Lecky Road Flyover
Improved fire resistance for concrete piers

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Background.

This bridge was constructed in the urban area of Londonderry during 1970-72 by Farrans at a cost of circa. £250k. It was immediately unpopular, seen as divisive by those who lived in the vicinity, and became a centre for anti-social activity.

In 1993 the following repair work was carried out at a cost of £144k:-

- Deck waterproofed.
- New surface.
- New parapet upstand.
- New parapet railings.
- Crash barrier protection to piers.
- Concrete repairs (due to fire damage)
- Silane application.

Then in August 2005 a large bonfire underneath the flyover caused damage to the underside of the deck and parapets; also to some of the piers.
Repair work cost £175k and included palisade fencing to secure the area and protect the piers from further fires. However, small fires and anti-social behaviour continued to be a problem.

Following meetings with local residents and community leaders, further work was carried out during March – June 2008 to improve the area. This included removal of graffiti from the structure and associated retaining walls, removal of the palisade fencing in an attempt to normalise the appearance of the area and erection of new safety barrier. It was also decided to place sacrificial concrete around the existing piers to offer protection from future potential fire damage.

Concrete Spalling.

From a structural perspective the protection of the piers from fire damage is the most important aspect of the recent work.
Extensive research was carried out prior to instructing the contractor of the concrete mix to be used with the following results:-

When concrete is exposed to the high and rapidly rising temperatures experienced in fires spalling occurs.
The 3 main types of spalling are:-

- Surface Spalling – concrete fragments typically up to 20mm in diameter become detached from the concretes surface.
- Corner Break-Off – tends to occur in the later stages of a fire
- Explosive Spalling – the most dangerous form where early rapid heat rise forcibly separates pieces of concrete at high pressure with an explosive effect.

The conventional theory of explosive spalling is that it is chiefly caused by the build-up of water vapour pressure in concrete during a fire. If the concrete is not very permeable, water vapour formed within it during heating will be unable to dissipate

and pressure is formed. When that pressure exceeds the tensile strength of the concrete explosive spalling will result.

Sacrificial Concrete.

Following research into fire resistant concrete it was decided to use the following concrete design mix:-
RC2 (40N/mm²) using a lightweight aggregate with the addition of Polypropylene fibres (pp) at a rate of 0.9kg/m³ and a bond breaker between the existing columns surface and the sacrificial concrete.
Due to the fact that Lightweight Aggregates (LWAs) are not extensively used in NI and therefore excessively expensive and difficult to source further research was required. This revealed that of all Normal Weight Aggregates (NWAs) only those of carbonaceous origin (e.g. limestone) remain stable at high temperatures.
Furthermore there is scientific consensus that concrete made with limestone aggregate is less susceptible to spalling than that made with siliceous aggregate. It was decided to use a 10mm limestone aggregate.
The polypropylene fibres acted in a two-fold manner.

1) To provide reinforcement, as the concrete was being placed at a depth of cover of 150mm thus negating the need for re-bar.
2) To lower the risk of explosive spalling. This works on the basis that, as the concrete is heated by fire the pp fibres melt, creating vents along which water vapour can dissipate so avoiding a build up of pressure.

The bond breaker should in the event of a fire let the sacrificial concrete fail but remove the potential for damage to the existing piers.
Protection was provided to the 7 piers using the sacrificial concrete mix as described placing the concrete to a height of 2.5m above ground level with a further 0.5m below ground level taking it to the existing foundation.

The future

With the wider changes in Northern Ireland and perhaps the social efforts mentioned earlier, there have been no more bonfires under this bridge, so the pier protection has not so far been tested. While from a research and engineering perspective, it would be desirable to have an indication of its effectiveness, it must be said that from a Roads Service and social aspect, we would prefer not to have the testing carried out in-situ. If not already covered, perhaps this would merit a research project.