UNIT-V

Strengthening of structural elements, Repairs of structures distressed due to corrosion, fire, leakage, earthquake - Demolition Techniques - Engineered demolition methods - case studies.

DEMOLITION OF BUILDINGS

Demolition of building generally arises in the following situation

1. The building is very old, and for further period it cannot be put in use.
2. Whenever, structural changes required.
3. Due to the modernizations, old buildings may require demolition for new construction
4. Development of cities, where horizontal expansion not possible, they are liable for multistoreys flats constn

5. Structural failure of buildings and when repair works may not be possible

6. Expansion or extension of buildings over existing building if required.

Precautionary measurements before demolitions

1. All water gases, electricity lines must be shut off before the start of demolition works.
2. All the windows and door openings must be boarded up.
3. Internal entrances to lift the shaft should be barricated and warning lights should be placed at the night
4. Adequate artitical lightening and ventilation should be done at the demolition site.
5. Safety devices like steel helmets, safety belts, gloves etc. should be done provided according to necessarily.

6. The approaches to all areas where flooring has to be removed should be provided barricaded to indicate the need for special care and the possibility of danger.

7. Balconies and cantilever masonry projections should be cut down and the debris removed before the demolition commences.

8. Neither stone nor concrete staircase should be used. Once they have been disturbed, as in many cases the bearing areas are very small & even a small movement can lead to collapse.

9. If the walls are unsound, adequate lateral bracing should be provided.

10. Staircase should be kept free form debris.

11. Any timber removed from the building being demolished should carefully stacked, and project nails and screws should be removed whenever possible.

12. Whenever possible, windows should be taken out to avoid damage being caused by broken glass, window frame should be left in, to help to maintain the strength being caused by broken glass. window frame should be left in, to help to maintain the strength of walls.

13. No persons should be allowed to work in the area directly underneath when floors are being removed.

14. On completion of each day's work, the building being worked on should be left in a stable condition without any over hanging brickwork or timbers

15. Adequate shoring facilities must be provided before removing trusses, girders (or) beams.

Sequence of demolition

1. The first task to be carried out on site is to ensure that services have been disconnected and made safe over the whole site to be cleared.
2. Demolitions process in the reverse order of Construction.
3. The prediminary "STRIPPING OUT" moves such as roof covering, fitting, Pipework and generally all non structural parts of the building have been removed.
4. Roof trusses and timbers should be lifted down and as far as possible only steel, concrete or brickwork should remain
5. All the rubble & debris should be lowered to ground & constantly cleared so as to avoid the build up.

METHOD OF DEMOLITIONS

1. Demolition by hand
2. Pulling down by rope
3. Mechanical demolition
   (a) Demolition ball
   (b) pusher arm machinery
4. Deliberate Collapse
5. Explosive.

1. Demolition by hand:-

This method is usually used for the highest & most inaccessible section of the prior to breaking down by machinery for Complete buildings where access may be not possible for machinery. Operatives use tools of the portable variety, long chisel, hammers, crowbars, Pneumatic drills, hand-saw, power saws etc.

2. Pulling down by rope:

Inspite of housing no of dis advantages, this method demolition is probably the one most widely used for masonry & brick structures, which foom the bulk of present day demolition projects. If it is at all possible all timbers the bulk of present day demolition projects. If it is all possible all timbers pypes, beams clintels should be removed prior to pulling down operations.

In no case should this method be used where the long members are present in the building.

A wire band set around a portion of the brickwork & then dragged by a traled vehicle. As a result it cuts into the brickwork causing it to collapse.

3. Mechanical demolition

a) Demolition ball

This method is used in the main for fairly large brick structures and for reinforced concrete buildings, aswellas for breaking up mass concrete and reinforced slabs and floors. The ball, which usually weights half a ton (500kg)

-is dropped vertically onto the structure to the broken or sideways portion is imparted took by swinging or lowering the jib of the crane so that the ball hits the side of the structure.

