REPAIR OF FIRE DAMAGED STRUCTURES

The methods used for the repair of fire-damaged concrete are no different from those used for the repair of concrete damaged by corrosion of the reinforcement, with advice available from various sources.

For reinforced concrete, the main processes to be undertaken are as follows:

- Removal of damaged or weakened concrete
- Replacement of weakened reinforcement
- Replacement of concrete both to reinstate the original form and to provide adequate structural capacity, durability and fire resistance.

In some circumstances there may also be a requirement for the reinstatement of special finishes and appearance.

Before finalising remedial works specifications, the concrete should be thoroughly assessed to ensure that repairs and reinstatements address any inherent or pre-existing problems, such as low covers, excessive levels of chloride or depths of carbonation.

Before breaking out is undertaken, it is necessary to be certain that the reduction in structural section will not over-stress the member. In some cases it may be necessary to remove any heavy load (e.g. equipment or plant) supported by the member and reinstate it after repair. An alternative may be to prop the structure. Propping is essential, with full removal of the load, if a full structural repair is required, i.e. in cases where the new concrete or mortar is expected to carry its full share of the load in the repaired member.

Assessment of fire-damaged structures

Most fire-damaged structures can be successfully repaired, this being the more cost-effective solution than demolition and reconstruction. Before carrying out any repair it is necessary to determine the extent of the damage to the concrete and reinforcement and hence their residual strengths. Guidance on assessment is given in Concrete Society Technical Report 68, *Assessment, design and repair of fire-damaged concrete structures*.

There are a number of on-site and laboratory-based techniques available to aid in the diagnosis of reinforced concrete condition. Techniques conducted on site include visual inspection, non-destructive testing and the removal of concrete and reinforcement samples, which may subsequently be examined and/or tested in the laboratory. On site tests include hammer soundings, rebound hammer (Schmidt hammer) and ultrasonic pulse velocity testing. Laboratory tests include petrographic examination, core testing and reinforcement testing.

It may be sufficient to take ‘soundings’ on the damaged concrete to determine the degree of deterioration. The ‘ring’ of sound concrete and the ‘dull thud’ of weak material are readily distinguished, and this test may be successfully done with a hammer and chisel to determine the depth to which the concrete has been damaged.

For the sake of assessment, it is generally assumed that concrete heated to above 300^{o}C has lost all its strength. In many cases this temperature coincides with a change in colour of the concrete to red/pink; thus, identifying the boundary for the pink/red zone identifies the limit of damaged concrete. However, this colour change will not be evident with all types of aggregates and hence a physical assessment of the concrete strength should always be carried out.

There may be benefit in supplementing the normal on-site regime with some non-destructive testing. The rebound test gives a measure of the surface hardness of the concrete surface. Although there is no direct relationship between this measurement of surface hardness and strength, an empirical relationship exists. Due to the need for a flat surface to test and as a large number of tests is desirable to reduce the effects of variability, the rebound hammer is not generally suitable for use on spalled surfaces, which is often the case with fire damaged concrete. The UPV test for the estimation of concrete strength is well established but again there is no fundamental relationship between pulse velocity and strength. Although an estimation of strength can be obtained by correlation, the method has perhaps a greater potential for comparing known sound concrete with affected concrete. Other methods that have been less frequently used include the penetration resistance test (Windsor probe) and the BRE internal fracture test.