STRENGTHENING OF CONCRETE ELEMENTS
Part-2

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A Not-for-Profit Knowledge Centre
It is well established that corrosion of embedded reinforcement is the single most widespread cause of deterioration in reinforced concrete construction. It follows that repair is most commonly related to defects arising from reinforcement corrosion. The mechanism for reinforcement corrosion caused by carbonation or chloride ingress is controlled primarily by three transport mechanisms; diffusion, permeation (by pressure head) and capillary suction. It is the susceptibility of the substrate to these mechanisms, and the severity of the environment, that controls the rate of deterioration and demand for repair.

The first option requires major work to remove the accumulated effects of deterioration since construction. The second option is most commonly adopted, and often the aim is to remove loose concrete and stop corrosion, probably involving limited use of repair or protection systems. The last option is specific to defects arising from reinforcement corrosion and involves treatment to reduce corrosion rates.

Many concrete structures fail prematurely and require repair. The repair, if not properly planned and executed, can also fail early and can even be detrimental to adjoining sound concrete. Lasting repairs of deteriorated concrete structures depend on careful selection of materials and methods suitable for the service and application conditions. There are many causes of concrete failures and many methods available for the repair of failures. Effective repair requires a rational, analytical process that begins with diagnosing the reason for the failure, specifying the required properties of selected materials and methods that best meet the requirements for the repair.

More repairs fail because of poor surface preparation than from any other cause. All unsound concrete must be removed, leaving sound, clean, and suitably roughened surfaces. For any overlay installation or surface repair, what constitutes “suitable roughness” should be specified. While specifying a polymer for repair/retrofit/original work, it is not enough to suggest merely the generic type to which it should belong but also the properties expected out of it in use, that is, the functions it has to perform in the remaining service life of structure. Such properties duly quantified from performance point of view with a reasonable margin should form the basis of the acceptance criteria. Only those products that meet those criteria during pre-qualification stage should be considered during tendering/seletion process and successful vendor’s supply during execution should be compared with the test reports of the pre-qualification samples for compliance. Batches of polymer not meeting the specified criteria within the specified tolerance should be rejected. Only such a stipulation can ensure discipline, consistency of quality and integrity of the contractor, as the deficiencies will be to his cost.

It is generally accepted that repair materials should be selected to provide the best compromise of the properties required, and may be further influenced by the funding available, availability of materials, and technical or other constraints such as application techniques and environment of working. When selecting a repair, the behaviour and properties of different materials, and how different parameters affect service life, must be understood. Failure to appreciate these factors can cause detrimental effects to a structure by the repair process, such as an increase in corrosion activity caused the formation of incipient by anodes. Areas of intense corrosion, found in structures prior to repair, have an incidental protective effect on the surrounding steel even if the concrete is chloride contaminated, and therefore incipient anodes can develop into new corrosion sites after the intense corrosion site is repaired. There are many variables in past and present repair materials and systems. These include the technique or form of repairs, material composition, method of application, fresh properties and set properties.

Unfortunately, there is no single solution that offers a simple, straightforward method for all repair and strengthening projects. Further, the processes of repair and retrofit of existing structures are complicated because most of these structures are occupied, and lack of expertise in repair and strengthening works. However, success can be achieved if the repair and strengthening systems are tailored to serve a structure’s intended use without interfering with its occupants or function. The key to success is a combination of the different design skills and application techniques - structural strengthening and structural repair - necessary for such projects. As such, the engineer must relay his or her expertise in using mechanical and structural behavior principles to develop a comprehensive retrofit solution.

The assessment of repair options will include a comparison of repair cost to expected service life and ideally the selection of the most cost-effective method. There are considerable benefits in modeling the costs and implications of different repair strategies in order to provide a future maintenance strategy and budget. It is particularly important in instances where the extent of repair works exceeds available funding, and hence there is a need to optimize spending. After the repair is completed, it is important to monitor it on a regular basis to ensure that it is durable and that no damage to the adjacent concrete is occurring.

We have dedicated this of ReBuild more on surface preparation and corrosion repair as part of series of publication on strengthening of concrete elements.
Concrete Removal, Bar Cleaning & Surface Preparation for Concrete Repair


1.0 Introduction

This article describes detailed procedures for concrete removal; rebar cleaning and proper surface preparation for a durable concrete repair system. Removal of deteriorated, damaged, porous or defective concrete is a must for any repair work but the extent of this removal cannot usually be determined in the planning stage. The decision about how much damaged concrete is to be removed and what level of aging for existing concrete is allowed to remain in place is very tedious. This decision becomes particularly difficult because the change in properties of concrete occurs gradually along the depth of concrete and there is no hard and fast border line. One guideline for the extent of removal in medium and high strength concretes is to continue removing material until aggregate particles are being broken rather than simply removed from the cement matrix. It is not a good practice to remove material only up to the plane of reinforcement and to have a joint between new and old materials right at the same location. Even in those cases where it is decided not to encase the bars fully, it is better to expose about three-fourth of the bars diameter and to expose the corner bars fully.

The depth to which the concrete is removed has a profound effect on the method to be used and the cost of the work. The following classification can be made for removal of concrete (see Fig. 1):

- **Surface removal**: This is defined as the minimum amount of work needed to remove surface contamination and provide a clean, long-lasting bond between the existing material and the material used to repair or rehabilitate the structure.
- **Cover concrete removal**: Cover concrete is defined as the concrete that lies outside or above the first layer of reinforcing steel. The removal task does not involve any interaction with the reinforcement and is not hindered by its presence.
- **Matrix concrete removal**: Matrix concrete is the concrete which lies around and between the steel reinforcement. The removal tasks are severely hindered by the need to work in confined spaces around, below and between individual bars. Contaminated concrete in this zone is thus extremely difficult to remove. The removal of deteriorated concrete is somewhat easier because of fracture planes caused by cracking and delamination. The depth of the zone is defined to extend a small distance (about 25 mm) below the steel to allow for the flow of replacement material into all the voids created.
- **Core Concrete Removal**: Core concrete forms the core of the structural element and lies between the reinforced zones. The removal task is inhibited by the reinforcing steel that was exposed during the removal of the matrix concrete. Conventional cutting, grinding and sawing techniques cannot be used. The quantity of material in this zone is dictated by the size and shape of the structural element. Thin deck sections contain little core concrete material, while piers and pile caps may contain a fairly substantial quantity. The volume of material to be removed is limited by the extent of chloride contamination.

- **Bar Cleaning**: Bar cleaning operations are aimed at removing rust and chlorides to provide a fresh surface for bonding with the repair material. The minimum amount of material needed to achieve the required quality must be removed.

