Composites UK
Trade Association

In Service Inspection and Maintenance of FRP Structures

Overview

This Technical Sheet gives advice on the in service inspection and maintenance of:

- Traditional structures strengthened with FRP plates or wraps;
- Traditional structures with FRP replacement components; and
- Fully FRP structures.

Testing during fabrication/installation and for acceptance of a completed scheme is dealt with in the separate Technical Sheet 'Tests and Standards For FRP Structures'.

Types of Inspection

All structures containing FRP materials should be subject to regular inspection, which can be regarded as falling into four distinct types:

- Initial;
- Visual;
- Detailed; or
- Special.

Detailed guidance on how to undertake inspections and the significance of any defects identified should be included in the project Health and Safety File, together with the required frequency of inspections, which will be held by the structure owner. This should be examined by the person undertaking the inspections prior to starting work on site, as it may recommend specific safety measures that need to be in place prior to an inspection.

The person undertaking an inspection must have sufficient knowledge and experience to detect defects in FRP and understand their significance. They must complete a written report, illustrated with sketches and/or photographs, which should be kept with the structure's Health and Safety File to facilitate examination in advance of future inspections and to enable the monitoring of the progress of any defects identified.

The inspection periods described below are specific to bridge structures but gives an indication of typical requirements for more general FRP structures.

An **Initial** inspection for all FRP structures should be undertaken six months after acceptance into service.

All initial inspections should take the form of a detailed inspection of the FRP parts only. It is advisable that the designer is in attendance at, at least, the first of these inspections.

Visual inspections, covering the whole structure, should be carried out at annual intervals (+ 3 months) without the need to use special access equipment, but using simple equipment such as binoculars, and are basically intended to reveal the presence of gross defects such as delamination, debonding or mechanical damage.

Detailed inspections, also covering the whole structure, should be carried out at intervals of 6 years (+ 6 months). Detailed inspections should be carried out at "touching distance" using appropriate tools; this will normally require the use of special access equipment and, if necessary, the (at least partial) removal of decorative coverings.
(NB A visual inspection need not be undertaken in the year that a detailed inspection is scheduled.)

Special inspections should take place in the following circumstances:

- If a detailed inspection raises concerns;
- When fire or impact damage is suspected;
- If overloading has occurred;
- On a change of use; and
- Before and after structural work or refurbishment.

These inspections will take the form of a localised detailed inspection and may additionally require the use of testing, especially if concerns have been revealed during a detailed inspection.

Contact

Email: info@compositesuk.co.uk
Web: compositesuk.co.uk/construction-sector-group

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Potential Defects

Inspections should be used to detect the presence of the following types of defect in the FRP:

- Deterioration of the outer surface of the FRP;
- Delamination within the FRP material;
- Bond line integrity;
- Adhesive degradation;
- Inappropriate interventions;
- Visibility of warning signs (if provided);
- Continued presence of sacrificial samples (if provided);
- Galvanic corrosion (when CFRP is in intimate contact with a metallic substrate); and
- Deterioration of protective coatings.

Testing

The in service testing of FRP structures is still quite limited in scope, since a number of the tests recommended for use during acceptance are not readily transferrable to a site environment.

For FRP strengthened structures the main test available is the “tap test”, used to determine the integrity of the bond line. The successful application of this test is highly dependent on the skill of the operative as it relies on differentiating the different sounds emitted when the FRP is lightly tapped with a coin or small hammer to detect the presence of voids within the bond line. It is also difficult to undertake this test when multiple layers/plates of FRP have been used for strengthening as signal is quickly attenuated. Infra-red thermography has been shown to reveal bond line defects under laboratory conditions but is not yet in use commercially. Similarly acoustic emission testing is claimed to be able to detect the difference between bond line cracking and fibre rupture within the FRP matrix but does not seem to have been used in practice.

On some strengthening schemes non structural sacrificial plates have been applied close to the structural strengthening plates so that they experience the same preparation, installation, loading and climatic conditions. These can be removed at appropriate intervals (ideally specified in the project Health and Safety file) for more detailed testing. The force required for removal will give a good indication of the strength of the bond and samples taken from the adhesive can be used to determine whether there have been any changes in adhesive properties such as Tg.

For fully FRP structures testing will normally be confined to the determination of global performance by load testing or similar. Where they are provided during fabrication fibre optic sensors can be particularly useful in this respect but conventional strain gauges may be used if necessary.

Maintenance

Routine maintenance of FRP structures will normally be limited to occasional cleaning; however abrasives should not be used as they could damage the surface of the resin matrix and the reinforcing fibres close to the surface of the FRP. This is particularly true for structures that have been painted for decorative effect.

Damage to the surface resin layer (or decorative gel coat), either as a result of accidental damage due to cleaning or from vandalism or impact damage, can be repaired by the application of additional resinous material that is compatible with the original. If reinforcing fibres are damaged the implications of the damage must be assessed by a competent engineer and, if necessary, additional FRP material, in the form of a properly designed patch, will have to be applied.

Localised areas of debonding or delamination can be treated by the injection of a compatible low viscosity resin directly into the void. This should be undertaken through the bond line rather than through the composite itself to avoid introducing further localized damage to the fibre matrix.

The effect of damage caused by inappropriate interventions, such as drilling holes through an FRP component, accidental impact or fire should also be assessed by a competent engineer and may be repaired by the localized addition of properly designed FRP patching. In extreme cases it may be necessary to completely remove the damaged section of FRP and install new FRP material with adequate overlaps to ensure good load transfer.

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