From the Editor's Desk

As part of the series of publication on concrete strengthening, we earlier published on the guidance on concrete repair, materials for structural and non-structural repair, methods of concrete breaking, surface preparation and rebar corrosion crack repair in the last two issues of ReBuild. In this issue, we shall discuss more on structural crack repair, crack repair of concrete in water retaining structures, different methods of structural strengthening, quality assurance during repair work and safety, health & environment issues of concrete repair.

While considering restoration work, it is important to realize that even fine cracks in concrete members that are unreinforced reduce their resistance in a very large way. Therefore all cracks must be located and marked carefully and the critical ones fully repaired either by injecting strong cementitious or chemical grout or by providing external bandage. The cracks in wet retaining structures need to be repaired with specialized materials based on specific requirement and performance of the materials to match with the environment.

The strengthening of existing reinforced concrete (RC) structures is a common requirement. Strengthening may be required because of a change of use resulting in an increased loading due to additional floor or equipment, changes in seismic zones/codal provision, design or construction error and damage to the structure due to ageing. The most popular means of strengthening RC beams, slabs, and columns is namely the addition of new concrete and/or steel reinforcement ("jacketing" and "overlays"), by using fibre reinforced plastic (FRP) plates, structural steel or external prestressing steel. In addition, the strengthening of columns by jacketing with new concrete or wrapping with FRP is most widely used. The structural assessment is very important before doing any repair and strengthening of the structure. The strengthening of concrete structures with various techniques is available. However based on the durability, cost economy and ease of application, the strengthening technique needs to be considered. In the last couple of decades, the attempts to strengthen the RCC structures have been mainly concentrated around the following methods:

i. sectional enlargement by using micro-concrete.

ii. external post tensioning of steel bars.

iii. strengthening by steel plate bonding.

All the above methods have been well experimented and widely used and are found to be very effective for strengthening purposes. However, the main obstacle or rather limitations faced in these methods are:

i. destructive in nature, as a lot of drilling to fix anchor bars is required.
ii. bulky methods, i.e. increasing self-load on the structural members.
iii. labour intensive, i.e. requires more labour for execution.
iv. time consuming, i.e. takes more time to complete execution.

v. increased member size, i.e. reduces commercial space.
vi. complex arrangement, i.e. bulky set-up requiring complex formwork arrangement.

The disadvantages in strengthening by jacketing with micro concrete are high risk of corrosion of embedded reinforcing steel and concrete deterioration thereafter. These problems are associated with relative dimensional incompatibility between existing and new concrete. Hence the micro concrete material to be used should have high tensile strain capacity with low shrinkage properties to avoid any volume changes resulting in formation of cracks. Similarly the disadvantage in post tensioning method is vulnerability to corrosion in strands and tendons. The problem associated with steel plate bonding is the heavy weight of the plates to be bonded, durability of bonding and corrosion of steel at interface of adhesive.

An alternative to the above methods of strengthening is to use epoxy-bonded fiber reinforcement polymer composite system for strengthening applications. Although the technology was originally developed for the aerospace industry, its use for the purpose of strengthening RCC structures has been increasingly pursued and popular in the recent past due to its light weight, ease of handling and rapid implementation. A number of structures like bridges, building, jetties, silos, etc., have been strengthened for various load requirements that were not incorporated during the original design. Strengthening of concrete members with externally bonded fiber reinforced polymer (FRP) system received remarkable attention. Typically used to compensate for steel in structures, available as glass, carbon or aramid fibre, it has to be fixed properly to the underlying surface. On the application side, FRP materials have been used in various projects worldwide for strengthening bridges, parking garages, multi-purpose convention centers, office buildings, silos, etc. The drivers for this technology are several, but perhaps the most relevant ones are the ease and speed of installation. ACI standard ACI440.2R-02, "Guide for the design and construction of externally bonded FRP systems for strengthening concrete structures" provides the detailed procedure for FRP strengthening system.

In the repair/upgrade arena, one of the most important unresolved questions remains that of durability of repair system. Addressing this issue as a part of quality control and quality assurance programme would increase the degree of confidence in any repair technique and allow for its full exploitation.