2.0 Factors to be considered during concrete removal

Removal tasks must be performed selectively on parts of the structure so that only the contaminated or deteriorated concrete and rusted reinforcing steel marked for removal must be removed. It should also ensure that the remaining concrete and reinforcing steel retains its structural integrity. Equipment used to perform the work must not overload the structure. Any impact forces used to remove damaged concrete should be applied in a manner that minimizes cracking in the residual concrete and damage to the bond between the remaining concrete and steel. Methods to remove rust and chlorides from the steel should also minimize damage and loss to the remaining steel.

Blasting of damaged concrete can produce problems in the surrounding concrete and hence its use must be carefully planned. Use of impact tools may also produce small-scale cracking to the surface of the concrete left in place. The debris removal by some primary means is usually followed by using a secondary method such as chipping, sand blasting (impacting sand with high air pressure) or high pressure water jetting to clean the surface. For more precise removal of damaged concrete in small areas, saw cutting may be used but the surfaces obtained must be treated with thin layers of materials to improve the feather edge surface.

When exposing narrow but deep areas for repair along
cracks, the cavity is better to be undercut to lock the repair material, for two alternate methods. For large areas, the edges of the area are cut back sharply perpendicular to the face of the existing concrete without any undercut. For large cavities to be filled, the top surface is preferably made slopping towards the interior for easy placement and compaction of the repair material.

The concrete removal techniques used should be effective, safe and economical, and should produce minimum damage to the concrete left in place. Some removal techniques take much longer time than the others but are environment friendly. Some techniques permit a portion of the work to be accomplished without removing the structure from service. A single removal technique may not be the optimum solution for all portions of a given structure. Before removing the damaged concrete, sufficient props should be given to the structural members to relieve the loads and avoid any failure of the structure.

3.0 Methods for Removing Concrete

The removal of cover concrete over a relatively wide area is frequently necessary in structural rehabilitation projects. The work involves removal to a depth less than the cover depth of the steel and thus no work between, around or under the reinforcing mat is included in the task. Scrabbling, planing, sandblasting and shot blasting all can be used in repeated passes to achieve the required depth. This is an inefficient use of these methods, and the only really effective way of doing the work when large areas are involved is by using a concrete milling machine. A milling machine removes concrete by the impact of numerous tungsten-tipped teeth mounted on a rotating drum or mandrel.

It is necessary to remove matrix concrete when contamination, spalling and delamination have progressed into the concrete layer that surrounds and encases the reinforcing mat. The work involved is awkward as it must be performed between, around and under the steel without damaging the steel, cracking the substrate concrete, or destroying the bond between steel and concrete in areas where the concrete is not to be removed. There are basically two methods available: pneumatic breakers and hydrodemolition. Both of these techniques may be used to remove cover and matrix concrete in a single operation or may be used to remove only matrix concrete after a more specialized and high-production method, such as milling, has been used to remove the cover concrete.

Core concrete removal necessitates the removal of concrete at the core of the structural element in a manner which respects the three quality constraints of selectivity, residual damage and bond quality. Pneumatic breakers and hydrodemolition are the only two techniques available if the surrounding mats of reinforcing steel are to be left intact. Both of these methods, however, suffer serious losses in productivity due to the difficulty of reaching the material. There also is no efficient way to remove substantial quantities of core concrete while leaving the reinforcing steel in place. Core concrete material can be more efficiently removed if the reinforcing steel is cut. This will of course require that it be replaced at a later stage but it does permit. The different methods of removal of concrete are discussed in detail in the following sections.

3.1 Cutting methods

Following methods can be used to cut the damaged concrete and the selection of the method basically depends on handling and transportation of the cut pieces.

3.1.1 High-pressure water jet (without abrasives)

A high pressure small water jet is used for producing pressures of 69 to 310 MPa and above to cut the concrete surface.

3.1.2 Saw

Diamond or carbide saws (Fig.2) are available in sizes ranging from very small hand-held saws to very large saws capable of cutting depths of up to 1.3 m. A plane or diamond grinder removes concrete by abrasion. Numerous diamond tipped concrete saw blades are mounted close to one another on a horizontal spindle, which is rotated to cut and remove up to 12 mm of concrete in a single pass. The process requires water to cool the blades and the resulting slurry of concrete particles can be vacuumed up for collection and disposal.

Fig. 2: View of a concrete saw cutting machine

Sawing is a low-cost, versatile technique for performing a number of tasks including: cutting the perimeter of an area (Fig.3) where pneumatic breakers are to be used for removing concrete; cutting to full depth in slabs and decks so that sections may be removed; and cutting joints in new concrete.

Fig. 3: Hand held saw cutting of column surface
3.1.3 Diamond Wire Cutting
A continuous wire having modules impregnated with diamonds is wrapped around the concrete mass to be cut and is connected to a motor to form a revolving loop. The limits of the power source determine the size of the concrete structure that can be cut.

3.1.4 Mechanical Shearing
The mechanical shearing is achieved by hydraulically powered jaws to cut concrete and reinforcing steel for making cuts through slabs, decks, and other thin concrete members. The cuts must be started from free edges or from holes made by hand-held breakers and care must be taken to avoid cutting into other members.

3.1.5 Stitch Drilling
In this method, overlapping bore holes are drilled along the removal perimeter to cut out desired sections of concrete. This method is especially useful for making cutouts through concrete members where access to only one face is possible and the depth of cut is greater.

3.1.6 Thermal Cutting
The powder torch, thermal lance, and powder lance can be used for thermal cutting that use intense heat generated by the reaction between oxygen and powdered metals to melt a part of concrete. These methods are usually slow and the progress depends on the rate at which the resulting slag can flow out of the slot. These devices are best to cut reinforced concrete.

3.2 Impacting Methods
In these methods, repeated striking of concrete surface is done with a high energy tool or a large mass to fracture and spall the concrete. This method may cause micro-cracking in the adjoining concrete particularly if partial depth removal is required. Following equipment are used for this method:

a) Hand-held breakers (Fig. 4)
b) Boom-mounted breakers
c) Scrabblers

Fig. 4: View of hand-held breaker machine

3.2.1 Scrabbling
A scrabbler (Fig. 5) uses pneumatically driven bits to impact the surface to remove concrete to a depth of between 1 mm and 6 mm. Scrabblers vary in size from large, self-propelled machines that can only work on large horizontal surfaces to small, hand-held tools for use in restricted, vertical or irregular surfaces. Vacuum collection systems are frequently used to collect the concrete debris.

Fig. 5: View of scrabbler for concrete removal

3.3 Milling Methods
Milling methods are used to remove a specified amount of concrete from large areas of horizontal or vertical surfaces; having removal depth ranging from 3 mm to approximately 100 mm. These methods usually produce a sound surface free of micro-cracks.

