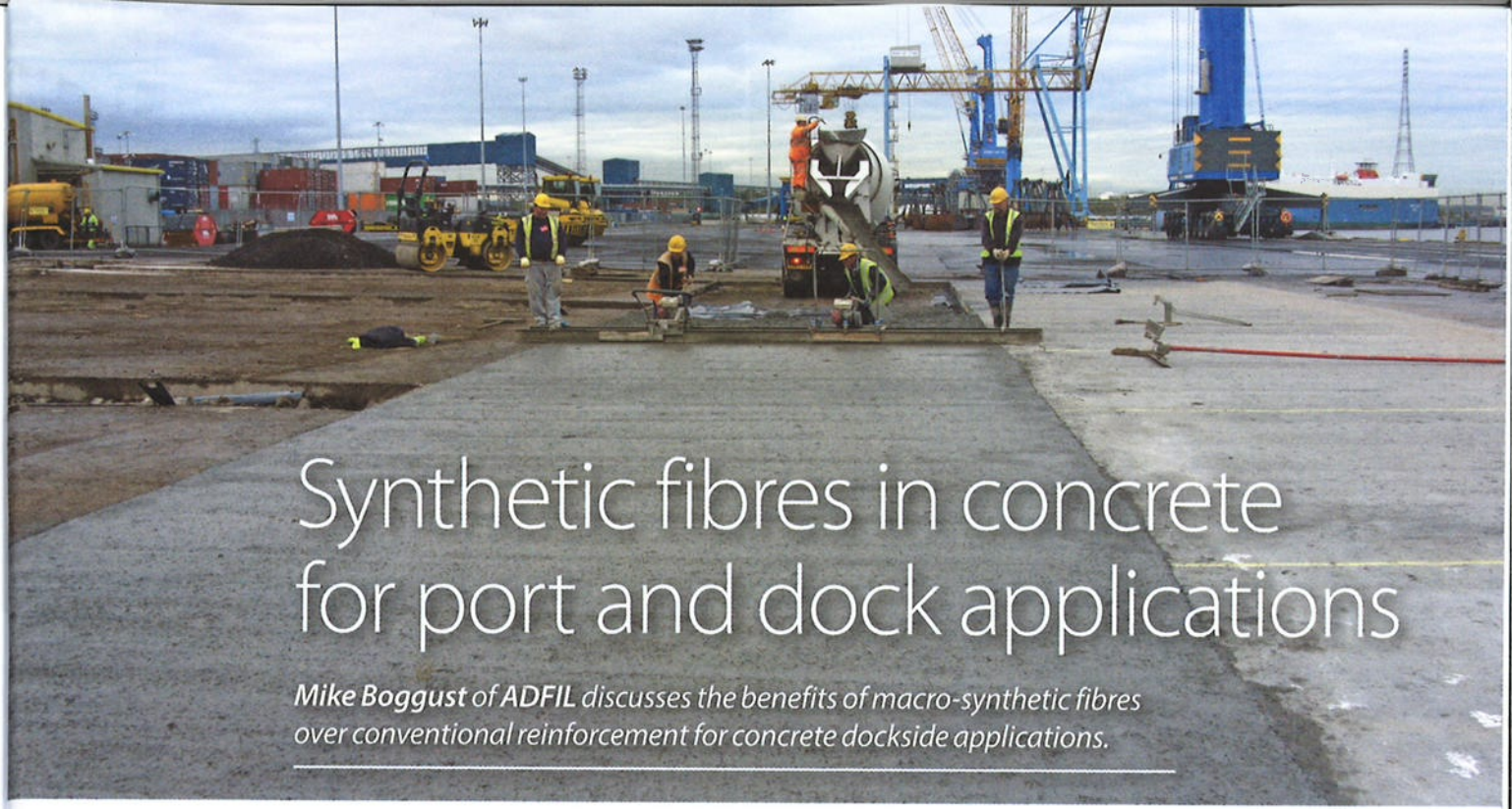

Synthetic fibres in concrete for port and dock applications

Mike Boggust of ADFIL discusses the benefits of macro-synthetic fibres over conventional reinforcement for concrete dockside applications.

Ports and docks are key logistical hubs supporting the distribution of commercial cargo worldwide. The cargo is usually stored in large steel containers, which are loaded and unloaded using cranes, reach stackers and specialist handling equipment from the docked cargo ships.

