STRUCTURAL CONSTRUCTION WORKS

LEVEL – II

Based on March 2022 Version- I Curriculum

Module Title: - Repair and Rectify Structural Construction work

Module code: EIS SCW2 M08 0322

Nominal duration: 60 Hours

Prepared by: Ministry of Labor and Skill

August, 2022

Addis Ababa, Ethiopia

Table of Content

Acknowledgment

Ministry of Labor and Skills and Regional TVT Bureau wish to extend thanks and appreciation to the many representatives of TVT instructors and respective Ministry of Labor

and Skills experts who donated their time and experience to the development of this Teaching, Training and

Acronym

TTLM Learning Materials

AIA	Annual Investment Allowances
TTLM	Teaching, Training and Learning Materials
TVT	Technical and vocational Training
PVC	Polymerizing Vinyl Chloride
ACP	Aluminum composite panels

Introduction to the Module

In structural construction work; Repairing and Rectifying Structural construction work module helps the trainee how to plan and prepare for repair works, Carry out minor repairs, rectification of cracks and other major defects. And it is also designed to meet the industry requirement under the structural construction work occupational standard, the knowledge, attitudes and skills required in Erect Pre-Cast Concrete Structural & Cladding Units

This module covers the units:

- Plan and prepare.
- Carry out minor repairs
- Carry out rectification of cracks and other major defects
- Clean up

Learning Objective of the Module

- Plan and prepare.
- Carry out minor repairs
- Carry out rectification of cracks and other major defects
- Clean up

Module Instruction

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit one: Plan and prepare
This unit is developed to provide you the necessary information regarding the following content coverage and topics: • Work instruction • Safety plans and policies • Signage/barricade requirements • Tools and Equipment • Calculate Material quantity • Materials handling • Environmental protection This unit will also assist you to attain the learning outcomes stated below. Upon completion of this learning guide, you will be able to: • Apply Work instruction • Follow Safety plans and policies • Implementing signage/barricade • select tools and equipment • Calculate Material quantity • Identify materials handling • Identifying environmental protection

1.1 Work Instruction

Work Instructions are documents that clearly and precisely describe the correct way to perform certain tasks that may cause inconvenience or damage if not done in the established manner. That is, describe, dictate or stipulate the steps that must be followed to correctly perform any specific activity or work. A document describing specific activities and tasks within the organization. It contains the greatest amount of detail.
As a component of a process, "defines how one or more activities in a procedure should be executed in detail, using technology or other resources.

Here are some examples of documented work instructions which may be found on a typical construction site:

- ✓ Working Drawings issued for construction such as Plans, elevations, sections etc.
- ✓ Specifications/Contract specifications
- ✓ Construction method statements
- ✓ Quality requirements
- ✓ Operational details
- ✓ Maintenance manuals

1.2 Safety plans and policies

1.2.1. Occupational Safety and Health

The word safety refers to your freedom from danger, injury and damage, and to your personal security.

1.2.2. What Safety Means

- ❖ Safety means a complete understanding of your work and knowledge of every step that must be taken and the realization that mistakes could be costly to yourself and to the company.
- ❖ Safety means good judgment. Never rely on luck; always be prepared to cope with unexpected situations and being alert when following your routine.
- ❖ Safety means remembering the safety rules set up by your company and applying them every minute when you are on the job.

1.2.3. Goals

The goal of safety basically focus on the following points

- Maintaining a safe and healthy working environment.
- Preventing fatalities and lost time injuries.
- Preventing damage to the equipment, facilities and potential effects on progress.
- Eliminating risk to the environment.
- No fires. A Safe and Productive Project, in Scheduled time.

1.2.4. Safe Work Method

A written Safe Work Method for a job is prepared by the Safety Personnel in consultation with the concerned engineers. The Work Method helps to foresee the risk involved in the job, take precautionary action for the risk involved and plan the materials required for the safety cause. The safe work method is methodically done as followed:

a. Approach Safety.
b. Work Method Safety.
c. Work area Safety.
d. Men Material and Machinery.

Factors that Contribute to the Occurrence of Accidents in the Construction Industry:

1. Fall from heights is the predominant causes of accidents
2. Lack of supervision for workers working at heights
3. Workers lack awareness on OSH
4. Workers have limited trainings
5. Due to lack of training, workers
   - ❖ Build improper temporary structures
   - ❖ Tolerate improperly guarded floors
   - ❖ Work with unstable/unsecured/scaffolds
6. Accident reports lack relevant information

7. Proper investigations are hardly conducted

1.3 Signage/Barricade Requirements

This safety signs, tags, and barricades used on sites administered by Reclamation. This also covers standard hoisting signals and provisions about the use of signal persons.

1.3.1. Sign requirements

It shall be ensured that safety signs are erected to warn workers of specific hazards and to communicate necessary precautionary measures and emergency actions.

As a minimum, it shall be ensured that safety signs are erected in accordance with Queensland Work Health and Safety Regulation 2011, including, but not limited to:

- confined spaces;
- Specific personal protective equipment (PPE) requirements;
- Hazardous chemicals;
- Asbestos;
- lead;
- Fire protection equipment;
- Hazardous areas;
- Emergency and first aid information;
- Emergency eye wash and shower; and
- Traffic management and pedestrian control.

Barricading requirements barricading controls shall be implemented and authorized as part of the safe work system to protect persons from hazards such as:

- Being struck by falling objects;
- Being struck by moving plant;
- Fall from height, including falling into open excavations, penetrations, and falls from unprotected edges such as removed flooring, walkways, stairs and / or hand railings.
- Exposure to hazardous chemicals

1.3.2. Types of barricading

Barricades can be classed as either a soft barricade or a hard (solid) barricade. Soft barricades are those that use an approved tape to prevent or restrict access to an area. A hard barricade is a physical structure such as scaffold tubes or water filled devices that prevent or restrict access to an area.

A. Soft barricades:- they are to be used to identify and protect personnel from general hazards and also those which are high risk and may pose a risk to life and health.

Fig1.1.Soft barricades

B, Solid barricades:- the purpose of a solid barricade is to provide a physical barrier capable of performing the same function as a permanent guardrail.

A solid barricade shall:

- Have a solid top and mid rail (E.g. scaffold tube or equivalent) with the applicable sign attached.
- The installation of a kick rail or mesh to contain objects etc. shall be by risk assessment and detailed in the unprotected edge risk control authorization.
- Where solid barricades are used they shall be accompanied with signs to communicate the hazard information. As appropriate, barricade tape may be used to highlight the existence of the barricaded area.

Solid barricades example

Fig.1.2. Solid barricades:-

Construction Safety Signage

Warning / Safety Signs

A visual alerting device in the form of a label, placard or other marking which advises the observer of the nature and degree of potential hazards which can cause injury or death.

Persons should aware to the following:

A. Specific Hazards
B. Degree or Level of Seriousness
C. Probable consequence of involvement with the hazards
D. How hazards cab be avoided

Location

Safety signs shall be placed such that they will:

- ✓ Be ready visible to the intended viewer
- ✓ Alert the viewer to the potential

Protection

Against foreseeable damage, fading or visual obstruction caused by abrasion, ultra - violet light, or substance such as lubricants, chemical and dirt.

Warning Signs Dimension

Where:

S = Area of Safety Sign

L = Distance of Observation

Panel Signs

Area of safety sign having distinctive background color different from adjacent areas of the sign, which is clearly delineated by a line, border or margin.

Signal Word Panel

Area of safety that contains the signal word and the safety alert symbol

Message Panel

Area of the safety sign that contains the word messages which identify the hazard, indicate how to avoid the hazard and advises of the probable consequence of not avoiding the hazard.

Symbol/Pictorial Panel

Area of the safety sign that contains the symbol/pictorial

Safety Color Code

Will supplement the proper guarding or warning of hazardous conditions.

1.3.3. Standard Color of Signs

- SAFETY RED: FIRE PROTECTION

To call attention to fire protection equipment apparatus and facilities.

Fig.1.3. Fire Protection

- SAFETY GREEN: DESIGNATING SAFETY

- Location of first aid equipment, safety devices, and safety bulletin boards.

Fig.1.4 .Safety Green Designating Safety

- SAFETY YELLOW: CAUTION

- To designate caution and for marking physical hazards, such as striking against, stumbling, falling, tripping and caught in between.

Fig.1.5 Safety Yellow Caution

- SAFETY ORANGE: ALERT

- To designate dangerous parts of machines and energized equipment which may cut, crush, shock or otherwise injure, and to emphasize such hazards when enclosure doors are open or when gear, belt, or other guards around moving equipment are open or removed, exposing unguarded hazards.

Fig.1.6. Safety Orange: Alert

- SAFETY BLUE: PRECAUTION

- To designate caution, limited to warning against starting use of, or the movement of equipment which is under repair or being worked upon.

