

Techniques, Materials, and Design Considerations for Strengthening & Repair of Existing Concrete Structures



Although the analysis and upgrade of concrete structures is somewhat of a “scientific art” that has been practiced for many years it has evolved into a complex science that requires a blend of engineering, material science and construction perspectives. Strengthening projects may utilize traditional materials such as conventional cement-based and steel materials as well as advanced composite materials (FRP’s) that are commonly used for aerospace applications. The techniques used to design and install these materials for upgrade applications are not common to the engineering and general construction industry which can make strengthening projects even more challenging and complex than new construction.

There are many factors that create the need for strengthening. They include construction and design errors, increase in live load, new code requirements, low concrete strength, voids created during concrete placement, new penetrations and prevention of progressive collapse from blast loads.



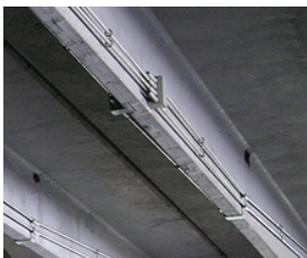
Factors affecting the performance or capacity of reinforced concrete

- New Loads - change in use
- Construction or design errors
- Missing, misplaced or damaged reinforcement
- Voids or Honeycombs created during concrete placement
- Cutting of new penetrations that affect existing reinforcement
- Low strength concrete



Strengthening with externally bonded FRP systems

- Typically used forms
- Installation techniques and QA/QC
- Design Concepts per ACI 440 2R-08 and ICC (AC125)
- FRP Limitations and strengthening limits



Conventional strengthening techniques for cases where FRP is not viable

- External and Internal Post Tensioning
- Section enlargement and bonded overlays
- Supplemental steel supports and span shortening

This presentation will describe the design strategies, different techniques, materials and design concepts used for upgrading concrete structures.

The use of each technique will be illustrated through actual case studies covering various types of projects that will display the strengthening of both new and old structures.

Case studies include two designed by **Frank Lloyd Wright** - Fallingwater and the Guggenheim in NYC.

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