3.3.1 Scarifier
A scarifier (Fig. 6) is generally used as a concrete cutting tool that employs the rotary action and its cutter bits cuts concrete surfaces. This equipment can remove deteriorated and sound concrete in which some of concrete contains form ties and wire mesh, loose concrete from freshly blasted surfaces and concrete that is cracked and weakened by an expansive agent. Scarifiers are available in a wide range of sizes. Depth of cut can be more precisely controlled than with a scabbler. Different styles of interchangeable cutter assemblies can be used for cleaning, grinding and light or heavy milling. Like scabblers, scarifiers are noisy, produce vibrations and generate a great deal of dust, although the latter can be controlled by using a dust collector attachment.

Fig. 6: Concrete scarifier during surface cutting

3.3.2 Grinder
Grinders use diamond-, ceramic- or silica-based abrasives of planetary or rotary types to abrade concrete surfaces. Planetary grinders typically used to abrade surfaces such as concrete for many different applications like...
profiling concrete in preparation for a coating such as an epoxy or urethane. Rotary grinders are often used for creating a more aggressive profile or removing concrete. Concrete grinders with dust extraction of hand-held and floor models can be used for surface grinding. The use of a dust extraction vacuum with the dust guard and brush rim ensures a clean working environment.

3.4 Hydro-demolition
The majority of hydrodemolition (Fig. 7) work involves the removal of matrix concrete. Extremely high-pressure water jetting of 80 – 240 MPa is used as a primary means for removal of concrete when it is desired to preserve and clean the steel reinforcement for reuse and to minimize damage to the concrete remaining in place. This method has a high efficiency and disintegrates concrete changing it back to sand and gravel-sized pieces.

Fig. 7: Hydrodemolition for concrete removal

The equipment can, however, be calibrated to remove concrete to almost any depth and the nature of the process is such that there is an element of self-adjustment in depth depending on the soundness of the material encountered. Hydrodemolition can be used on inclined, vertical and overhead surfaces but cost effectiveness is reduced by the inordinate cost of the specialized equipment needed to safely direct the jet and contain the debris when working on other than horizontal surfaces. Hydrodemolition is an emerging technology suited to all phases of concrete removal.

3.5 Pre-splitting Methods
Pre-splitting methods use hydraulic splitters, water pressure pulses, or expansive chemicals placed in bore holes drilled along a line to induce a crack plane for the removal of concrete. The direction and extent of the crack planes that propagate depend on pattern, spacing, and depth of the bore holes.

3.6 Abrading Blasting
Abrading blasting removes concrete by propelling an abrasive medium at high velocity against the concrete surface to abrade it. Abrasive blasting is typically used to remove surface contaminants and as a final surface preparation. Commonly used methods include sandblasting (Fig. 8), shot-blasting, and high-pressure water blasting.

Fig. 8: Sand blasting for concrete removal

3.6.1 Sandblasting
This method is the most commonly used technique to clean concrete and reinforcing steel, where common sands, silica sands, or metallic sands is used as the primary abrading tool. Vacuum systems are used to recover the sand and resulting debris. There are following three methods of implementing this method.

a) Dry sandblasting: The concrete surface is bombarded with sand with the help of high-pressure air in the open atmosphere. The sand particles are usually angular and may range in size from passing a 2.12 to a 4.75 mm sieve, larger size particles are used for rougher required surface condition. Compressed air at a minimum pressure of 860 kPa is used in this method. Finer sands are used for removing loose materials and grease from the concrete and reinforcing steel, while coarser sands are commonly used to expose fine and coarse aggregates in the concrete or tightly bonded corrosion products from reinforcing steel. The economical depth up to which sand blasting is effective is about 6 mm from the concrete surface.

b) Wet sandblasting: This method is same as dry sandblasting but the free particles bouncing back from the surface are collected in a circle of water to reduce air pollution.

c) High-pressure wet sandblasting: Sand is projected at the concrete surface or the reinforcing steel with the help of stream of water at high pressures ranging from 10 to 20 MPa. This method is not as effective as dry sandblasting.

3.6.2 Shot-blasting
This method is also similar to sandblasting but here metal pieces are projected at the concrete surface at a high velocity. The shot erodes the concrete from the surface and the removed material is collected by a vacuum chamber in the machine. The shot-blasting process is highly efficient and environment friendly method. A surface cleaning operation is done by using a small-sized shot and setting the machine for maximum travel speed. Removal of as much as 6 mm in a single pass is possible and up to 20 mm thickness can easily be removed. There are three factors that influence the depth of shot-blasting:
• Size of the abrasive (coarse shot etches the surface more deeply);
• Amount of abrasive (an abrasive control valve allows the operator to increase the flow of the abrasive for a deeper etch);
• Speed of the machine (slower speed is needed for a deeper etch). These factors, in addition to the cleaning path width, the desired removal depth, the hardness of the concrete, and the presence of previous coatings, affect production rates. For example, a heavy elastomeric coating on an old floor will cause shots to bounce off the surface rather than to scour it.

3.6.3 High-pressure Water Blasting (with abrasives)

High-pressure water blasting with abrasives uses a stream of water at high pressure of 10 to 35 MPa with an abrasive, such as sand, aluminum oxide. This equipment can remove dirt, grease or other small particles exposing the fine aggregate. The abrasive is removed from the water before it is disposed into a storm or waste water system.

The advantages of high pressure water blasting are as follows:
• There is no dust, and noise is minimal.
• There are no mechanical vibrations that might cause structural damage.
• The machine selectively removes deteriorated concrete and leaves good concrete intact.
• The reinforcing steel is not damaged as it could be by scarifiers or scabblers.
• The removal of deteriorated concrete is faster than by conventional methods such as jackhammers. Removal rates can range from 0.28–0.85 m³/h and 46.45–74.32 m²/h when used as a scarifier to remove surface material to a depth of 6 mm.

4.0 Bar Cleaning

Bar cleaning necessitates the removal of rust, chlorides and other unwanted material from the exposed reinforcing steel. The work follows the removal of matrix concrete and is extremely important as all the chloride contaminated rust and cement paste must be removed to stop corrosion from continuing in the backfilled concrete. Three methods such as sand blasting, wire brushing & hydrodemolition are frequently used for rebar cleaning. Chemical rust remover is also used to clean the rebar.

4.1 Wire Brushing

Powered rotary wire bristle brushes (Fig. 9) can be used to clean exposed rebar. Brushes are pneumatically or hydraulically driven and usually mounted on a small utility construction vehicle. Access to hidden and difficult-to-reach surfaces is restricted.