Fig.1.6. Safety Blue: Precaution

Where Signage are Needed

- Usage of PPE prior to entry to the project site
- Potential risks of falling objects
- Potential risk of falling
- Explosive and flammables substances are used or stored
- Tripping or slipping hazards
- Danger from toxic or irritant airborne contaminants/substances may exist
- Contact with or proximity to electrical/facility equipment
- Contact with dangerous moving parts of machineries and equipment
- Fire alarms and firefighting equipment
- Instructions on the usage of specific construction equipment
- Periodic updating of man-hours lost

1.4 Tools and Equipment

1.4.1. Tools

Common repairing and Rectify Structural construction work Tools used in Construction are listed below

1. **Blower**: an air compressor that produces air at low pressur
2. **Wire brush:**

3. Mortar barrel/ drum

This is used by mason, plasterer, tiller, etc, and serves to prepare small amount of mortar right at the working place. It is also used as temporary mortar storage, supplied from mixing station, and to control water ratio of the mix when it gets dry. Always, keep it workable and clean.

Fig1.7. *Bucket*

A Bucket is used to serve small amount of water or material and to take the tools after

4. Brush and Broom

Is used for wetting the building stones, cleaning fresh mortar joints of masonry wall, to clean hand tools before and after use and to clean dust on surfaces.

Fig.1.8.Broom

Fig.1.9. Hand broom or brush

1.4.2. Equipment/Machinery

1. Extension cable

To connect all electrical driven equipment properly

Fig.1.10. Extension Cable Drum

2. Wheelbarrow

Wheelbarrow is used to dispose disposal materials from working place, to transport or serve materials and tools activities in the during construction site. It is the most efficient way in transporting materials or items. ; In comparison to a barilla, (commonly used in the country), a wheelbarrow is much more efficient. For this reason, it is operated by one person and can be carried up to 100 kg at once. So that it saves operation cost; it is time effective and therefore in general.

Fig.1.11. *Wheelbarrow /85Lit*

3. Grinder

Grinders are available as one hand and two hands. They are operating with high speed rotary cutting discs. The protecting hood must not be removed by all means. A grinder is very useful for cutting hard material like concrete, steel, natural stones or tiles. It is effective to cut blocks or bricks perfectly than cutting with hands.

Fig.1.12. Angle grinder

4. Drilling machine

It is used to make or drill holes in concrete, stones and other building elements or material. Drilling holes is depending up on the size and materials to be drilled, i.e, the drill bits are of different size and types. Types of drill bit can be classified as bits for metal, wood and stone or concrete).

Fig.1.13. Electrical drilling machine

1.5 Calculate Material quantity

1.5.1. Estimating, Purchasing, Delivery, and Storing of Repairing materials

I. Grout

A. Estimating

1 To estimate the quantity of grout required for a job, calculate the volume of the cavity to be filled in cubic feet. Divide the calculated volume by the yield in cubic feet of one unit of grout to calculate how many units will be needed. Add 5% to 10% for waste and spillage, more for smaller jobs, and less for larger ones.

2 The most common shapes of cavities encountered in grouting operations are rectangular solids (for example, the space under a rectangular base plate), solid right cylinders (such as the space under a round, flat-bottomed tank), and hollow right cylinders (like the space between an anchor bolt and its hole).

Many other cavity shapes can be divided into some combination of the common shapes for estimating purposes.

3. To find the volume V of a rectangular solid in cubic cm, multiply the length L in cm times the width W in cm times the thickness T in cm.

$$V = LWT$$

4. To find the volume V of a right cylinder in cubic cm, multiply the square of the diameter D in cm times π/4 times the height H in cm.

$$V = 0.785\ D2H$$

5. To find the volume V of a hollow right cylinder in cubic feet, subtract the square of the inside diameter d in feet from the square of the outside diameter D in cm and multiply that difference times π/4 times the height H in feet.

$$V = 0.785\ (D2- d2)H$$

6. If all dimensions in these equations are in m, the calculated volume will be in cubic m.

B. Purchasing

1 To compare the cost of grout needed for a job, determine the cost per cubic m for each grout under consideration. To ensure that all prices are directly comparable, requests for quotation should be made in cubic m units. All cost comparisons must be made on the basis of delivered cost per cubic m to be meaningful. Grouts must not be compared, bid, or

purchased on a weight basis because there is not a constant relationship between weight and volume. The customary unit of volume is the cubic m, so requesting quotations in cubic m units allows direct price comparisons.

5. In estimating the quantity of grout that is sold in units other than one cubic m, divide the manufacturer's yield into the number 1 to determine the actual number of units required for one cubic m. For example, if a manufacturer's 55-pound unit has a yield of .42 cubic feet, 1 cubic foot /.42 = 2.38 units (bags or pails) per cubic foot.

C. Delivery

1 Non shrink cement-based grout should be delivered palletized and shrink-wrapped, and delivered to the job site in sound, dry packages.

2 Epoxy resin and hardener should be delivered, premeasured, in sealed containers, palletized and shrink-wrapped to prevent shipping damage. Epoxy grout aggregate, delivered as a separate component, should be premeasured, packaged in sealed, dry bags, also palletized and shrink-wrapped to prevent shipping damage.

D. Storage

1 Non shrink cement-based grout should be stored in a dry area in accordance with ACI instructions. The ideal storage temperature is 70°F. Avoid storing cementitious grout below 40°F or above 90°F.

2 Preferably, epoxy grout components should be stored at a temperature between 70°F and 80°F, but never below 60°F nor above 90°F.

E. **Storage Damage**

Immediately remove from the job site any cement-based grout material which becomes damp or otherwise defective. Epoxy grout aggregate that becomes damp or otherwise defective should not be used and should be removed from the job site. Liquid components that are found to be defective should also be removed from the job site.

II. Concrete Repair Materials

A. Estimating

1 To estimate the quantity of concrete repair material required for a job, calculate the volume of the cavity to be filled in cubic cm. Divide the calculated volume by the yield in cubic cm of one unit of concrete repair material to calculate how many units will be needed. Add 5% to 10% for waste and spillage, more for smaller jobs and less for larger ones.

2 The most common cavity shape encountered in repair operations is a rectangular solid. When the shape of the area to be repaired is irregular or uneven in depth, the average

length, width, and depth must be determined by measurement or by estimate. But consider that an irregular shape should be squared off for a durable repair.

3 To find the volume V of a rectangular solid in cubic cm (for example, a floor overlay) multiply the length L in cm times the width W in cm times the thickness T in cm.

$$V=LWT$$

The calculated volume will be in cubic cm.

B. Purchasing

To compare the cost of a concrete repair material needed for a job, determine the cost per cubic m for each material under consideration. Because concrete repair materials are sold in units that may be of different sizes, and may yield different volumes of concrete for a given weight.

C. Delivery

Concrete repair materials should be delivered, premeasured, and packaged in sealed, dry bags, and on stretch-wrapped or shrink-wrapped pallets to prevent shipping damage.

D. Storage

1. Concrete repair materials should be stored in a dry location at a temperature neither near 70°F, but never below 40°F nor above 90°F.
2. Concrete repair materials that become damp or otherwise defective should not be used and should be removed from the job site.
3. Concrete repair materials that are beyond the manufacturer's expiration date should not be used unless the manufacturer has requalified them by actual laboratory retest.

1.6 Materials Handling

Building materials have an important role to play in this modern age of technology. Although their most important use is in construction activities, no field of engineering is conceivable without their use. Also, the building materials industry is an important contributor in our national economy as its output governs both the rate and the quality of construction work.

Repair materials may be classified into **three general groups**:

- Cementitious,
- Polymer and
- Polymer modified.

Cementitious materials are those materials which require the addition only of potable water – they may also be termed "hydraulic materials". Polymer materials are modifying agents to

increase flexural strength and other performance properties. Both groups have advantages and disadvantages.

Cement-Based: These generally are prepackaged materials requiring only the addition of potable water. Their physical properties are very similar to those of concrete. As opposed to the polymer types, cementitious products are considered “user-friendly” and users have had considerable experience with them.

The cementitious materials achieve strengths to or greater than the concrete being repaired. Thermal coefficients of expansion are nearly identical to that of concrete.

The main disadvantage of most cementitious products is that they don’t develop adequate bond strength. Sand/cement mixtures, with or without “bonding” admixtures, and gypsum-based products, exhibit this disadvantage and are usually classified as temporary patches.

Of all the properties of cementitious repair materials, bond strength is one of the most important requirements.

One product on the market was developed specifically to produce excellent bond strength and the other desirable properties of an ideal repair material. It is called Five Star Structural Concrete®.

Polymer Based: These include epoxies, polyesters, and acrylics and are most commonly used where chemical resistance is required. Most of the polymer-based repair materials achieve high strength and good bond to a properly prepared and dry substrate.

There are some disadvantages to these materials:

- They are generally more difficult to work with as compared to cement-based material.
- They exhibit varying degrees of toxicity and flammability and must be used with caution.
- Proportioning the components and mixing are critical to proper curing.

Polymer-Modified: Dispersions of polymers in water have been in use for many years as admixtures to Portland cement mortar and concrete. The property improvements from this family of admixtures includes increased bond strength, reduced permeability, increased resistance to freezing and thawing, and increased flexural strength. The specific property improvement to the modified mortar and concrete will vary with the type of latex used.

Applications of these materials include floor leveling, concrete patching, and bridge deck overlays.

In addition, all of the polymer based repair materials are more expensive than cement-based materials. Regardless of the type of repair material, an adequate inventory should be kept in

stock. Any repair material chosen to be kept in stock must have an adequate shelf life. These materials may remain in inventory for months and must retain their efficacy. A shelf life of a minimum of 6 months is highly recommended. There are some companies, such as Five Star Products, Inc., who are constantly doing research and development work in this field. Individuals working in this area should keep in touch with Five Star Products, Inc. to stay current with the latest developments.