This method requires a higher standard of site supervision than do the method mentioned above, as the crane operator has to work at some distance from the structure being demolished, and his view of this is restricted. Considerable Stress is imported to the crane jobs, and supervision & maintenance. Standard must be high. The Standard being demolished should be detached from any other building, if necessary by partial hand demolition.

Before this method is used

b) pusher arm machinery;

This method which has gained in popularity in recent years, involves the use of an extended arm and it is fitted to tracked vehicle in place of the excavator bucket It considered that this type of machine is more controllable in some ways more versatile than the other machinery mentioned above. The pusher arm is placed on the top most section of a brick wall & forward motion is applied either by the hydraulic thrust mechanism or by driving the excavator

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Deliberate Collapse:

The method is used in case where removal of certain key structural members will cause collapse of whole or part of the building being demolished. It can be hazardous operation and very special attention must be paid to ensure that every one on site is convenient with the procedures beingused and to remove to a safe distance when the collapse is imminent.

Explosive

The use of explosives is considered by many experts to be most economic and quickest method of demolition. The basic principles are that holes are boarded into rubbles, the debris should be systematically explosive inserted. When the charges are exploded the structure collapses breaking upon impact with the ground.

Other methods

There are various machines and types of drills & mechanical breakers which have not been mentioned here. Also more than one or two techniques may sometimes be used on the same site. when the basic structure has been reduced to rubble, the debris should be systematically

removed from site or stockpiled for later use if required The foundations of the building are broken up using manual pneumatic breakers or tractor-mounted weight-dropping breakers.

Principles of dismantling

Mainly there are two methods of dismantling

1. Primary dismantling
2. Secondary dismantling

Primary Dismantling

a) To breakup the structure with an aim to reduce the height and size of the elements

b) To break the structural elements into pieces that can be easily handled for immediate removal from on site location.

Secondary Dismantling

To reduce the size of the demolished debits for disposal · Salvage of scrap or processing elsewhere

Primary Dismantling methods

* Spellers
* Non explosive cracking agent
* Controlled demolition
* Thermal lancing
* Crane and Ball method
* Diamond Sawing
* Robotic machines

Secondary dismantling methods

* Rock breakers
* Jack hammers → pneumatic
  → Electrical
  → Hydraulic
  → Petrol Engine
* Concrete pulverizer
* Hand held clippers
* Hydro demolition.

Modern demolition Techniques

* Hydraulic Rock Breakers
* Diamond sawing & Drilling
* Diamond wire sawing system
* Silent expansive chemicals
* Controlled Demolition
* Hydraulic Bursting / splitting
* Thermal Lancing
* Hydro demolition
* Robotic demolition

Controlled Demolition technique

Implosion is a term coined by the internationally renowned Company Controlled Demolition International USA (CDI) for their specialised method of demolition of tall structure, Concrete, steel & wood

Basic Diamond Tools

a) Diamond segment

* manmade arsenal to attack concrete
* Can be moulded in many shapes to suit brise weapon.

b) Common Shapes of Diamond Tools

Circular Blade: dia range from 100mm to 3000mm more

Core drill : dia range from 10mm to 2000mm

wire : String of beads to form endless wire

Spl. Shapes : cup grinder, Disc grinders

(c) Diamond Techniques

* Flat sawing
* Wall sawing
* Core drilling
* wire sawing
* Hand sawing
* Diamond Grinding

(d) Special diamond Tools

* Cup Grinders and discs
* Diamond Chain saw
* Diamond crack saw
* Span saw
* Multiple wheel saws for grooving & grinding.

(e) flat sawing

Use floor saw

Machines with circular diamond blade to cut horizontal members like slabs, beams & flooring

(f) wall sawing

Wall sawing uses circular diamond blade with hydraulic / Electric / pneumatic / drive motor mounted on tracks ideal for cutting RCC walls.

Max depth of cut : 1000 mm.

(9) Core drilling

Core drilling uses diamond tipped bits with hydraulic / Electric / pneumatic drill motors

Used for modelling holes or cutting long openings by Stitch drilling max dia: 2000 mm.