4.2 Using Chemical Rust Remover

In case of heavy rusting of steel reinforcement, remove the loose rust by wire brushing, chipping, hammering or grinding so that majority of rust scale is removed. Apply any chemical rust remover on affected surface by using cotton waste swab or by brush application. The rusty surface will change its colour to original blackish steel, remove the same with cotton cloth. Then remove the loose rust particles by scrubbing or simple dusting with the brush. Wash the steel surface with water jetty to remove all acidic residue left on the bar, and clean the surface with a cotton cloth.

5.0 Bond Quality

After the removal, the concrete surface is checked by visual inspection and by sounding at the surface, microscopic examination or bond testing for near-surface damage and by taking cores, pulse velocity tests and pulse echo tests for subsurface condition of remaining concrete. All damaged or deteriorated concrete is to be removed and the quantities must be estimated as accurately as possible in the start. The three quality constraints of selectivity, residual damage and bond quality must be met under all conditions. No removal technology can be used if it does not satisfy the constraints.

Removal tasks are only part of the repair process. Any new material needed to patch overlay or replace the damaged material will need to bond effectively with the remaining concrete and steel. Remaining surfaces must be clean and sufficiently textured to provide the required bond. The quality constraints, selectivity, residual damage and bond quality make removal are more demanding and expensive task than demolition. They also preclude the use of much high impact, high-production techniques developed for concrete demolition and limit suitable techniques to those that comply with the constraints.

6.0 Surface Preparation

Surface preparation is a critical factor in the performance of repair materials applied to concrete. The surface preparation of concrete in readiness for the application of a coating or repair material includes all the steps taken
after the removal of the deteriorated concrete. Many of the same steps apply when little or no concrete is removed. Proper surface preparation provides a dry, even and level surface free of dirt, dust, oil and grease. Removal of surface contaminants allows primers and repair materials to have direct contact with the substrate, increasing the surface area and roughness of the surface, and providing increased anchorage of the applied material. The optimal condition of the concrete surface, however, depends on the type of repair being undertaken and the condition of the substrate. Also, it is not always possible to determine which material must be removed, because the zones of damaged or deteriorated concrete are sometimes not well defined. Thus, the best approach is to remove material until aggregate particles are being broken rather than simply being pried loose from the matrix. The water blasting can be used during surface preparation application for removing any kind of laitance. Before applying cement-based repair materials, the substrate should be saturated and the surface then dried to prevent the rapid loss of water from the repair material (to the substrate) and subsequent shrinkage and cracking. However, for resin-based materials the concrete surface must be dry for maximum adhesion to be achieved. Prior to the application of coatings, the moisture content of the substrate should be checked by using an electrode-type moisture meter.

It is frequently necessary to remove surface contaminants such as oil, rubber and rust from the work area in order to provide a sound, long-lasting bond between the existing structure and the new materials used to repair or rehabilitate the structure. The objective is to clean rather than to remove material. The following methods are used to clean the surface depending on type of contaminants and nature of the surface:

6.1 Chemical Cleaning
Concrete contaminated with oil, grease or dirt can be cleaned with detergent, trisodium phosphate or various proprietary concrete cleaners. The use of these materials should be followed by vigorous scrubbing and thorough rinsing with water to remove all residues. Solvents should not be used to clean concrete since they will dissolve the contaminant and carry it deeper into the concrete. Muriatic acid is relatively ineffective in removing oil and grease.

6.2 Mechanical Cleaning
Mechanical cleaning devices are of two types, rotary and impact. Rotary equipment includes discs and grinders usually used on low compressive strength concrete substrates that do not have a steel trowelled finish. These devices are not effective on hard dense concrete, which they are likely to polish rather than abrade.

Impact tool devices such as bush hammers (Fig. 10), scabblers and needle guns (Fig. 11) will effectively remove several millimetres of surface concrete. Varying degrees of surface preparation may be achieved, depending on which hammer heads are used. Scabbling operations are dusty and noisy and produce some vibration. Because impact tools pulverize the concrete and can cause fracturing of the concrete substrate, it may be necessary to use water jetting or wet sandblasting for a final surface cleaning. Alternatively, a scarifier can be used which is very much effective on old floors, and will successfully remove old paint, but are relatively expensive and heavy, and require skilled operators.

Fig. 10: View of a Bush hammer used for surface removal of concrete

Fig. 11: View of a needle gun for cleaning concrete surface or rusting of steel

6.3 Blast cleaning
Blast cleaning includes abrasive sand blasting, both wet and dry, shot blasting, and water jet cleaning (Fig.12). All these methods have been discussed in removal of concrete section. But same can also be used during surface preparation of the concrete before application of repair mortar or coating. Additionally, if the existing coating has worn off in spots, the bare concrete will become more deeply etched, producing an irregular surface. When a thick topping is to be applied, the irregular surface will not be a problem, but when a coating is to be used, a uniform surface is needed. If the previous coating is thicker than 3 mm, or has worn off in spots, it should be removed with a scarifier or stripping machine before the surface is shotblasted.

Fig. 12: VHigh-pressure water blasting for concrete cleaning
6.4 Acid Etching
Acid etching removes enough cement paste to provide a roughened surface, which improves the bond between the replacement materials and the substrate. Because of the potential for corrosion, ACI Committee 515 recommends that acid etching only be used when no alternative means of surface preparation is acceptable.

6.5 Flame Cleaning
Flame cleaning is generally used to clean concrete surfaces that are to receive coatings or resinous overlays. This method is particularly useful for oil-stained floors because it permits the application of coatings to the concrete immediately after. A special multi-flame oxy-acetylene blowpipe is passed over the concrete surface at uniform speed. The thickness of the concrete layer removed depends on the speed at which the blowpipe is moved and the properties of the concrete. The most suitable blow pipe speed lies between 0.02 m/s and 0.03 m/s. Concrete and coating removal involves both the spalling and melting off of the surface. The laitance layer is usually removed to a depth of 1 or 2 mm and in a few instances up to 4 mm. The moisture content of the concrete has the greatest effect on concrete removal – completely dry slabs do not produce much spalling, while slabs soaked in water prior to flame cleaning produce uniform concrete removal. Past experiences indicate that flame cleaning does not promote the migration of deep-seated oil to the surface, does not remove the alkalinity of the matrix – the surface gradually attains alkalinity similar to that of new concrete – and does not promote the development of any visible cracks in the surface. The method has proven useful for such applications as the recoating of concrete floors or the removal of defective elastomeric waterproofing membranes from parking decks.