Classification of repair materials

1. Patch Repair Materials
   - Cementitious mortar / concrete
   - Polymer modified cementitious mortar / concrete
   - Polymer mortar / concrete
   - Quick setting compounds
   - High alumina cement based
   - Calcium sulphate based
   - Magnesium phosphates
   - Sulphur concrete

2. Injection Grouts
   - Cementitious grouts (with or without fibres)
   - Gas forming grouts
   - Sulpho-aluminate grouts
   - Polymer grouts

3. Bonding Aids
   - Polymer emulsion type
   - Polymer resin type

4. Resurfacing Materials
   - Protective coatings and membranes
   - Impregnants and hydrophobic sealers
   - Toppings / screeds
   - Overlays
   - Gunite / shotcrete

5. Other Repair Materials
   - Corrosion inhibitors
   - Rebar protective coatings

- Cathodic protection
- Re-alkalization
- Materials for surface preparation
- Chemical rust removers for corroded reinforcement
- Joint sealers
- Surface coatings for protection of RCC

Polyester Resins

A two-part polyester resin (unsaturated polyester such as methyl methacrylate) based material suitable for the repair, surfacing, jointing and bedding of concrete, brickwork and masonry. Available in summer and winter grades, the mixed mortar will harden to give rapid strength gain and can be placed in section thicknesses of 5mm to 50mm in single layers. Thicker sections can be achieved by placing multiple layers. The bond strength developed is stronger than the tensile strength of most construction materials. Typical uses include bedding and fixing of precast concrete units, fixing of concrete barrier units, patch repairs to concrete floors, bedding of coping stones and in fills where rapid service use is required.

Acrylic Concrete and Mortar

In this type, aggregates are mixed together with acrylic polymer to make concrete / mortar. Methyl methacrylate (MMA) and high molecular weight methacrylate (HMWM) monomers are used to make concrete. All components of the product can be mixed together and placed over a patch area filled with preplaced aggregates. Due to its rapid strength gain and high ultimate strength, it is widely used in bridge slabs, parking garage decks, industrial warehouse floors and tanks.

Quick Setting Compounds

Repairs in heavy trafficked areas are possible using faster setting and curing materials such as high alumina cement containing compounds, magnesium phosphates, molten sulfur and calcium sulphate based materials.

Grouts

Grout is a type of mortar used to fill joints, cracks, and cavities in tiles, masonry, and brickwork. It typically consists of water, cement, and sand; or cement and water. Used in semi-liquid form, may be pumped, spread, or poured into cavities and allowed to harden, creating a tight, water-resistant seal.

The three main types of grout are epoxy, Portland cement - based,and furan resin. The epoxy type is strong and water resistant. It is available in 100 percent epoxy resin and modified epoxy emulsion form. Epoxy grout is generally more expensive than other types and can be difficult to find.

Grouting formulations are comprised of three basic elements: binder (clay types and properties, lime, synthetic), aggregate (sand, synthetic materials) and dispersant (water).

Essential parameters for repair materials

- Low shrinkage properties
- Requisite setting / hardening properties
- Workability
- Good bond strength with existing sub-strate
- Compatible coefficient of thermal expansion
- Compatible mechanical properties and strength to that of the sub-strate
- Should allow relative movement, if expected, particularly in case of sealing of cracks or dealing with expansion joints
- Minimal or no curing requirement
- Alkaline character
- Low air and water permeability
- Aesthetics to match with surroundings
- Cost
- Durable, non-degradable or non-biodegradable due to various forms of energy, life, UV rays, heat, etc.
- Non-hazardous / non –polluting.

Criteria for selection of repair materials

A careful selection of repair material is necessary for the following reasons (Shan Somayaji, 1995 and ACI. 1980)

1 Almost every repair job has unique condition and special requirements

2 The composition and properties of repair materials have a profound effect and cured on

the performance and durability of a repair.

3 The repair materials perform adequately only if they are prepared, applied and cured as per the specified procedures, which may necessitate the use of appropriate tools and considerable skill.

4 Repair materials, being generally proprietary in nature, are very costly.

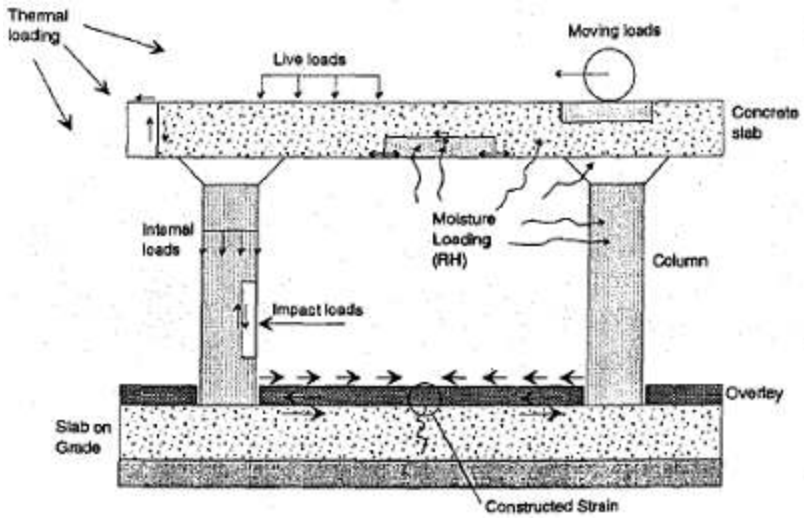


Fig.1.14. Possible loads acting on a repair

1.7 Environmental protection

1.7.1. What is Environmental Management?

Environmental management (EM) is a subject that combines science, policy, and socioeconomic applications. It primarily stresses on finding solution to practical problems that people face in cohabitation with nature, resource exploitation, and waste production.

In a purely anthropocentric sense, environmental management is all about dealing with the fundamental issue of how to innovate technology to evolve continuously while limiting the degree to which this process alters natural environment. Thus, Environmental management is closely linked with issues regarding sustainable economic growth, ensuring fair and equitable distribution of resources, and conserving natural resources for future generations.

There are a number of advantages to undertaking environmental management and these include:

i. Cost savings

ii. Ensuring legislative compliance

iii. Anticipating future legislation

iv. Reduced environmental risk

v. Meeting supply chain requirements

vi. Improved relations with regulators

vii. Improved public image

viii. Increased market opportunities

ix. Employee enthusiasm

1.7.2. What is an Environmental Policy?

An environmental policy is a document prepared by a company or an organization which clearly sets out its overall aims and intentions with respect to the environment. An environmental policy provides a sense of direction for a company and shows that it is committed to managing its environmental affairs in a responsible way. The policy should be endorsed by the company's senior management and should be publicly available. It should be an integral part of the business strategy and be compatible with company's other policies

(e.g. on quality and on health and safety).

Each of these benefits is now examined below:

Cost Savings

Most, if not all people, wish to protect the environment. However, many businesses fear that protecting the environment by improving their environmental performance will cost money. They fear there will be a conflict between their desire to protect the environment and their desire to keep down costs and run a successful business.

The good news is that many businesses have discovered that far from increasing costs, improving environmental performance actually reduces costs. Many companies have found that it is possible to save money, sometimes large sums of money, by improving their environmental performance.

Cost savings within a company or a firm can be achieved through changes in areas such as:

i. Process Efficiency

ii. Product Design

iii. Waste Disposal

iv. Sourcing of Raw Materials

v. Infrastructure

vi. Packaging and Transport

Various ways of achieving cost savings are described briefly below:

Process Efficiency

Improving the efficiency of existing processes

Optimizing the performance of existing processes minimizes the use of raw materials and energy and the production of waste. Reduced use of raw materials and energy and reduced waste production are all good for the environment and the reduced resource costs and waste disposal costs are good for business. Proper maintenance of equipment is important as it minimizes costly downtime and the resource waste often associated with shutdown and start-up periods.

Introducing more efficient processes

Introducing new and more efficient processes also reduces resource use and waste production. Many companies have been able to make large cost savings by reducing the amount of raw materials, energy and water that they use.

Product Design

It may be possible to redesign a product so as to reduce the amount of resources it contains whilst still maintaining the level of service it provides.

Waste Disposal - Making Money from Waste

As mentioned above, improving process efficiency will reduce the amount of waste that a process produces. Once waste has been generated, it is often possible to reuse it or pass it on to other companies that can use it and so avoid the costs of waste disposal.

Sourcing of Raw Materials

Changing the source of raw materials used in a particular process can result in cost savings. Companies could make large savings by using recycled wool rather than virgin wool to manufacture its products, or use recycle paper rather than manufactured paper that could save substantial number of tress being felled.

Infrastructure

It is also possible to make savings by making efficiency changes to infrastructure e.g. installing energy efficient lighting, insulating buildings, improving the efficiency of heating systems.

Packaging and Transport

Once goods have been produced, they need to be packaged and transported. It is possible to make cost savings in these areas at the same time as improving environmental performance.

Ensuring Legislative Compliance

By ensuring that it complies with relevant environmental legislation, a company or a firm can avoid the possibility of being fined by the regulatory authorities for noncompliance and the adverse media publicity and public criticism & outrage that can accompany such fines.

