation & subsequent demolition of all built facilities accounts for 40 – 50% of global energy use.

"Global material use is projected to more than double from 79Gt in 2011 to 167Gt in 2060"

Global material resources outlook to 2060 (October 2018)

Fiber reinforced plastics (FRP's) are amongst the most widely produced type of composite material, the best established FRP's are glass reinforced plastics, more commonly known as GRP. The long lasting, maintenance free properties of GRP make it an extremely attractive alternative to traditional building materials such as steel & timber. Steel production is incredibly energy intensive which leads to unwanted emissions of greenhouse gases and air pollutants often damaging to human health & eco-systems.

Life Cycle Assessment:

A life cycle assessment is a tool used to evaluate the environmental impacts of a structure over its entire lifecycle from extraction of raw materials through to end-of-life product disposal. An in-depth study was carried out to review the material options for a new pedestrian bridge located in the 'Noorland inner harbour, province of Zeeland, an existing steel bridge had functioned for 35 years but had largely deteriorated due to corrosion.

Table 1: Proposed Materials:

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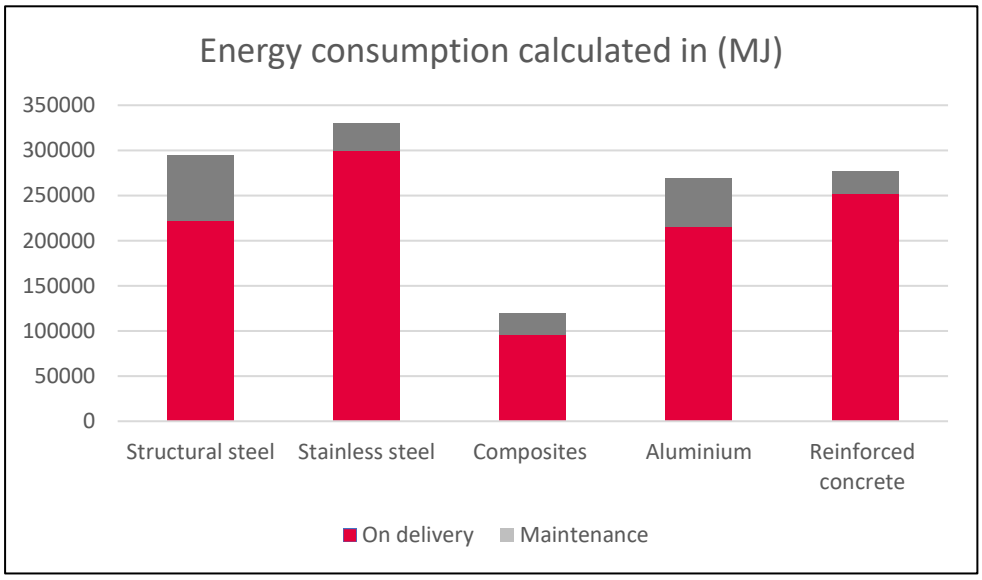

European Bridge Engineering Conference Lightweight Bridge Decks, Rotterdam (March 2003)

The study highlighted the environmental advantages of composite material in terms of energy consumption, other material options resulted in more than twice as high energy use. Importantly, the lightweight properties of the composite option also helped to reduce transport costs.

Cumulative Energy Demand (CED):

Cumulative energy demand (CED) assesses the energy consumption of a process whilst greenhouse gas (GHG) measured in C02 contributes directly to climate change. GRP products have consistently shown lower production phase CED & GHG values than both aluminum & steel.

The energy consumed during the production of GRP also referred to as 'material embodied energy,' can vary significantly according to the type of fibres & manufacturing processes used, the embodied energy value will increase as the percentage of resin in the composite increases. A 'greener' product based on the embodied energy of a composite can be achieved by increasing the fibre volume fraction which coincidently improves strength & stiffness.

Fibre glass strands (Relinea 2021)

Recycling & Reuse:

In most cases, FRP's are incinerated in cement kilns to recover embodied energy, incombustible waste such as glass fibre & mineral filler can be incorporated into the production of cement. Other recycling methods for GRP/CFRP products include:

Material Development:

Glass reinforced plastic continues to evolve. Recently researchers have been exploring the use of bio-based GRP's in which the polymer matrix, reinforcement fibres or both come from renewable resources. Natural fibre reinforced plastics (NFRP's) incorporate animal, mineral & plant-based fibres which can be used as reinforcements.

In general, the tensile strength and young's modulus of plant-based fibres such as hemp & flax is lower than commonly used glass fibres. Plant based fibres have a higher specific strength and modulus which makes them attractive when weight reduction is critical.

Conclusion:

Our future depends on managing the earth's resources better and the construction industry has a key role to play. Therefore, it's important to consider the environmental impact of a product at every stage of its lifecycle. GRP structures have proven to have less environmental impact than conventional construction materials.

By working together using research & innovation, we can reduce our effect on the environment, creating a sustainable future for all.