Wire sawing : Ultimate Demolition Tool

In wire sawing, a diamond beaded wire is reared around the RCC members to be cut. The wire is rotated at a high speed (10Kmph) by a special machine while constantly applying a pulling force. The diamond wire penetrates & cuts through the steel & concrete

water is used as a lubricating coolant

Wire sawing has no limitation on the size of RCC members to be cut

This technique is ideal for last primary demolition

Hand sawing

Hand sawing uses a light weight hand held machine with diamond Blade to cut RCC in any direction By this technique even over head Cutting is possible.

Max-depth of cut : 150 mm.

Diamond advantages

Time: Diamond tools Cut Concrete fast, reducing downtime which leads to early project completion.

Diamond Tolerance:

Diamond cutting allows removal of large amounts of concrete without damaging, remaining or surrounding structures.

Structural integrity:

Diamond Cutting allows removal precise and controlled little or no patching is required.

Noise, Dust and Debris: diamond cutting is relatively quiet and virtually dust free concrete pieces can be cut to specified size for easy removal.

Limited Access: Diamond cutting techniques can be used to confined areas and allows existing equipments or utilities.

Hydraulic Splitters / Busters

Creates enormous stresses within the concrete bars producing tensile cracking of concrete.

Dismantling Tools:

* Hand operated Machines
* Crane mounted Machines
* Excavator mounted machines
* Special machines
* Robotic machines

Which tool to choose for the job on hand?

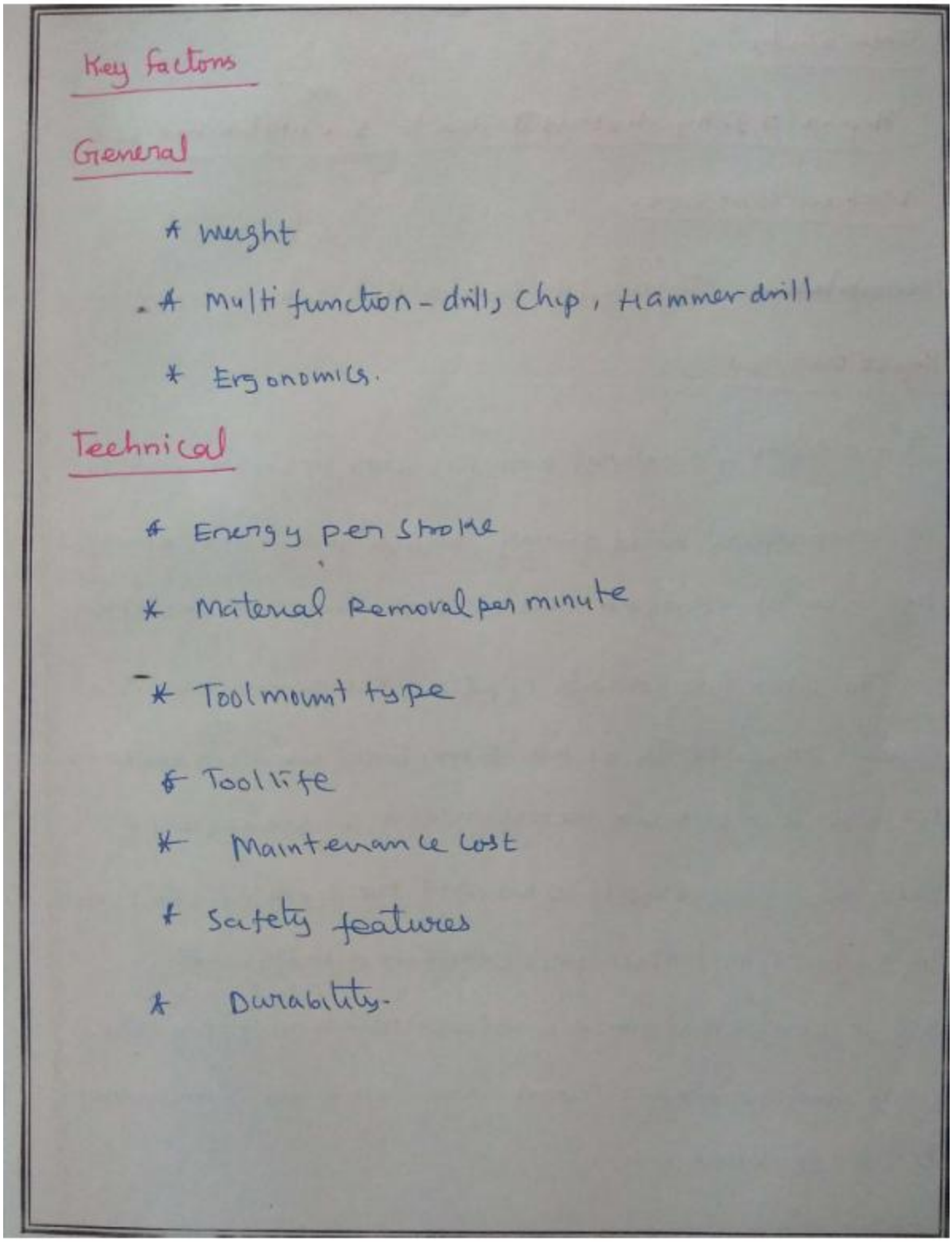
The following factors should determine the technique