Anticipating Future Legislation

Developing an awareness of likely changes in environmental legislation allows companies to plan for these changes and make appropriate investment decisions. If a company or an organization is not aware of proposed legislation it may make investments that are futile when the new legislation is enacted. Alternatively, a company may find out about a legislative change at the last minute and be forced to undertake rapid investment to comply with its requirements. Prior knowledge of likely changes allows a longer time period over which to make the necessary investment and prevent possible cash flow problems.

Reduced Environmental Risk

Environmental risk is the single largest hidden risk for many companies. By undertaking environmental risk assessment as part of the environmental management process it is possible to reduce the risk of the occurrence of events that could have adverse environmental consequences. Banks, insurance companies and investors all base their decisions on an assessment of risk. The higher the risk, the less likely a bank is to lend, the less likely investors are to invest and the higher insurance premiums are likely to be.

Therefore a reduction in environmental risk is likely to be viewed favorably by all these parties, putting a company in a better position to obtain loans and insurance cover and to attract investment.

Meeting Supply Chain Requirements

An increasing number of large organizations are requiring their suppliers to demonstrate sound environmental management and are prepared to delist those that fail to do so. In some cases having an environmental policy is not considered sufficient proof of sound environmental management and evidence is required that a company is taking action to meet the commitments set out in their policies. Hence, undertaking effective environmental management will increasingly be necessary to gain or maintain supplier status with large organizations.

Improved Relations with Regulators

The ability to demonstrate sound environmental management may lead to environmental regulators taking a more "hands-off" approach to regulation e.g. a reduction in the number of inspection visits required per year.

Improved Public Image and Community Relations

By publicizing its efforts to improve environmental performance, a company can improve its public image, thereby enhancing its position in the market place. And by demonstrating sound environmental management, a company can reassure the local community about its activities and thus build up good community relations.

Increased Market Opportunities

Lower production costs resulting from environmental management and good public image resulting from publicizing good environmental performance can result in a company increasing sales and gaining a larger market share.

Employee Enthusiasm

The environment is an issue about which many people are concerned. Undertaking environmental management can generate a lot of enthusiasm within a company as it allows employees to express their environmental concern in a practical way by contributing towards improving environmental performance

Self-Check 1	**Multiple choice**

Instruction: Select the best answer and encircle the letter

1. ---------One of the following including in Work Health and Safety Regulation 2011,

   A/Specific personal protective equipment (PPE) requirements;

   B/Hazardous chemicals;

   C/Fire protection equipment

   D/ All of the above

2. A construction worker should aware one of the following safety rule

   A/Specific Hazards

B/Probable consequence of involvement with the hazards

C/How hazards cab be avoided

D/ All of the above

3. The purpose of a solid barricade is to provide a physical barrier capable of performing the same function as a permanent guardrail.

A/ True B/ False C/ A & B are correct D/ None

4. ……is used to dispose disposal materials from working place, to transport or serve materials and tools activities in the during construction site.

A. spade B. Wheelbarrow C. mixer D. ladder

5. Creating a good environment will play an important role in guaranteeing the quality and safety of construction projects,

A/True B/ False C/Both D/All

6. Minimizing waste, sorting waste into the appropriate bins and leaving the site clean and tidy at the end of each day.

A/ Land disturbance B/ Noise and vibration

C/Waste management D/All

7. -----is firstly to do rational planning and management of construction plan

A /Control of working environment B/Waste management

C/Noise and vibration D/ None

Test II: short Answer writing

Instruction: write short answer for the given question. You are provided 3 minute for each question and each point has 5Points.

1. What is the purpose of Personal Safety?

2. What is the advantage of bucket?

Operation Sheet 1

Operation Title	Preparing Work Area

Purpose:- To apply quality work and health care

Instruction: - Using the right tools to perform your task within the given time. You have given 10Minut for the task.

Equipment and Tools

- Shovel
- Chisel
- Brooms
- Concrete Saw
- Hammer
- Drill
- Cleaning Materials

precaution:-

- ✓ Safe working area environment
- ✓ Ensure the work area hazard free
- ✓ Avoid horse play
- ✓ Availability of proper tools and equipment

PROCEDURE,

1. Wear your PPE properly.
2. Secure workshop manuals, Specifications, tools and equipment.
3. Sort different tools and materials based on their size and kind.
4. Select appropriate way of house cleaning.
5. Identify and prepare resources and technical requirements for Carry-out Concrete Bursting
6. Observe the proper application of Occupational Health and Safety requirements.

Quality Criteria: Assured to follow the kaizen principle

LAP Test 1	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction I: Given necessary templates, tools and materials you are required to perform the following tasks within 10 min.

Task 1: Prepare Work Area

Unit Two: Carry out minor repairs
This unit to provide you the necessary information regarding the following content coverage and topics: • Effects of dusting • Repairing damage concrete either by grinding or covering • Repair mortars self-leveling floor compounds • Cover and colored paints • Repair and maintain cloven timber form work • Maintain or repairing masonry structure This guide will also assist you to attain the learning outcomes stated below. Upon completion of this learning guide, you will be able to: • Repair the effects of dusting • Repair damage concrete either by grinding or covering. • Apply repair mortars self-levelling floor compounds. • Apply Cover colure paints. • Repair and maintain cloven timber form work. • Maintain or repair masonry structure

2.1 Effects of dusting

2.1.1 Repairing effects of dusting

❖ What is dusting?

A dusting floor surface is marked by an Accumulation of fine material requiring to be swept up after the floor has been used. A hand rubbed over the surface of a dusting floor will be coated with a fine powder

❖ **What causes Dusting?**

Dusting is caused by the wearing surface being weak and the matrix not properly bonding the fine aggregate particles. The major causes are:

- Inappropriate concrete specification for the required strength and abrasion resistance.
- The addition of water in excess of that required by the mix design. This generally increases
- Premature finishing. If finishing operations are performed while bleed water is on the

Surface, the water will be worked back into the surface layer of the concrete producing a very High water-cement ratio and, therefore, a low strength surface layer.

Fig2.1 Dusting Surface

❖ **Repair of dusting surfaces**

Repair of dusting floors is difficult; it is best to avoid or minimize the risk by adopting the techniques outlined above. Recommended repair methods include:

- Application of a chemical surface hardener or dust inhibitor. In the majority of cases, dusting can be rectified by the use of a surface hardener such as sodium or flour silicate.
- These products react with the calcium hydroxide in the concrete to produce additional cementitious compounds.
- Grinding the surface. In more severe cases, the complete removal of the weak surface layer with a concrete grinder may be required. .
- Applying a topping. The weak surface layer could be removed by scrabbling and replaced by a topping. If levels need to be maintained, a number of proprietary topping products that bond to the existing concrete can be placed at thicknesses of about 10 mm. If levels are flexible, a 70- to 80-mm-thick unbounded topping (overlay) on the existing floor can be used.
- In some domestic applications, installation of a floor covering such as carpet or tiles may be a cost effective solution. The concrete surface should be checked for adequate strength if the floor covering is to be bonded to it.

Fig2.2 concrete surface repair

2.1.2. Practices to Minimize the Risk of Dusting

To minimize the incidence of dusting:

- Specify an appropriate concrete strength for abrasion resistance; Do not add excess water to the concrete mix.
- In general, use concrete with a moderate slump, say 80 mm. In cold weather, delayed setting will increase bleeding and may require the use of a lower slump. In hot weather, acceptable setting times and bleed rates can still be achieved with higher slump levels, providing the mix is designed to perform at such slumps without causing excessive bleeding or segregation.
- Do not overwork the concrete initially as this may seal the surface and trap bleed water under the surface layer. Also, fine material may be brought to the surface.
- Do not perform any finishing operations with bleed water or rainwater present on the surface.

If rain threatens, a method to protect the surface should be available. Final bull-floating or trowel ling should be performed only after all the bleed and surface water has evaporated or been removed.

- Do not sprinkle or trowel dry cement into the surface of plastic concrete to absorb bleed water or rainwater. Remove bleed water by dragging a garden hose across the surface or by using a rubber squeegee.

Compact the surface of the floor with a surface vibrator and/or use one of the finishing techniques giving improved abrasion resistance

2.2. Repair damage concrete either by grinding or covering

2.2.1. What is Repair?

Action taken to reinstate to an acceptable level the current functionality of a structure or its components which are defective or deteriorated, degraded or damaged in some way is called repair

The actions will include the following:

(i) Patching up of defects such as cracks and fall of plaster.

(ii) Repairing doors, windows, replacement of glass panes.

(iii) Checking and repairing electric wiring.

(iv) Checking and repairing gas pipes, water pipes and plumbing services.

(v) Re-building non-structural walls, smoke chimneys, boundary walls, etc.

(vi) Re-plastering of walls as required.

(vii) Rearranging disturbed roofing tiles.

(viii) Relaying cracked flooring at ground level.

(ix) Redecoration, whitewashing, painting, etc.

Rehabilitation

It is the process of bringing the structure to its original level of function including durability and strength.

It includes:

- ❖ Removal of portions of cracked masonry walls and piers and rebuilding them in richer mortar. Use of non-shrinking mortar will be preferable.
- ❖ Addition of reinforcing mesh on both -faces of the cracked wall, holding it to the wall through spikes or bolts and then covering it suitably. Several alternatives have been used.
- ❖ Injecting epoxy like material, which is strong in tension, into the cracks in walls, columns, beams, etc.