With some freight containers weighing in excess of 20 tonnes and stacked in multiple layers, it is critical that the supporting concrete slab contains appropriate reinforcement to accommodate such loads. Deterioration of the concrete due to conventional reinforcement corrosion could lead to loss of serviceability and temporary closure of an affected area. This has the potential to cause delays to loading/offloading operations, which could lead to lost revenue and disruption to tide-dictated ship movements.

With the majority of ports and docks located in coastal areas, the concrete pavement will be exposed to the problem of chloride attack, which usually arises when chloride ions ingress into the concrete. This can be caused by de-icing salts but in these locations the most important source will be chlorides deposited by seawater. This can be either by direct contact with the sea or in the form of very fine droplets of seawater (raised from the sea by turbulence and carried by wind). It is important to note that airborne chlorides can travel up to 2km[1].

As a consequence, steel fabric reinforcement in the concrete can eventually degrade and lead to surface spalling, which will dramatically reduce the service life of the concrete in these aggressive conditions.

Above: Installation and finishing of macro-synthetic-fibre-reinforced concrete at the Port of Tyne.

Left: Macro-synthetic-fibre-reinforced concrete slab pour and finish at Port of Boston.

The solution

The replacement of conventional steel fabric with a synthetic macro-fibre will eliminate the risk of corrosion and any associated problems.

Synthetic macro-fibre reinforcement will allow more efficient installation as there is no requirement for handling, placement and fixing of steel fabric. This will significantly reduce construction time, which may be limited due to tidal conditions.

The risk of steel fabric being placed incorrectly, with inadequate cover, will not be a factor if it is replaced with macro-synthetic fibres, which should be dispersed consistently throughout 100% of the volume of the concrete on delivery to site. This will

Pavement damage at Port of Tyne was a risk to freight-handling equipment.

Storage of steel coils at Boston Port.

also eliminate significant health and safety hazards associated with steel fixing and there may be confined working conditions inside a cofferdam.

The addition of micro-synthetic fibres can enhance the abrasion resistance of the concrete significantly and more than double the impact resistance. This will extend the service life of the concrete structure where durability is a significant consideration.

Harbours and slipways

With harbours and slipways being governed by tidal fluctuations, concrete structures in these situations can be above and below the water level. Any steel reinforcement is at high risk of corrosion, resulting in a shortened service life.

Polypropylene fibres are not susceptible to corrosion so will maintain the integrity of the concrete in this environment and their use also negates the need for steel fixing, resulting in easier and quicker installation where tidal factors are a consideration.

Case histories

Port of Tyne

The container handling terminal at the Port of Tyne has a storage capacity of 5000 TEU (20-foot equivalent units). This is serviced by three Hyster reach stackers. The success and growth of the facility as a key logistical hub had resulted in wear of the concrete pavement, exposing conventional steel fabric. Exposure to the marine environment led to accelerated corrosion of the steel. As a consequence, areas of the pavement became unserviceable. Urgent replacement of these areas was necessary to eliminate the risk of damage to the reach stacker pneumatic tyres.

The reinforced concrete pavements used in large-container freight-handling facilities, such as the Port of Tyne, are subject to excessive dynamic loads from heavy-duty freight-handling equipment, high impacts from container movements and abrasion from constant HGV traffic tyre scrub. Concrete pavements used in this type of application need a high durability to ensure service life is maintained.

The use of synthetic macro-fibres, to replace steel fabric, eliminates any risk of puncture or damage to HGV traffic and site-handling equipment tyres.

Port of Boston

The Port of Boston handles sea cargo from around the world. One of the main imports and exports at this facility are large coils of steel wire, due to the port's proximity to local manufacturing facilities. The port is also a hub for the storage and handling of waste material products awaiting incineration.

Boston Port is relatively small, so space is at a premium. Over time, existing reinforced concrete storage areas have been under constant load from the weight of the steel coils and the conventional steel reinforcement has been subject to corrosion. This has led to failures in the concrete pavement and also caused rutting along the lines of steel rope coil stacks.

The specification of macro-synthetic-fibre reinforcement in the concrete used to repair damaged areas has allowed minimum disruption to port operations during installation.

Armoured joints

A combination of synthetic-fibre-reinforced concrete and a specialist armoured joint system can provide a reliable solution, which ensures prolonged service life. Construction joints are particularly at risk of damage from constant heavy traffic. ■

Reference:

1. NEVILLE, A.M. *Properties of Concrete*. Fourth edition, Pearson/Prentice Hall, 1995.