* Volume of concrete to be dismantled
* Space available for walling
* Risks involved
* Acceptable noise and vibration levels.

Hand Held Machines

Types:

* Electrically operated
* Battery operated
* Pneumatic
* Hydraulic
* Engine.



Key factors

General

* Weight
* Multi function - drill, Chip, Hammer drill
* Ergonomics.

Technical

* Energy per stroke
* Material Removal per minute
* Tool mount type
* Tool life
* Maintenance cost
* Safety features
* Durability.

Case Study

Repair of Jetty distressed due to sea water and sea breeze Corrosion:

~~Rehabilitation~~ Rehabilitation of RCC Jetty

Project overview

In odisha, a natural port RCC Jetty of 445m length at Gopalpur, build during british period is damaged because of corrosion due to seawater and sea breeze.

The structure consists of piles, RCC Beams and RCC Slab. All elements of the structure were under severe distress due to rebar corrosion as a consequence of chloride ingress upto & beyond the depth of steel rebar. The same was further facilitated by a moderately dense concrete, an abundant number of concreting joints and no proper maintenance since the commissioning of the structure.

Project challenges

The structurally safety of the Jetty was no longer fully assured due to corrosion caused by loss of effective rebar cross section. The rehabilitation project had to ensure that the structurally safety of the entire structure is restored and that environmental for the next life cycle. The rough sea, a tight three month time-frame for execution of works & the fact that the jetty was in normal use determining the works caused additional challenges.

Solution

After in depth inspection and assessment of the structure proposed to the owner, Cropalu port limited, an integral rehabilitation solution consisting of the following steps.

1. Initial condition survey. non-destructive testing & visual inspection.
2. Surface preparation by removal of all loose/ unsound concrete
3. Replacement of excessively corroded rebars, refix with anchoring mortar.
4. Application of protective coating on the rebars, a zinc rich epoxy coating.
5. Drilling of core holes through the top slab to serve as inlet/outlet points for the micro-concrete.
6. Installation of watertight shuttering from the underside with the help of the hanging platform.
7. placement of micro-Concrete using positive displacement pumps. Suitable for wet/ moist conditions, admixed with a corrosion inhibitor.
8. Application of full surface protective coating a heavy duty protective coating.

VARIOUS METHODS OF STRENGTHENING

* Injection grouting, impregnation & coating
* Stitching : stirrups jacketing
* Jacketing
* Metal sleeve Jacketing
* Gunting or shotcreting
* Externally bonded plate Strengthening
* Cracks arrested by post tension
* Membrane - coating
* plastering
* Joint sealing.

Repair of structures distressed due to corrosion

1. Sulphate attack

Mechanisms - sulphates are found in most of the soils as calcium, potassium, sodium & magnesium sulphates. Sulphate attack occurs when pore system in concrete is penetrated by solution of sulphates.