7.0 Safety, Health & Environment
Demolition work involves many of the hazards associated with construction. However, demolition incurs additional hazards due to unknown factors such as deviations from approved plans, unauthorized modifications, hidden materials and weaknesses of construction materials used on the project. The vast majority of hand tool injuries occur when the proper tool is not used for the job. The following health and safety aspects should be taken care:

- All personnel involved in a demolition project must be fully aware of the various hazards, which may be encountered, and the safety precautions that may be taken in order to control the hazards.
- Make sure that wrecking bars or crowbars have a sharp point or keen edge that allows the bar to get a firm hold on the object being moved. Using poor substitutes for these tools, such as pieces of pipe, angle, iron or other building materials can be a serious mistake, since they are more likely to slip or break and cause injury.
- Wire and bolt cutters require the wearing of eye protection at all times. Don’t use a cutter too small for the task, or try to gain added leverage by putting a length of pipe over its handle.
- Sledges and hammers require workers to wear eye protection in order to prevent possible blindness from concrete chips and splinters. Inspect equipment prior to use for unacceptable conditions such as mushroomed heads, cracks, looseness and splinters.
- Shovels are often thought of as a relatively safe construction tool, but improper use can cause serious back injuries, as well as injuries to other parts of the body.
- Falling debris is of particular concern in demolition projects, both in terms of the workers actually doing the demolition work, and other workers or bystanders. Make sure the demolition area is clear of all unnecessary personnel prior to work.
- A large part of demolition safety involves proper dress and the use of appropriate safety accessories, especially when using power tools. Ensure the use of PPE equipment such as safety goggles or glasses with side protection, face mask in dusty applications, ear plugs, heavy work gloves and steel-toed shoes.

Effects of the breaker operations must be monitored to ensure minimal impact on the surrounding environment. The primary environmental issues of concern are dust, noise and flying debris created both from the breaker operations and from the subsequent debris removal process. Noise level of such jobs should be within permissible limit. Before taking any kind of repair job necessary barricades and screens should be provided near the repair area. Any statutory permission required from local administrative authority should be taken before the commencement of repair work.

The debris generated from the breaker operations consists of pieces of concrete and aggregate in a variety of sizes. The larger pieces can be removed by hand and loaded into a wheelbarrow or a loader bucket. The small pieces and dust can then be blown away with an air blower. Disposal of the debris generated from breaker operations is generally not a major concern because the debris is readily accepted by most material processing centers which can be used as recycled aggregate after proper cleaning in concrete manufacturing industries.

8.0 Conclusion
One of the biggest problems impacting the long-term performance of concrete repairs and bonded overlays is cracking of the repair material and repair material debonding from the concrete substrate. A prerequisite for monolithic action is long lasting bond between the existing concrete substrate and the repair material which mostly depends on the proper surface preparation.
Rebar Corrosion Crack Repair
[Excerpts from Dr. Fixit Guide to Healthy Construction, Cracks & Crack Repair (Unpublished)]

1.0 Introduction
Cracks that run directly over reinforcing bars in such a position that they could not have been caused by shrinkage, plastic settlement, or thermal contraction, must have been caused by build up of rust forming on the reinforcement. These cracks are a symptom of deterioration which will eventually lead to spalling and complete loss of cover. Horizontal surface repair is common on slabs either elevated or on grade. Deterioration may be caused by corrosion of embedded reinforcement resulting in delamination and spalling. Other common causes include deterioration due to carbonation and chloride ion ingress and chemical attack. After an evaluation of the deterioration by an engineer, a plan should be developed including objectives and specifications for the repair. Steps for repairs that include layout, removals, edge preparation, mixing, bonding, placement, and curing have been included below as a step-by-step guide for use by field personnel (Fig. 1).

The purpose of spall repair is to repair deteriorated concrete, repair damaged reinforcing steel, and replace the lost concrete section. This method should be used for repairing spalls on horizontal surfaces such as structural slabs, exterior slabs on ground, balconies, and interior floors.

Damage of concrete due to corrosion cannot be treated without removing and renewing the concrete cover. The step by step approach for corrosion crack repair is given below.

1.1 Removal of Damage Concrete
The repair areas should be clearly defined and marked. All loose and damaged concrete should be broken to sound dense substrate. The edges at the periphery of repair should be saw cut to minimum 10 mm depth to avoid feather edging. The removal of concrete cover which constitutes the major damaged portion in a structural element to be repaired becomes essential at a time when the reinforcement is rusting enough to crack the concrete (Fig. 1i). The cover is cut away to the level of reinforcement and usually up to 20 mm beyond it.

A method, hydro-demolition, (removing concrete with high pressure water jets), helps greatly in removing the bulk of the concrete behind the reinforcement. It offers dust free operation and produces the cleanest surface ready to receive new concrete. The removal of cover can also be carried out using power hammers which are cheap to use and widely available. However, if not kept properly sharpened, they suffer from the disadvantage of shattering aggregate which does not get removed. Power hammer and jack hammer can be justified for initial chipping and removal of large quantities of concrete. Final chipping to be done with light hand held hammer to avoid damage to the structure. Cutters are also used for removal of damaged concrete. The profile at edge of repair is prepared.

In the case of reinforcement corrosion, concrete removal must be carried out to a depth that includes all the affected reinforcement and leaves some room for replacement behind it as well. Concrete is usually specified to be removed around all exposed reinforcing bars.
bar so that a distance of at least 20 mm popularly known as a finger gap is removed around each bar. This allows better cleaning of reinforcing bar and repair material to coat the entire perimeter of the bars. When carbonation is the cause of the problem, and carbonated concrete in contact with the reinforcement has to be removed. If the corrosion takes place due to chloride contamination, there are two cases to be considered. Firstly, if enough chloride contamination to cause corrosion comes from the original mix, any amount of further removal would not give complete protection as chloride can spread from contaminated concrete into new concrete. Hence if the new concrete is of sufficiently high quality, it is likely to provide protection to the reinforcement for a very long time. Secondly, if the chloride contamination is from an external environment, the chloride concentration would decrease as the distance from the surface increases and at some depth would be insignificant. Hence in this case, it is possible to remove the contaminated concrete altogether and replace it with highly impermeable concrete.

1.2 Surface Preparation

Once the unsound concrete has been removed, the existing surface may need further preparation to provide an appropriate platform for the repair. Surface preparation should include removal of dust particles and loose material by pressure washing, high pressure air or light abrasive blasting. An important aspect of surface preparation is wetting the concrete prior to application of cementitious repair materials.

When the affected concrete has been removed, the reinforcement is inspected and cleaned. This is carried out by water jetting or wire brushing. Water jetting is the best method of removing chlorides from the pits in rusting reinforcement.

