Technical Advice Note 11

Structural, Strengthening of Concrete

INTRODUCTION

There are five main considerations to be taken into account when deciding which strengthening technique is to be adopted.

- **Structural Assessment** by a structural Engineer including survey and sometimes testing of the existing structure, examining materials, load bearing capacity, impact of external forces, identify weaknesses and any vulnerability to environmental factors.
- **Material Selection** is critical to the success of the strengthening process and consideration of the structures existing structural requirements as well as any challenges may face in the future. Selection of traditional materials through to the latest composites to ensure alignment with requirements.
- **Design Considerations** this is where the structural engineers use the information from the structural assessment to calculate things like the load distribution to make detailed plans to make a structurally sound strengthening procedure which is in line with all of the current building standards and codes of practice.
- **Construction Process** the proper installation of any new strengthening procedure is crucial to the success of the project and structural integrity of the structure. Ongoing quality control and the conducting structural tests throughout the process by a skilled works team controls the effectiveness and can also identify any potential issues that may become apparent.
- **Maintenance and Monitoring** ensures the structure continues to meet its requirements. Regular Inspections, monitoring of any maintenance equipment fitted, and checking for any changing environmental conditions along with any repair or recoating works are all key the structural health of the building or structure.

STRUCTURAL TECHNIQUES

1. **Adding steel or concrete to existing elements of the structure.**

   This technique increases the load bearing capacity of the element being strengthened, for columns and beams it is called Jacketing and is essentially adding another layer of material.

Additional reinforcement added to existing floor slab to extend existing mesh to reach the full slab width.

External columns fitted with new reinforcement and micro porous concrete to strengthen the Railside columns of this platform.

South West Concrete Repairs Ltd 01752 561300

Author : Russell Berry MCIOB MISSE

sales@swconcreterepairs.co.uk www.swconcreterepairs.co.uk

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This type of strengthening is usually used when the original structural elements are deemed inadequate for the implied loads or if increased loads are anticipated. Because it can be targeted to specific areas it can often be the most economical method, and although it does increase the size of the element it can be moulded to make it blend in or be more aesthetically pleasing.

2. Underpinning

This method is used to strengthen the foundations of existing buildings, usually when there has been some evidence of subsidence or if the load bearing ability of the soil around the building is compromised. It involves the reinforcement or extension of the existing foundations. Excavation below the building in sections and introducing new material (usually concrete) to strengthen the existing foundations.

3. Post– Tensioning

External post tensioning uses high strength tendons (usually steel) fixed to the exterior of the structure, the tendons are anchored at both ends to create a compressive force to counteract the external loads. This method increases the load abilities of the structure, whilst keeping the disruption and construction cost to a minimum. As the tendons are accessible it also makes future monitoring and maintenance easier.

3. Application of Carbon/Fibre Reinforced Strengthening

Fibre reinforced polymers (FRP) and carbon reinforcing provide an increased tensile, flexural and compressive strength to beams, columns and floors. They use glass fibre or carbon strips or grid embedded in a polymer matrix or epoxy coating. They are lightweight and relatively easy to install and add only minimal weight to the structure.

Carbon fibre solid strips used to underside of concrete beam to strengthen flexural movement

Carbon fibre mesh wrapped around beam to secure beam to floor above.

Typically FRPs are laminate type structures, with each layer unidirectional or bidirectional. The Carbon Fibre, Aramid (Kevlar) or Glass sheets provide the strength and the matrix which can be polymer, nylon or epoxy secures them in place.

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4. Concrete Repairs and Specialist Coatings

Traditional concrete repairs, where defective concrete is broken out, underlying reinforcement cleaned of rust and treated before cementitious, polymer modifies or epoxy modified repair mortars are applied, repair existing defects. The addition of specialist renders and anti-carbonation or elastomeric coatings give additional protection to the structure.

5. Crack Repairs

There are a variety of crack repair methods, the selection of which will be determined by the size, width and type of the crack. Crack stitching uses new steel rebar or stainless steel helical bars chemically bonded into cut joints which cross the crack, redistributing the tensile forces and stabilising the structure. Resin Injection techniques use epoxy or polyurethanes injected under pressure through drilled injection nipple points at set locations along the crack.

6. Installation of New Anchors

Rock anchors drilled through parts of the structure into the rock , ground or solid parts of the structure can be used to stabilize structures. Drilled core holes are fitted with steel anchors mechanically fixed to the solid material behind and capped off with plate and bolt.

7. Installation of New Tie Bars

New stainless steel wall ties and helical ties can be used to bind elements of a structure together. Replacing old and defective wall ties between the inner and outer walls of buildings and adding additional bracing through brickwork to buildings and structures is quite common.

8. Sprayed Concrete

Spraying concrete in a semi liquid form onto the surfaces of the structure under high velocity provides an additional concrete layer to the structure. There are two main methods, Dry mix and Wet mix. Dry mix entails putting the ingredients into a hopper which are mixed and sent pneumatically down the hose to the nozzle where the water is added. Wet mix uses a pre-mixed concrete which is pumped through the hose where compressed air is used to fire the material onto the surface

9. Base Isolation

This is a technique used in earthquake prone areas. Base isolation uses flexible bearings installed at foundation level to letting the structure move independently of the ground reducing the transmission of the seismic forces to the building. The bearings are fitted between the foundation and the superstructure usually at the construction stage, but they can be fitted retrospectively if necsarry.