Chemical Mechanism

The effect of sulphate on concrete can be mainly chemical & physical, they are closely related. The sulplate attack on reaction is indicated by the characteristic whitish appearance on the surface. As a result of chemical reactions b/w sulphate & hydration products, changed in the microstructure & pore size distribution of the cement paste takes place. Sulphate converts calcium hydroxide into large of calcium sulphate

$Na_2SO_4 \cdot 10H_2O + Ca(OH)_2 \rightarrow CaSO_4 \cdot 2H_2O + 2NaOH + 8H_2O$

The second Hydration products tricalcium aluminates hydrate reacts with sulphate solution to form sulpho aluminates hydrate, which has a greater volume than that of the original compound

$2(3CaO \cdot Al_2O_3 \cdot 12H_2O) + \rightarrow Na_2SO_4 \cdot 10H_2O +$

$3CaO \cdot Al_2O_3 \cdot 3CaSO_4 \cdot 31H_2O \quad 2Al(OH)_3 + 6NaOH + 17H_2O$

When concrete cracks, its permeability increases & the aggressive water penetrates more easily in to the interior, thus accelerating the process of deterioration

Salt attack / weathering

Solid salts do not attack concrete, but when present in solution they can react with hardened concrete. It is a more general problem in masonry structures. Efflorescenes is a whitish crystalline deposite

on the surface. Efflorescence is the formation of Calcium carbonate precipitate on the concrete surface owing to carbonation.

Prevention measures

* Using sound materials free from salts
* proper concrete proportioning
* Consolidation & Curing
* preventing the access of moisture to the structure.

Repair of structures distressed due to fire

A fire in a concrete structure cause damage. The extent of which depends upon the intensity and duration of fire.

Types of damage

* Reduction in Strength
* cracking & spalling
* Deflection
* Discolouration

Factors

* The capacity of concrete itself to withstand heat
* The conductibility of the Conc. to heat
* The coefficient of thermal expansion of conc.

A large no of rcc structures salvaged from destruction in fires by timely fire fighting operation can be put to further service after strengthening & providing some cosmetic repairs since the cost of restoration of such structures less than that of dismantling & construction of new ones.

High temp. during a fire reduces the strength of RCC structures due to change in strength & deformability of materials, reduction in CIs dimensions, weakening

of bond b/w the reinforcement & Concrete which determines structural action under the load.

The carrying capacity of axially loaded depends upon the cross section of the column coefficient of change in strength under high temp. & corresponding critical temperature. The carrying capacity can be restored by increasing the c/s with suitable increase in the longitudinal steel.

Repair of structures distressed due to Leakage

It causes inevitable damage to the RCC. Const-Joints, shrinkage & restraint cracks may form leakage paths. The amount of water involved vary from damp-paths which tend to evaporate as they are formed, to running - Leaks which may eventually form undrained surfaces, Damp patches may also be formed when water passes through the voids along reinforcing bars formed due to plastic settlement.

Techniques

- conventional leak - sealing methods
- Leak - Sealing by injection techniques

* one leak spots have been identified the remedial action may involve the application of local or complete surface seal in the form of a coating system.

- surface preperations
- filling of surface imperfection with resin - based mortar
- Application of primer.
- Application of 2 coats of high build paint

* From liquid flow & pressure consideration the simplest & most cost effective way is to seal the leakage from the water-retaining side of structure when the wet side is inaccessible, the leakage must be tackled from the dry side which is considerably more difficult. Successful Leak sealing requires injection of sealant to fill passages completely.

Repair of Structures distressed due to Earthquake

once the elements damage has been assessed, actions to take afterwards are suggested in module II. Three types of actions are considered, depending upon assessment

* repair
* restoration
* NDT tests.

Repairs Considered in this expert system include

* injection of cracks with low or high viscosity epoxy resins
* Strengthening with steel ties
* concrete or steel plate jacketing
* epoxy glued steel plates & others