Retrofitting

Action to modify the functionality of a structure and to improve future performance in terms of load carrying capacity is called retrofitting.

Effects of repair, rehabilitation and retrofitting

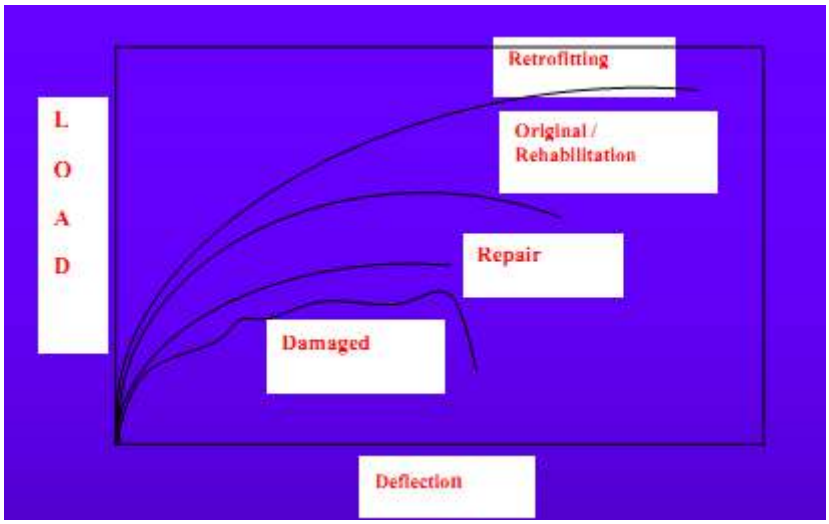


Fig.2.3. Effects of repair, rehabilitation and retrofitting

The expected economic life of the building under normal occupancy and maintenance conditions is considered to be as below:

(i) Monumental buildings 100 years.

(ii) RCC Framed construction 75 years

(iii) Load bearing construction 55 years.

(iv) Semi permanent structures 30 years

(v) Purely temporary structures 5 years

Surface Coatings

The protective coatings of concrete surface generally improve the durability and greatly help to protect concrete deterioration due to environment effects. The protective coatings properties are:

1. Possess excellent bond to substrate
2. Be durable with a long useful life normally 5 years
3. Little or no color change with time
4. Little or no chalking
5. Should have maximum permeability to allow water vapors escape from concrete Substrate
6. Should sufficient impermeability against the passage of oxygen and carbon dioxide from air to concrete
7. Should be available in a reasoning range of attractive colours.
8. The properties of concrete which affect the successful application and

Performance of a coating is

(i) Porosity
(ii) Moisture content
(iii) Presence of contaminants on the surface.

Most of the protective coatings used are

(i) Bituminous coatings and mastics
(ii) Polyesters and Vinylesters
(iii) Urethanes
(iv) Epoxies
(v) Neoprene
(vi) Coal Tar Epoxy
(vii) Acrylics.

2.2.2. What causes damage to concrete?

So we've done our evaluation and now we are ready to determine what caused the damage—this is often called troubleshooting. Start by thinking about the basic characteristics of concrete—strong in compression, weak in tension.

Therefore, a crack implies that the concrete was in tension. Recognize that the crack is always perpendicular to the direction of the tension—always!

Think of a typical shrinkage crack running diagonally from a re-entrant corner in a concrete slab. The concrete was shrinking back in each direction from the corner and that diagonal crack is perpendicular to the direction of shrinkage.

Look at a diagonal crack across the corner of a slab panel where it was run over by heavy traffic or the sub base was poorly compacted—the bending force created tension across the top of the slab. Take a saltine cracker and bend down the corner—it breaks in a diagonal line exactly the same as a concrete slab. I guess you could think of a concrete slab as nothing more than a big cracker!

Here are a few typical concrete problems and their causes:

- Corrosion of reinforcing steel: Steel rebar is protected inside concrete because the concrete is very alkaline which prevents rust. But if there are chloride ions present, such as from deicing salts, the chloride destroys the "passivating layer" of alkalinity around the steel, allowing it to rust. Rust has greater volume than steel and the expansion presses against the concrete putting it in tension and causing it to crack and pop off. Chlorides get to the concrete through cracks or by simply penetrating through the concrete's pore structure.
- Freeze-thaw disintegration: Concrete is porous, so if water gets in and freezes it breaks off small flakes from the surface. Deicing salts make it worse. This is typically called scaling and it can occur during the first winter and get worse over time. When severe, it can lead to complete destruction of the concrete. Proper air entrainment completely prevents scaling.

Fig2.4. Concrete crack repair

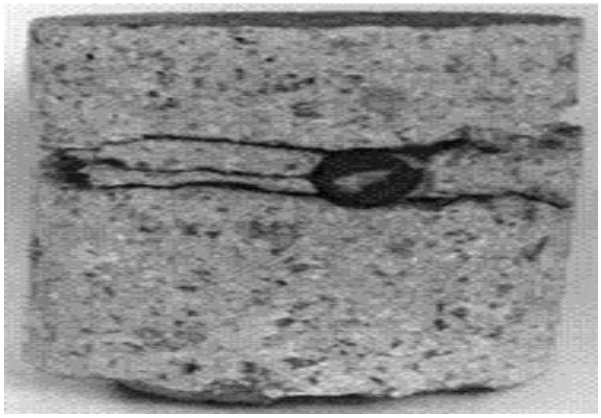


Fig2.5. Concrete crack

Even decorative concrete can suffer damage, and these repairs require special expertise. Endure Stamped Concrete

❖ **Concrete crack repair**

With low-pressure crack injection, you can permanently repair a basement leak and foundation crack without high cost and disruptive excavation.

While concrete cracks appear to be typical, it is not recommended that they remain ignored. Most homeowner's best identify concrete cracks in their basement, either on the foundation wall or on the floor. They may also recognize cracks on the garage floor, patio or in-ground pool.

These cracks typically due to drying shrinkage, thermal movement or other causes usually are minor and result in few problems. More often than not, a foundation crack will widen over time and result in water seepage or possibly the loss of structural integrity. Foundation and slab cracks are not only an eyesore, but they may hinder the value of the home.

Fig2.6 Concrete crack

Fig.2.7. Concrete crack repair

2.2.3. Why Does Concrete Need Repairing?

- Corrosion of reinforcement

- Insufficient reinforcement
- Chemical damage
- Excessive loads
- Structural damage
- Fire damage
- Seismic damage
- Blast damage

2.2.4. Repairing damage concrete by covering

Hanne card can provide new coverings or recovering in every area of the paper mill from pulp preparation to converting.

Covering and recovering takes place at our workshop (polyurethanes, composites, rubbers and carbides) or on site (carbides).
Hanne card also provides grinding and machining (drilling and/or grooving) services.

All types of covers can be ground at the workshop. Machining and cylindrical grinding on metallic or carbide-covered rolls can take place on site.
In addition, Hanne card can carry out inspections, repairs and cleaning and supply expertise and optimization.

2.3. Repair mortars self-leveling floor compounds

2.3.1. Concrete Repair Mortars

Concrete repair can be due to a number of reasons, from natural structural defects caused by buildings settling and adjusting during temperature highs and lows to damage caused by unexpected water ingress or produced by preventable corrosion on internal supports. While each of these jobs will call for a repair in a similar way, i.e. filling cracks or gaps with a specialized concrete repair mortar, the repair mortar used may differ between each of the repairs required.

Concrete repair mortars are generally split into two different groups, cementitious and epoxy, based on their repair qualities and both of which can be used for different applications.

Concrete Repair Mortars We Use

At Concrete Renovations Ltd, we keep stock of a variety of concrete repairs mortars, this ensures that different systems can be correctly applied to specific repair job situations,

extending the lifetime of the repair and allowing us to closely match mortars to the original structure in order to blend repairs seamlessly.

You have different goals for every project. Master Builders Solutions repair mortars meet multiple application requirements, while keeping your end goal in mind. Do you need a rapid setting mortar or one with extended working time? Are you working on a large area or restoring fine architectural details? With our portfolio of durable repair mortars, we've got you covered.

2.3.2. Epoxy Concrete Repair Mortars

Epoxy Bonding Agents

Various epoxy products are available for the bonding of freshly placed concrete to cured concrete and of concrete to steel. Most products contain resins that are 100% solids. In severe drying conditions, the open time for bonding coats may be too short to ensure a good bond and such situations epoxy resin bonding is preferable.

Fig.2.8. Epoxy concrete repair

A specially formulated epoxy for use with eroded or cracked concrete flooring, epoxy concrete repair mortars are used to provide new strength to damaged concrete and, in most cases, offer a permanent repair that is tough enough to stand up to most heavy use.

Epoxy concrete repair mortars are popular for use in repairing concrete as they are fast curing and can be layered up to fill cracks and gaps greater than 50mm in depth, making it versatile for most repair situations.

2.3.3. Self-Leveling Compound

Concrete mortars are a mortar with self-leveling properties. Hydraulic cement-base compound, selected silica sands and special additives, that when mixing them with water

form a fluid and self-leveling mass, ideal to correct imperfections in floors where thicknesses of up to 10 mm are required.