Sand is introduced into water jets to provide sufficient abrasion to clean the steel properly. While cleaning reinforcement, it must be ensured that the rust deposited on the blind side of the reinforcement is completely removed. Sand blasting is also another method of cleaning the steel. After water jetting and wire brushing, the reinforcement is washed with potable water to remove all contaminants in the vicinity of the reinforcement. Phenolphthalein is being sprayed to find out the carbonation. If pink colour turns to white then carbonation is there. Rust remover is also being used for cleaning corroded reinforcement.

1.3 Addition of Reinforcement

If rusting has reduced the cross-sectional area of the reinforcement by more than 20%, extra reinforcement is provided before the repair is made good. When the loss of section is under 10%, no added steel is needed. When between 10% and 20% of bar section in lost, the answer requires some judgment and analysis. The usual method of adding reinforcement is to lap the weakened bars with additional bars or spliced by welding to restore the original cross-sectional area. In some situations, reinforcement is also added by drilling into the concrete or polyester and bonding new bars into the drilled holes with epoxy or polyester resin.

1.4 Coating on Reinforcement

Once the reinforcement has been cleaned, it is coated with zinc rich primer which provides active galvanic protection to steel (Fig. 1 ii). The zinc thus acts as a sacrificial anode and in addition to protecting the steel in the repair area; it corrodes in preference to adjacent steel thereby protecting it from further immediate corrosion. In addition to zinc primer, epoxy resins are also used to coat reinforcement especially in very aggressive environments.

The coated film should have a minimum dry film thickness of 40 microns. The film shall be continuous especially in the regions where pitting, imperfections etc., are present on the surface of the bars. It is important that the rear portion of the bars should not be left without coating. A second coat if needed may be provided to achieve a uniform and continuous film. The additional reinforcement provided and also the shear connectors shall be coated with epoxy zinc primer. The weld mesh if provided shall also be coated with epoxy zinc primer.

1.5 Application of Bonding Agent

Bonding agent is applied on the prepared concrete surface for better bonding of new concrete with substrate. When repair mortar is used as repair material, it should be used in, layer of 25 to 30 mm thick and bonding coat is applied on each layer.

The epoxy based bonding agent is most suitable as bond coat for structural repair. The base and hardener component of epoxy resin based bonding agent must be mixed well to get a uniform grey coloured mix. Apply the material to properly cleaned and dry concrete substrate using stiff nylon brush by scrubbing it well into the substrate. The coat should be uniform and well spread on the entire surface area of the repair patch. The mixed...
material must be applied before the elapse of its pot life and the new repair mortar must be applied before the elapse of overlay time. As a fully dried epoxy resin coat acts as debonding layer, the repair material should be applied whilst the bonding coat is tacky. In case the applied epoxy bond coat gets dry, an extra coat should be applied before application of repair mortar.

1.6 Replacement of Concrete
The areas of concrete which have been cut away can be made good in the following ways: Patch repairing i) with cementitious mortar ii) with polymer modified repair mortar and iii) with resin mortar.

Polymer modified mortar/concrete is being applied tightly by hand trowel on prepared surfaces. (Fig. iii). Then the excess of materials are being striked out (Fig. 1 iv) and repaired area is finished with a trowel (Fig. 1 v). Finally the repaired area is cured with a curing compound.

The patch repair of a beam starting from surface preparation, cleaning, application of epoxy bonding agent and the additional reinforcements provided shown in (Fig. 2.i). The polymer mortar is placed by hand and followed by application of bonding agent on concrete surface for application of final layer of polymer mortar. The surface is finished by trowel.

The other replacement of concrete for repair: Spraying new concrete for building more thickness and recasting (Fig. 3) and recasting with polymer modified concrete (Micro concreting).
1.7 Recasting with Polymer Modified Concrete (Micro Concreting)

Micro concrete is a free flow, self compacting with high early and final compressive strength used where hand applied PMM (polymer modified concrete) is not possible due to inaccessible and congested reinforcements. There are certain advantages of using micro concrete over normal concrete.

These are: flow-able grade micro concrete reaches in all corners easily as it can be used even without using vibrators. Use of epoxy based bonding agent provides better bonding with substrate. It provides more impermeable concrete. Curing time is reduced to great extent. When micro concreting is used, formwork should be very rigid without any leakage in shuttering. If there is enough repetitive work to justify the cost, permanent formwork of glass reinforced plastics can be useful in some applications. Pourring of micro concrete is made through a funnel or a hopper.

It can be applied for sections up to maximum 100 mm thick and addition of pre-calculated aggregates may be required if thickness is more than 100 mm. The step by step approach right from mixing to pouring of microconcrete are shown in (Fig. 4 i - v).

1.8 Formwork and shuttering

Slurry tight and strong formwork shall be provided for micro concreting. The shuttering for encasement shall be kept ready such that the formwork shall be placed in position and fixed such that the micro concrete can be poured into the formwork within the overlay time of the bonding agent (5 hours). Adequate supports shall be provided for the formwork. Care should be taken to ensure leak proof shuttering. Under no circumstance the slurry should flow out of the shuttering during pouring of micro concrete.

Mixing of micro concrete: It should be mixed using the appropriate water powder ratio as mentioned in the product data sheet. The mixing shall be done mechanically and under no circumstance hand mixing shall be done. Mixing shall be carried out for 3 to 5 minutes to ensure that homogeneous mix is obtained without any bleeding or segregation. In hot climate ice cooled water shall be used to maintain the temperature of mixed material. If the encasing thickness is more than 100 mm, add stone aggregates up to 50 % by weight of micro concrete to the mixed micro concrete directly into the mixer hopper. The stone aggregates must be 12 mm and down and shall be clean, washed and dried. The mixing should be done for 3 minutes in mixer and then pre weighed stone aggregates into the mixer. Mix further for 2 minutes till lump free mix is obtained.

Deshuttering: The shuttering from the sides of the R C members shall be removed after a period of 24 hours.

However, the formwork of the soffit shall be retained and removed after 3 days.

Pouring of micro concrete: The mixer should be poured into the formwork using a suitable funnel or through a hose pipe. It must be poured from one end only. A suitable hopper / funnel arrangement shall be made at site to facilitate the pouring operations. The pouring operation shall be continuous and it shall not be stopped unless the job is completed. To achieve this sufficient mixers / drilling machines and wok force shall be arranged at site.

Curing: All the repaired and encased area shall be fully cured as per standard concrete practices. Curing compound shall be used for effective curing of sides and soffits of beams. If a curing compound is applied, care shall be taken to ensure that proper surface preparation is carried out so as to remove any traces of curing compound on the surface. If this is not done, it may lead to debonding of any protective coating applied on top.
**2.0 Bill of Quantities (BOQ) of Structural Repair**

A standard bill of quantities of concrete structural repair is given in table below for a reference.

