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# Skill-set for repairs

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*The skills required for executing a civil engineering repair work have assumed major importance. A considerable expansion has taken place in the range of skills needed for repair work and a number of scientific disciplines are having a bearing on repair work. There is a deluge in the availability of different construction materials including newer chemicals, which demands careful product selection. Many a times, the interpretation of results of 'non destructive testing' raises more questions than answers. The simple objective of effective repairs is becoming increasingly difficult to define. This 'Point of View' is an attempt to do some loud thinking to examine the set of skills required for doing justice to a repair assignment.*

Despite the fact that the number of scientific disciplines having a bearing on repairs has increased with an influx of various construction materials, the simple objective of effective repairs is becoming increasingly difficult to define. In fact, there is a general lack of awareness regarding most of the matters concerning repairs. Today, people who are practising in allied fields are handling the majority of repairs. These practising professionals from allied fields may have only a passing acquaintance or a limited working knowledge of repairs. Professionals, who are committed to full-time repairing are, indeed, a rare breed.

The visible inspection of damages or signs of distress are prone to many different interpretations and versions. These 'allied practitioners' deliver incorrect or half-baked verdicts to the ignorant user/owner. Such practices are liable to lead to a less-than-satisfactory repair. An experienced counselling is the need of the hour at this crucial stage. Second and third opinions are, also generally, always helpful. Proof consultancy concept needs to be employed for repairs.

Proper attention needs to be given and detailed preparation is required at every stage of the repair work. The following areas of repair work have to be clearly defined and monitored.

## Engineering survey

Engineering survey comprises of many activities such as inspection and quantification of damages, defining a pattern in the visible signs of structural distress, observing of typical symptoms, interacting with users to ascertain details of previous repairs (many structures come up for repairs a number of times) and to ascertain changes affected in the original structure.

The person/agency undertaking visual inspection must be experienced in the job, otherwise there is every chance that important symptoms may be missed. It is always advisable to record all observation during visual inspection in the form of sketches, photographs, etc and analyse them in totality.

The bill of quantities and the subsequent cost estimates are heavily dependent on the

completeness and thoroughness of the survey. However, the distressed structures are generally always in use and hence hundred percent complete inspection is not possible. This calls for certain amount of approximation and extrapolation. In addition, the external facade of any high-rise building cannot be inspected in detail or physically measured at the time of survey.

## Non-destructive testing

Non-destructive testing (NDT) is a very scientific and specialised discipline. Its effectiveness is dependent on many basic parameters. The interpretation of NDT results calls for very high degree of skills. There should be greater emphasis on the technical capability and unimpeachable reputation of NDT agencies. Sometimes it is seen that there is a tendency to give a verdict rather than to simply report the test results.

Sometimes the distress signs are so typical and obvious that NDT is not necessary. This is a little difficult for the concerned people to digest. Invariably, this leads to wasteful expenditure. Sometimes, it is a full-blown exercise to decide upon the type of diagnostic testing to be employed. Typically, in case of a fire-damaged structure, this exercise assumes a major importance and the million-dollar question of deciding whether to repair or rebuild, depends completely on the expert diagnostic skills.

Since NDT is an expensive affair, it is generally employed in large and critical projects. Small, medium and routine repair

works are hence dependent on the calibre and experience of the consultant-in-charge, if any. An experienced consultant, brings invaluable expertise at this stage of assessment. A very scientific and methodical approach can only help in the proper identification, definition and solution to the problem.

### Assessment

Appraisal or assessment is the most crucial link in the effectiveness of the assignment, and it needs a thorough exercise in reasoning on various issues such as assessment of damages, analysis of observed cracks, diagnostics, establishment of the likely causes of damages, history of the structure, establishment of principal or unequivocal cause of damages, quantification of damages, etc.

### Seismic retrofitting

Since a number of buildings and other structures are reported to be seismically deficient, the repair of the facility offers an excellent opportunity to verify its seismic-retrofitting requirements. In the light of what happened in Gujarat recently, this is an important step, as nearly 80 percent of the regions in India now fall in moderate to severe seismic zones. Seismic retrofitting assessment is, no doubt, a time consuming and costly exercise involving study of the as-built design/drawing, NDT, re-analysis and design strengthening, etc. It is, however, the duty of everyone involved in the project to make the owner aware of these requirements.