Use of Self-Leveling Compound

- To achieve leveled surfaces
- To fill thicknesses or voids with differences between 0.5 and 10 mm (0.02 - 0.39 in)
- Ceresin DM may be used on: concrete, mortar, ceramic tiles, natural stone and old substrates with adhesive remnants firmly attached
- The product is for indoor use only. Do not use it as final finish

Self-leveling concrete

- Self-leveling concrete is polymer-modified cement that has high flow characteristics and, in contrast to traditional concrete, does not require the addition of excessive amounts of water for placement.
- Self-leveling concrete is typically used to create a flat and smooth surface with a compressive strength similar to or higher than that of traditional concrete prior to installing interior floor coverings. Self-leveling concrete has increased in popularity as the degree of flatness and smoothness required for floor covering products has increased, with vinyl goods becoming thinner and floor tiles becoming larger, for example.
- Floor Self-Leveling Screed is a cement-based, rapid-hardening, low-shrinkage, self-leveling 'underlay', used to rectify uneven or damaged concrete and other cement-based floor surfaces. Produced from carefully selected raw materials for consistency of product, it only requires the addition of water on site.
- Application can be by means of 'hand-mix' or by automated pumping equipment - the final floor finish being smooth, durable and designed to accept various floor coverings such as vinyl sheeting and -tiles, laminates and marmoleum, rubber floors, carpeting, parquet, epoxy or urethane coatings and ceramic/porcelain tiles.

❖ General

Floor Self-leveling Screed should not be applied to exterior surfaces when there is a risk of rain or frost within six hours after application

❖ Surfaces preparation

The following minimum curing periods must be observed, before application of this Screeding compound:

- New concrete floors: 28 days
- New screeds: 28 days
- New brickwork: 14 days

Ensure that all surfaces are clean, dry, sound and free from dust, grease or any contamination that could impair bonding.

Make good any unsound areas and remove flaky or peeling layers before

2.4. Cover and colored paints

2.4.1. Applying cover and colored paints to concrete

Paint is a great way to completely cover concrete with an opaque color. Concrete is easy to paint and will accept any acrylic latex or oil paint. Special concrete paint is formulated to withstand abrasions that concrete is likely to incur, however any paint can be applied to a clean, debris-free concrete surface.

Concrete Floor Refresh

A fresh coat of color solves everything! And it's easy when you can rely on strong, innovative tools that take the heavy lifting out of painting even a large floor.

Fig.2.9. Concrete Floor Refresh

Concrete is one of the most durable construction materials around, but the characteristic dull gray of a concrete slab can seem cold and unappealing, especially as flooring. Lucky for many DIY-inclined homeowners, concrete is also a fairly versatile material that offers many options for repairs, alterations, and improvements.

The bottom line: If you have concrete floors in your basement, garage, or screened-in patio, you don’t have to live with lackluster. You can refresh the entire space by painting your concrete floors.

In combination with the right tools and techniques, today's masonry paints, designed specifically for concrete, make it easy to turn a drab concrete floor into an attractive surface that can complement a variety of spaces, both indoors and out.

Painting concrete surfaces requires more skill, tools, and time than throwing a coat on drywall. Here's how to do it right.

Concrete painting is trickier than painting most surfaces: It breathes, transports moisture, and sucks up paint.

While you can paint drywall in a day or two, you'll need a week or more to finish painting concrete. Continue reading below for tips -- plus costs -- on how to paint concrete surfaces:

Fig.2.10. Concrete Painting

2.4.2. Simple 4-Step Guide to Concrete Painting

1. Strip Old Paint

   Strip peeling or blistering paint indoors with a wire brush, a paint scraper and lots of elbow grease.

2. Seal Interior Concrete

   Water moves easily through porous concrete, so sealing interior walls is necessary to prevent moisture from seeping in, promoting mold growth and that cold, damp basement feel. Use a masonry sealer, such as Thoron Seal, that also patches cracks.

   Carefully follow directions for mixing, applying, and curing the sealer. Thoron Seal, for example, requires two coats; the manufacturer recommends curing for five to seven days before applying the second coat.

3. Prime the Concrete

   Concrete primer, called block primer, fills pores and evens out the surface. For exterior foundations and walls, use exterior-grade block filler, such as Behr's Concrete and Masonry Bonding Primer, which also is good for interior concrete ($17.98 per gallon)? Primer dries in two hours; wait at least eight hours, but no more than 30 days, to paint.

4. Paint the Concrete

Masonry paint (also called elastomeric paint or elastomeric wall coating) is a good choice for concrete painting because it contains binders that contract and expand with the concrete. Exterior house paint can crack and peel on concrete.

2.4.3. Concrete Sealing

Once decorative concrete floors or new concrete colored are finished the best way to keep them looking great is to seal and protect their surface. Parched supply some of the hardest wearing decorative concrete sealing systems in the world.

It is essential that your decorative concrete surface is resealed periodically in order to lock in the color, protect the surface from impurities and maintain its glossy appeal

Fig.2.11. Colored Concrete Sealers

I. Colored Concrete Sealers

Dramatically improve the appearance of your concrete by adding a Colored Concrete Sealer.

The Colored Concrete Sealer system is ideal for coloring and protecting plain concrete. It is a two part system; Part A the color sealer clear base and Part B the color tint. The Color Tint (Part B) is added to the Color Sealer Clear Base (Part A), and then applied using a roller or soft bristled broom

2.5. Maintain or repairing masonry structure

2.5.1. Defects In Masonry Walls

General aspects

Problems with the behavior of buildings normally appear through the occurrence of defects. The behavior of buildings is quite complex and involves aspects of material science that sometimes are not well understood yet. Also, masonry is a subject which is not taught in depth during Engineering and Architecture University courses. These aspects increase the difficulty in accurately identifying defects in buildings elements and determining the cause. In general terms, the main causes of defects are associated with human and natural causes (Table 2.1).

Causes	Type	Agent
Human actions	Design	Improper calculation methods and errors, insufficient technical information and level of detailing, improper design assessment (loads, local conditions, compatibility between different functionally aspects…)
	Execution	Use of bad quality materials, inadequately qualified and experienced personnel, inadequate execution control of construction works, bad interpretation of the project
	Utilization	No, or inadequate, maintenance procedures, changes in the utilization, excessive loading…
	Disasters	Fire, explosion, impact, …
Natural actions	Physical	Wind and rain effects, snow, creep, thermal/moisture movements,
	Chemical	Oxidation, carbonation, acid rain, salts…
	Biological	Vegetation (roots, fungus,...), animals (warms, insec
	Disasters	Seismic, cyclone, avalanche, flood, volcanic eruption, …)

Table 2.1 - General causes of defects in buildings

2.5.2. Cracking Prevention in Masonry Partition Walls

I. General

Interior walls have as their function the separation between different spaces (rooms). They don't have a structural role, so their thickness is generally only 5 to 10 cm. They are often constructed in brittle masonry materials such as clay bricks or blocks, concrete blocks (dense or lightweight), calcium silicate units, gypsum, etc. This means that their ability to

adapt to deformations in the building is very low - they are building elements that can be exposed to cracking in various forms. The cracks have an influence on the aesthetic function and on some of their physical properties such as noise insulation.

In practice, the cracks in the interior walls can often cause litigation since repair costs can be very high if properly done.

II. Origin of defects in interior walls (partitions)

Excessive deformation of slabs or beams supporting partitions is the most frequent cause of damage to partitions. While the beam or slab can deflect without any damage, the supporting brittle masonry elements cannot follow and will crack (Figure Below).

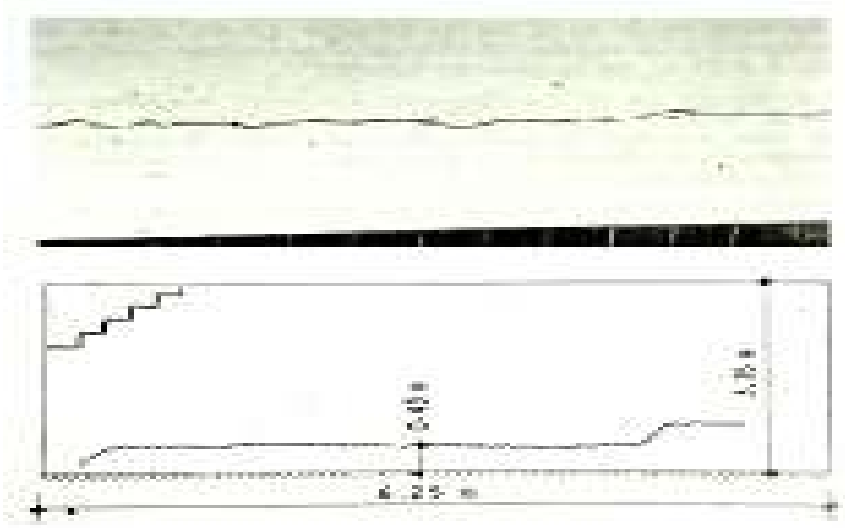


Fig.2.12. Cracks in a partition due to the deformation of support

The form of these cracks depends on several factors:

- The ratio of length to the height of the wall
- The type and quality of the masonry material in the partition;
- The presence of door and window openings in the partition;
- Any interaction with other walls, partitions, columns, etc.