<table>
<thead>
<tr>
<th>Sr.</th>
<th>Description</th>
<th>Unit</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Dismantling &amp; Surface Preparation</td>
<td>Cum</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>1.1 Dismantling and removing damaged core concrete by manually/mechanically means in columns, beam, roof slab, chajja, lintels, etc complete including disposal of unserviceable debris</td>
<td>Cum</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>1.2 Diamond wire saw cutting making profile at edges and avoiding feather edges (measurement to be made on cut cross section of the area of surface).</td>
<td>Sqm</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>1.3 Hydro-demolition cutting with high-pressure water jetting of 80 – 240 MPa (measurement to be made on cut cross section of the area of surface).</td>
<td>Sqm</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>1.4 Chipping of loose concrete from surface to expose sound concrete beneath using light chisel &amp; hammer &amp; also preparing concrete surface to receive further treatment, disposing the unserviceable debris</td>
<td>Sqm</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>1.5 Sand blasting for cleaning of reinforcement and chipped surface of concrete so as to cause an intense abrading of the reinforcement and removal of rust from entire surface of reinforcement to achieve shining bright surface</td>
<td>Sqm</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>1.6 Reinforcement Cleaning: Cleaning reinforcement of total rust by tapping or using wire brush or any other suitable way including from behind and around the reinforcement bars to give it a totally rust free finished steel surface (measurement to be made on repair surface area).</td>
<td>Sqm</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>1.7 Rust remover of Dr. Fixit Rust Remover/equivalent: Providing and applying approved chemical rust remover with paint brush on corroded rebar and removing loose particles after 24 hours of its application and washed with sufficient quantity of water to make rebar free from corrosion (measurement to be made on repair surface area).</td>
<td>Sqm</td>
<td>-</td>
</tr>
<tr>
<td>1.8</td>
<td>Surface preparation to remove all dust, dirt, loose rust scales etc., with wire brush, emery papers, rotary wire bristle brushes and grinding (if required) to the concrete surfaces to receive further repair treatment</td>
<td>Sqm</td>
<td>-</td>
</tr>
</tbody>
</table>

**Repair & Strengthening**

| 2.1 | Fixing new reinforcement: Providing & fixing new reinforcement of various diameters as required at site in the form of mild steel and/or steel confirming to Fe 415 and lapping, welding, anchoring suitable to the old reinforcement including cutting, bending with all tools & tackles etc. complete as per direction of Engineer-in-charge | Kg   | -    |
| 2.2 | Shear keys: Providing and fixing ‘L’ type shear keys using 10mm diameter TMT bars after drilling holes of 12 mm diameter and minimum 100mm depth on the concrete substrate & 75 mm outside @ 500 mm c/c on all the faces of repaired surfaces in staggered form, cleaning and grouting the holes with approve polyester resin anchoring grouts of Dr. Fixit Anchofix P/equivalent. Item rate is inclusive of the material, all labours, supervision, tools and tackles, transportation etc., complete as per direction of Engineer-in-charge | Nos  | -    |
| 2.3 | Fixing GI weld mesh: Providing and fixing GI weld mesh (4“ x 4“ x 12 gauge) with 30 cm lap at junction, one layer around the cross section of beams and along the span length completed complete as per specification and as directed by Engineer-in-charge | Sqm  | -    |
| 2.4 | Anti-corrosive Treatment to steel: Providing and applying approved epoxy zinc rich anti-corrosive coating of 40 micron dry film thick/approved thickness of Dr. Fixit Zinc Rich Primer/ equivalent to the exposed reinforcing bars after application of rust remover, on the shear connectors/welded mesh/additional reinforcement of entire concrete repair surface. Testing method of anti-corrosive treatment should pass the requirement of BS 6920/equivalent (Bond Strength). (measurement to be made on repair surface area) complete as directed by Engineer-in-charge | Sqm  | -    |
| 2.5 | Non-structural bonding: Mixing and applying approved polymer modified cementitious bond coat of Dr. Fixit Pidicrete URP/ Dr. Fixit Pidicrete MPB/equivalent to meet the requirement of ASTM C:952/equivalent, on prepared non-metallic / cleaned concrete surface with specified proportion of polymer to weight of cement as per specification etc. complete as directed by Engineer-in-charge | Sqm  | -    |
| 2.6 | Structural Bonding: Providing and applying approved two components epoxy bond coat of Dr. Fixit Epoxy Bonding Agent/equivalent to meet the requirement of ASTM C:882(equivalent on the prepared surface to receive new polymer mortar / polymer modified concrete. Laying of reinstatement polymer mortar or micro concrete shall be completed within the overlay time of bonding agent between old and new concrete. Item rate inclusive of all materials, labours, supervision, tools, tackles, transportation, fixing etc., complete as per specification and as directed by Engineer-in-charge. | Sqm  | -    |
2.7 Site mixed PMM treatment: Providing, mixing by mechanical means and applying cement mortar mixed with Dr. Fixit Pidicrete URP/equivalent approved polymer modified cement mortar in layers having 28-days tensile strength to meet the requirement of ASTM C190, each layer not exceeding 20 mm thick, up to 50 mm thick with a bond coat at 2nd layer, including trowelling with wooden tools etc. (Pre-measurement of average thickness shall be done before laying of repair mortar). Polymers shall be mixed in approved proportion or as specified and applied while bond coat is still tacky and as per direction of Engineer-in-charge.

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>a) Up to 50 mm thick without addition of any aggregate in to the micro-concrete</td>
<td>Sqm</td>
<td>15</td>
</tr>
<tr>
<td>b) 50 mm thick admixed with 10 mm down cleaned washed aggregates @ 50% by weight of micro-concrete.</td>
<td>Sqm</td>
<td>15</td>
</tr>
<tr>
<td>c) 75 mm thick admixed with 10 mm down cleaned washed aggregates @ 50% by weight of micro-concrete.</td>
<td>Sqm</td>
<td>15</td>
</tr>
<tr>
<td>d) 100 mm thick admixed with 10 mm down cleaned washed aggregates @ 50% by weight.</td>
<td>Sqm</td>
<td>15</td>
</tr>
</tbody>
</table>

2.8 Single part PMM treatment: Providing and laying of approved polymer modified single component, fibre reinforced, shrinkage -compensated, cementitious patch repair mortar of PAGEL U40/equivalent having 28-days tensile strength to meet the requirement of ASTM C190 and compacting the same around the rebars and finishing with trowel up to 40 mm thick (Pre-measurement of thickness shall be done before laying of repair mortar) after applying bonding coat while in tacky (bonding coat shall be payable separately), complete as per specification and as directed by Engineer-in-charge.