### Decision making

The decision making process embodies the repair philosophy undertaken and is a precursor to its execution. Concurrence between the owner, consultant, user, repair agencies is achieved by rigorous discussions and meeting of minds. Some of the difficult questions to be resolved in a practical manner:

- part or full demolition and part or full new construction
- extensive or selective patch repairing
- part patch repairs against full repairs
- strengthening/renovation/rehabilitation
- worthiness of cost of repairs
- cost versus benefit analysis
- viability studies
- optimisation studies
- estimation of costs involved and es-

timation of completion time (it is nearly impossible to correctly estimate the cost and time parameters in advance).

### Designing of specifications

Designing of specifications is another elaborate exercise requiring:

- detailed planning
- designing of temporary propping
- detailing of all the steps (as many as 25 different sequential events may have to be carried out in case of patch repairs) involved in repairing
- sequencing of the work flow
- minimisation of chances of inflicting increased damages during repair work.

At the specification stage itself, one can obviate the faults related to the "materials, workmanship and methods". This crucial stage also involves preparation of tender documents, bill of quantities, designing of finishing treatments, interior decoration items. The exterior facade treatment needs to be designed taking into account heritage structure considerations.

The design of "in use repair" parameters as well as those concerning designing 'structural safety during repairs' should take into consideration the static and live loads during the process of repairs.

### Construction chemicals

Construction chemicals have to be carefully selected as per the specifications. Many new construction chemicals are being marketed as 'over the counter' products without adequate technical back up. This poses a dangerous trend. The serious business of repairs becomes as good as the *mukadams'* experience. Most of the construction chemicals are very sensitive to application methodology. Their performance is highly dependent on the skills of the applicator workmen. Highly trained and skilled workmen produce a high level of reliable repair performance.

Today, the construction chemicals market is a "seller's" market. A majority of the repair consultants are "guided" by the manufacturer's "advice". There is an urgent need to develop test methods and guidelines for acceptance of the materials to be used.

### Supervision

Constant supervision is imperative in any repair project with project management

consultants providing third party inspection and supervision. At times, inter stage inspection and condition monitoring is essential, as treatment for individual structural members has to be decided based upon extent of damages and site parameters. This necessitates regular site meetings.

### Red bulb alerts

There are certain situations and/or practices which require immediate intervention to have a successful repair project.

- Non-availability of original structural drawings
- Usage of acidic rust remover in highly alkaline concrete
- Reckless removal of terrace waterproofing by indiscriminate hammering and amplification of the minor distress of slab into a major cracking and spalling problem
- Breaking of full exterior plastering (In effect causing more damages to the structure by avoidable hammering)
- Scanty attention or near zero detailing of the leakages, which are the predominant culprits for causing the structural damages
- Low quality guniting or shotcreting
- Near absence of quality control.

### Engineering attention

There are certain crucial activities in a repair programme which demand scrupulous engineering attention. Some of them are:

- criticality of surface preparation
- adherence to codes and standards
- hands-on-training for the repair workmen
- pre-repairs testing of chemicals
- testing for selection of construction chemicals
- testing the quality of water to be used in repairs
- recording of violations of consultants' specifications
- safety considerations: scaffolding, staging, stacking of site materials, falling debris, overloading of scaffold
- curing, confirmation of complete curing, time requirements for curing
- post repairs testing
- structural stability certification, condition survey after a few years to ascertain the efficacy of repairs.

### Skill set

Skill-set required for repairs may consist of the following, which is obviously an incomplete list.

- State-of-the-art mastery in current structural designing practices
- Thorough understanding of the original structural construction
- Up-to-date expertise about construction materials and their usages
- Understanding of corrosion phenomenon
- In depth field exposure
- Designing of individualised formats for recording of damages
- Investigative skills
- Meticulous observations
- Diagnostic skills
- Judgmental skills
- Previous experience of similar case histories
- Insight into the specific and unique features of the structure
- Anticipation of future demands on the structure
- Discretionary judgement for employing NDT
- Expertise in performance evaluation of materials used in repair
- Step-by-step detailing of various tasks
- Familiarity with demands of interior design
- Working in tandem with architectural constraints
- Tender preparation
- Selection of experienced agencies for special tasks
- Selection and appointment of approved agencies for effective application of specialised materials
- Decision making at intermediate stages of repairs via thorough record keeping and reporting for foolproof monitoring of repairs
- Auditing skills
- Employing ingenious solutions and innovative concepts – particularly in modifications of existing structures

### Conclusions

It is obvious that the input of such diverse skills will mandate a teamwork approach. One individual cannot possibly do full justice to the necessities of a dependable repair assignment. It is also observed that RC structural designers are forced to contend with usage of new construction chemicals, even though there is a major lacuna of credible data on long-term post repair performance.



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