Different situations may occur.

a) The deflection of the slab on the upper level of the partition is higher than that at the foot of the partition (Figure below).

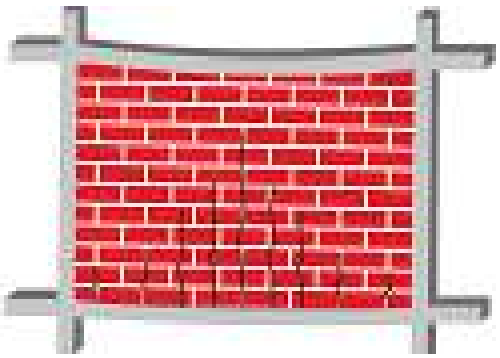


Fig.2.13. Cracks in a partition due to the deflection of the upper support

In this case the partition takes on a structural function. It will behave as a deep beam
under flexure but the partition was not designed for this function so if the tensile stresses in the partition produced by such a deflection are higher that the tensile strength of the masonry, cracks will occur (Figure below).

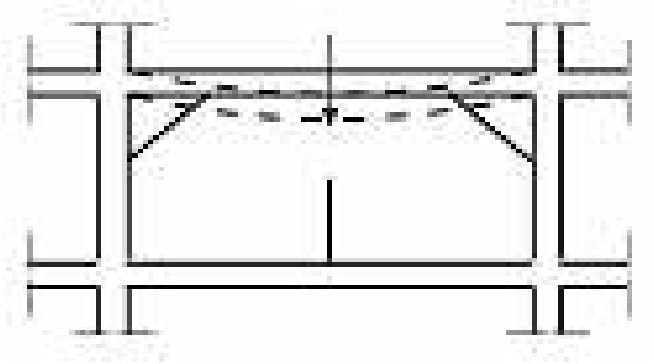


Fig.2.14. Partition is acting as a deep beam in flexure

These are similar to the cracks in a concrete beam under flexure. In reality a new distribution of the loads occurs with the partition as a structural element. The part of the load distributed to the partition depends on:

- The stiffness of the partition;
- The rigidity of the partition support;
- The position of the partition in relation to the other supports (walls, beams, etc.);
- The physical characteristics of the masonry of the partition.

Active Cracks Repairing

Active cracks occur because of thermal movement. These cracks always reoccur after some time once they are repaired.

1. **Repairing of Cracks in Brick Wall (Crack width below 2 mm):**
   - If the cracks remain under 2 mm in width, then the crack can be repaired with the snow filla paint (ACC make) that is extended in the cracks after it becomes dry. It is recommended to cure painted crack for minimum five days.
2. **Repairing of Cracks in Brickwork (Crack width among 2 mm to 5 mm):**
   - If the cracks remain among 2 mm to 5 mm in width, then the crack should be repaired by injecting the flowing grout in the ratio like cement 1 kg, grout polymer 0.1 kg, and 1-litre water. Bore the hole at a distance of 350 mm c/c for attaching the nipple with the sealant. The grout mixture is injected with the pressure of 3 kg/cm2 through a pressure pump.
3. **Repairing The Cracks In Brickwork (Crack width among 5 mm To 10 mm):**
   - If the cracks remain among 5 mm to 10 mm in width, then eliminate all the loose materials and keep the width of the groove of cracks as 25 mm and depth as 10 mm. Detach the plaster up to a width of 300 mm on the both sides of the cracks and fill the groove with CM 1:3 having 10% polymer by weight of cement. Once the cracks are filled, 12 mm diameter nipples should be inserted at 100 mm c/c and 30 mm to 40 mm deep along the crack line and employ the above grouting method for grouting the cracks.
4. **Repairing of Cracks in Brick Masonry (Crack width over 10 mm):**
   - Eliminate all the loose materials from the crack and detach the plaster up to 450 mm on both side of the cracks. Fill the cracks with CM 1:3 with 10% polymer by weight of cement.

Self –Check 2	Short Answer writing

Test I: Short Answer writing

Instruction: write short answer for the given question. You are provided 3 minute for each question and each point has 5Points.

1. Why Does Concrete Need Repairing? (5pts)
2. What causes damage to concrete? (2points
3. What is dusting? (3pts)

4. What is Repair of dusting floors(4pts)
5. What is Concrete repair? (5 points)
6. What is Self-leveling concrete is? (3point)
7. What is Painting Concrete?(4point)
8. List Simple 4-Step Guide to Concrete Painting(4point)

Operation Sheet 2

Operation Title	Applying cover and colored paints to concrete

Purpose:- To apply quality work and health care

Instruction: - Using the right tools to perform your task within the given time. You have given 50Minut for the task.

Equipment and Tools

- Shovel
- Chisel
- Trowel
- Brooms
- Concrete Saw

- Hammer

precaution:-

- ✓ Safe working area environment
- ✓ Ensure the work area hazard free
- ✓ Avoid horse play
- ✓ Availability of proper tools and equipment

PROCEDURE,

Step 1. Wear your PPE properly

Step 2. Select required materials

Step 3. Select required tools and equipment

Step 4. To chisels the repairing surface and Strip Old Paint

Step 5. Seal Interior Concrete

Step 6. Prime the Concrete

Step 7. Paint the Concrete

Quality Criteria: Assured to follow the proper application of Occupational Health and Safety requirements

LAP Test 2	**Practical Demonstration**

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction I: Given necessary templates, tools and materials you are required to perform the following tasks within 50 min.

Task 1: Apply cover and colored paints to concrete

Unit Three: Carry out rectification of cracks and other major defects
This unit to provide you the necessary information regarding the following content coverage and topics: • Cause of the defect • Concrete flexible epoxy pitches • Applying coverings concrete materials techniques

- Safely requirements
- Replacing and Rectifying masonry structure
- Brushing rusted reinforcement.
- Rectification and reparation timber stair components
- Installing and replacing windows and doors.

This guide will also assist you to attain the learning outcomes stated below. Upon completion of this learning guide, you will be able to:

- Determine and resolve cause of the defect.
- Prepare Concrete flexible epoxy pitches
- Apply coverings concrete materials techniques
- Apply safely requirements
- Replace and rectify masonry structure.
- Brush rusted reinforcement.
- Do rectification and reparation timber stair components
- Install and replace windows and doors.

3.1 Cause of the defect

3.1.1. Types of Concrete Defects – Causes, Prevention

Various types of defects which can be observed in hardened concrete surface and their prevention methods are explained below:

I. Cracking

Cracks are formed in concrete due to many reasons but when these cracks are very deep, it is unsafe to use that concrete structure. Various reasons for cracking are improper mix design, insufficient curing, omission of expansion and contraction joints, use of high slump concrete mix, unsuitable sub-grade etc.

To prevent cracking, use low water – cement ratio and maximize the coarse aggregate in concrete mix, admixtures containing calcium chloride must be avoided. Surface should be

prevented against rapid evaporation of moisture content. Loads must be applied on the concrete surface only after gaining its maximum strength.

Fig3.1 Cracking

II. Crazing

Crazing also called as pattern cracking or map cracking, is the formation of closely spaced shallow cracks in an uneven manner. Crazing occurs due to rapid hardening of top surface of concrete due to high temperatures or if the mix contains excess water content or due to insufficient curing.

Pattern cracking can be avoided by proper curing, by dampening the sub-grade to resist absorption of water from concrete, by providing protection to the surface from rapid temperature changes.

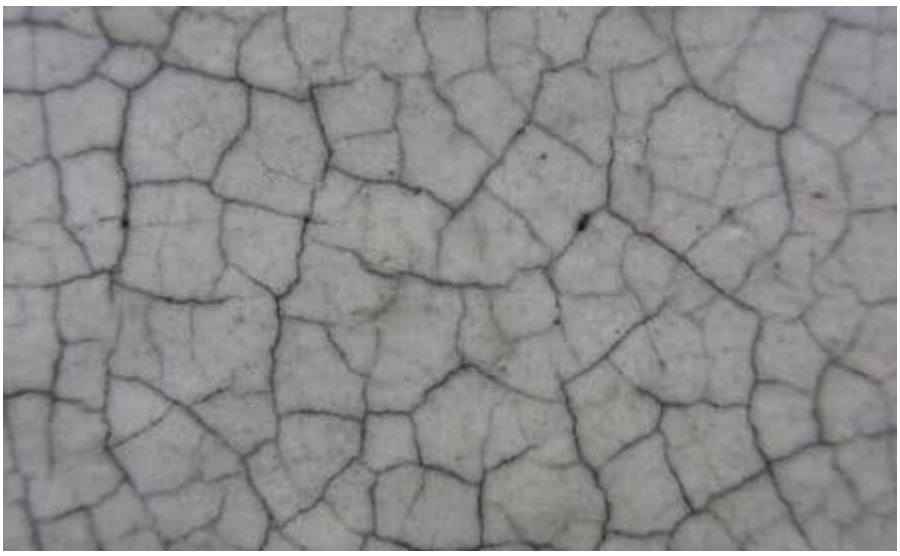


Fig3.2 Crazing or pattern cracking

III. Blistering

Blistering is the formation of hollow bumps of different sizes on concrete surface due to entrapped air under the finished concrete surface. It may cause due to excessive vibration of concrete mix or presence of excess entrapped air in mix or due to improper finishing. Excessive evaporation of water on the top surface of concrete will also cause blistering.