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application of curing compound -Providing and applying approved water based curing compound of Dr. Fixit Curing Compound/equivalent to the newly provided concrete surface by spray applied/brush applied as per manufacturer’s specification immediately after removal of formwork or shuttering as directed by Engineer-in-charge.</td>
<td>Sqm</td>
<td>15</td>
</tr>
</tbody>
</table>

2.9 High-build polymer modified mortar: Providing & applying approved single component ready to use structural grade high build polymer modified repair mortar of Dr. Fixit Polymer mortar HB/ equivalent having 28-days tensile strength to meet the requirement of BS:6319: part 7 on prepared concrete surface for a maximum 50 mm thick as per specification and as directed by Engineer-in-charge.

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rebar: Providing and fixing additional rebar for 300mm deep with Hilti HIT-HY150 as per structural drawing, manufactures instructions and as designed by Structural Consultant for anchoring of reinforcement bars including cost of drilling by mechanical means in concrete, cleaning the drilled holes, inspection of Hilti HIT HY-150, placing rebar and fixing with approved polyester resin grout of Dr. Fixit Anchorfix P/equivalent and allow adhesive to cure as directed by Engineer-in-charge.</td>
<td>Kg</td>
<td>15</td>
</tr>
</tbody>
</table>

2.10 Form work: Providing, fixing 100 % water tight shuttering (form work) using film coated 12 mm thick plywood sheets brush applied with Dr. Fixit Doshuttering Oil/equivalent for micro-concreting to the structural members in line and level with proper props supports inclusive of all materials, labours, tools, tackles, transportation, fixing etc. and removing as per specification and as directed by Engineer-in-charge.

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circular Jacketing Work: Providing, fixing 100% water tight circular steel shuttering brush applied with Dr. Fixit Doshuttering Oil/equivalent for the jacketing work in line &amp; level with proper supports, etc. complete and removing as directed by Engineer-in-charge.</td>
<td>Sqm</td>
<td>15</td>
</tr>
</tbody>
</table>

2.11 Circular Formwork: Providing, fixing 100% water tight circular steel shuttering brush applied with Dr. Fixit Doshuttering Oil/equivalent for the jacketing work in line & level with proper supports, etc. complete and removing as directed by Engineer-in-charge.

<table>
<thead>
<tr>
<th>Description</th>
<th>Unit</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drilling holes in concrete- Making holes of 75 mm dia in slab after scanning with rebar locator and without cutting the rebars by core cutting for pouring of micro concrete as directed by Engineer-in-charge.</td>
<td>Nos</td>
<td>15</td>
</tr>
</tbody>
</table>

3.0 Conclusion
Performance of a concrete repair needs to be measured in physical terms and other parameters such as environmental effects, safety and whole-life costs. The polymeric repair materials fail due to improper surface preparation, wrong application methods, incompatibility of the repair material with the original concrete etc.

The most of the failure takes place at the interface of the bonding for which bond strength is very important. All corrosion related cracks should be tested by corrosion analyzer etc. Structural crack repairs should be tested for an in-situ non destructive load testing to demonstrate satisfactory performance under an overload above the design working value after 28 days.
The Institute’s Activities

Skill Up-gradation Training Programme
Topic: Liquid Applied Membranes and Wet Area Waterproofing Applications
Date: 15 & 16 June 2016
Venue: Pidilite Taloja plant, Navi Mumbai
Participant: Percept Waterproofing Services Group, Bangaluru

Date: 20 & 21 June 2016
Venue: Pidilite Taloja plant, Navi Mumbai
Participant: Nina Waterproofing Group, Mumbai

Corporate Training Programme
Participant: Dosti Group Site Executives
Topic: Waterproofing Technology
Date: 29 April 2016
Venue: Dr. Fixit Institute, Mumbai

Topic: Concrete Technology – Good Concreting Practices
Date: 7 May 2016
Venue: Dr. Fixit Institute, Mumbai

Open Training Programme
Topic: Building Maintenance-Waterproofing and General Repairs
Date: 21 & 22 April 2016
Venue: Dr. Fixit Institute, Mumbai

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Participants performing crack repair before waterproofing application systems at Taloja

Participants performing heavy-duty acrylic based waterproofing application systems at Taloja

Participants performing cementitious waterproofing application systems at Taloja
Advanced Diagnostic Laboratory & Consultancy Services

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- Quality of concrete by Digital Schmidt Hammer
- Concrete cover mapping & rebar scanning by Profometer
- In-situ compressive strength of concrete by core extraction
- In-situ Pull-out test for compressive strength of concrete
- Rapid Chloride Penetration Test (RCPT)
- Corrosion analyser by Galvapulse for Half-cell potential, Rate of corrosion and Concrete resistivity
- Infra Red Thermography for leakage detection and building defects
- Microscopical analysis of thin concrete samples and aggregate

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- Structural Audit
- Periodical health check up
- Diagnosis of structural defects and recommendation for suitable repair and rehabilitation
- Leakage Investigation of Buildings and recommendation for remedial waterproofing

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The Manual on “Joints and Sealants” covers different types of joints and their need in concrete structures. It explains the movement of joints and how to design such joints at different locations consisting of different materials both for cast-in-situ as well as precast constructions. It also provides solutions to seal those joints with different types of sealants. The manual provides guidelines for selection of materials for structures with fluid pressure and industrial floor joints and how to install those sealants including use of water stops / waterbar. The environment, health and safety aspects are also covered.

The Manual on “Protective Coatings for Concrete and Masonry Surfaces” is aimed to guide the practising and maintenance engineers in selecting suitable protective coating for durability of concrete and masonry structures. It also provides details on method of application, standards and specifications for executing the jobs at site. The various topics covered: Introduction, Properties and Test Methods, Characteristics Performances of different Coatings, Application, Quality Assurance, Safety, Health & Environment and Preparation of Tender documents including Appendixes, List of Relevant standards, equipment and their function.

For purchase of above Manuals, please send your Demand Draft / Cheque in favour of “Dr. Fixit Institute of Structural Protection & Rehabilitation” at the address given overleaf or contact Ms. Clotilda Dsouza on Tel.:022-28357188, Mob.: 09594420601
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MISSION
To act as a platform of national and international networking for sharing of knowledge and practices in the fields of waterproofing, repair, restoration, and renewal engineering in the context of life cycle assessment of the built environment for adoption of best practices by the country’s construction industry.

DFI - SPR : ACTIVITY CHART

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