It can be prevented by using good proportion of ingredients in concrete mix, by covering the top surface which reduces evaporation and using appropriate techniques for placing and finishing.

Fig3.3 concrete blistering

IV. Delamination

Delamination is also similar to blistering. In this case also, top surface of concrete gets separated from underlying concrete. Hardening of top layer of concrete before the hardening of underlying concrete will lead to delamination. It is because the water and air bleeding from underlying concrete are struck between these two surfaces, hence space will be formed.
Like blistering, delamination can also be prevented by using proper finishing techniques. It is better to start the finishing after bleeding process has run its course

Fig3.4 Delamination

V. Dusting

Dusting, also called as chalking is the formation of fine and loose powdered concrete on the hardened concrete by disintegration. This happens due to the presence of excess amount of water in concrete. It causes bleeding of water from concrete, with this fine particles like cement or sand will rise to the top and consequent wear causes dust at the top surface.
To avoid dusting, use low slump concrete mix to obtain hard concrete surface with good wear resistance. Use water reducing admixtures to obtain adequate slump. It is also recommended to use better finishing techniques and finishing should be started after removing the bleed water from concrete surface.

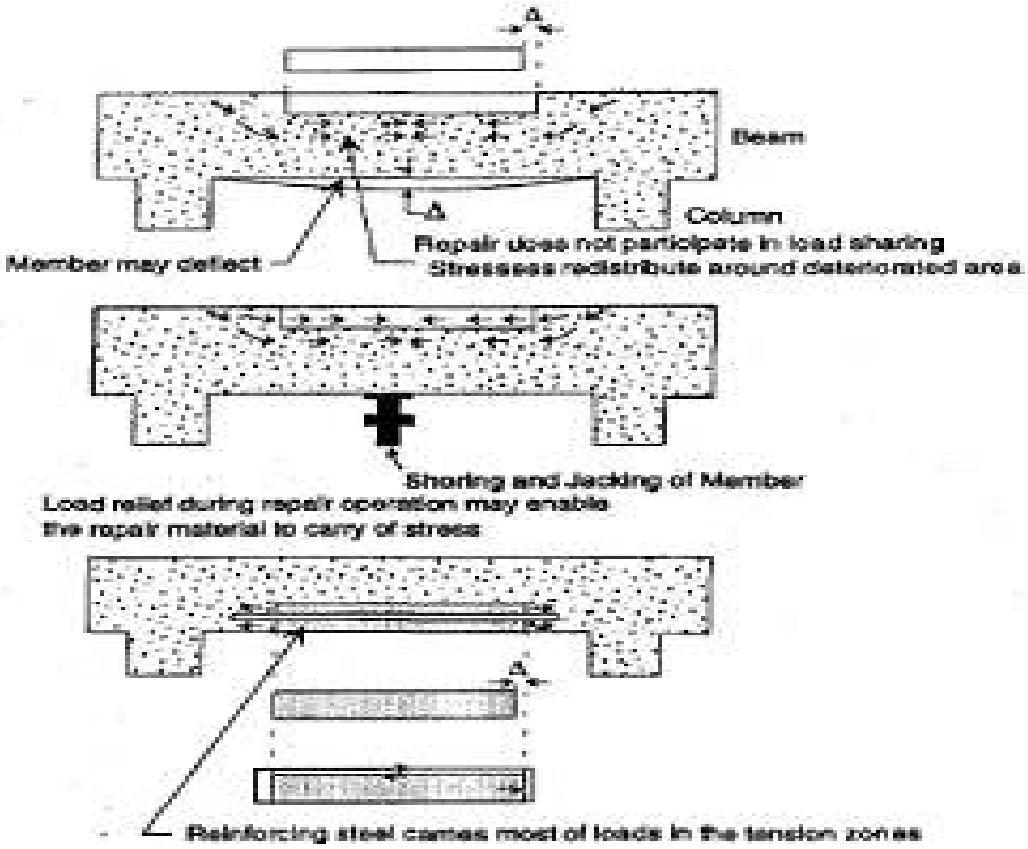
Fig.3.5 Dusting

VI. Curling

When a concrete slab is distorted into curved shape by upward or downward movement of edges or corners, it is called curling. It occurs mainly due to the differences in moisture content or temperature between slab surface (top) and slab base (bottom).

Curling of concrete slab may be upward curling or downward curling. When the top surface is dried and cooled before bottom surface, it begins to shrink and upward curling takes place. When bottom surface is dried and cooled due to high temperature and high moisture content, it will shrink before top surface and downward curling occurs.

To prevent curling, use low shrink concrete mix, provide control joints, provide heavy reinforcement at edges or provide edges with great thickness.



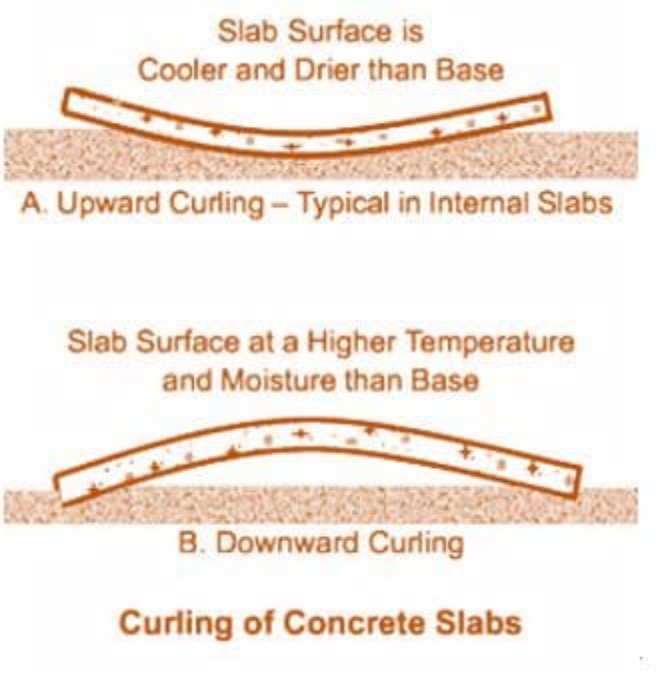


Fig3.6: Curling of Concrete Slab

VII. Efflorescence

Efflorescence is the formation of deposits of salts on the concrete surface. Formed salts generally white in color. It is due to the presence of soluble salts in the water which is used in making concrete mix.

When concrete is hardening, these soluble salts gets lifted to the top surface by hydro static pressure and after complete drying salt deposits are formed on the surface.

It can be prevented by using clean and pure water for mixing, using chemically ineffective aggregates etc. And make sure that cement should not contain alkalis more than 1% of its weight.

Fig3.7 Efflorescence

3.1.2. Design and construction defects

Defects are not strictly deterioration mechanisms in the same way as those described in previous sections. These mechanisms should not occur in properly designed, detailed and constructed structures.

- **Incorrect cover**

Low cover to reinforcement has two effects on reinforced concrete:

- **Durability** is reduced –in particular the time to corrosion is reduced, as there is less of a barrier to carbonation or chlorides
- **Bond strength** – can be reduced

High cover is also of concern, particularly in cantilevers. If the reinforcement is placed too far from the tension face, then the lever arm will be reduced, and it will not be effective in carrying load.

- **Low concrete strength**

One of the more common defects in some countries is low strength concrete. This can result from a number of causes, but the prime cause appears to be low cement contents.

Low concrete strength implies a high water-cement ratio (w/c). In addition to low strength, a high w/c ratio is likely lead to low durability, as the effects of most deterioration mechanisms are inversely proportional to the w/c ratio.

- **Overload**

These are not strictly deteriorations mechanisms in the same way as those described in previous sections. However, the structural mechanisms can lead to cracking if the members are overloaded.

- **Flexure**

Flexural stresses result from the bending of a member. These stresses will either be tensile or compressive depending on the orientation of the member and its loading.

3.2 Concrete flexible epoxy pitches

3.2.1. Epoxy-resin mortar and concrete

Epoxies also come in the category of polymer but in the case the of epoxies, the polymerization process take place when tow materials called the epoxy resin and hardener come in contact by thoroughly mixing in specified proportion.

The epoxy resin materials have good mechanical strength, chemical resistance and ease of working.

Field of applications:

3.2.2. Anti-corrosive and water proofing coatings: Fusion bonded epoxy powder (FBEP) coatings are being used for protection of reinforcing bars against corrosion in RC structures located in highly aggressive areas. FBEP process provides a tough film, which can withstand bar bending without cracking.

Bond coats and grouts: Epoxies are used as bond coats and grouts due to their excellent adhesive qualities on cementations as well as metallic surface. An epoxy film is brushed or sprayed onto the surface of the cleaned substrate and the new concrete is placed as the epoxy becomes tacky but before it hardens.

Structural repair to concrete: Due to their excellent mechanical properties and bond characteristics with most of the materials, epoxy mortars / concretes are used to make up the damaged or lost cover concrete, etc.

3.2.3. Applying flexible Epoxy Resins

Epoxy resins cure to form solids with high strength and relatively high modulus of elasticity. These materials bond readily to concrete and are capable, when properly applied, of restoring the original structural strength to cracked concrete.

The high modulus of elasticity causes epoxy resin systems to be unsuitable for rebinding cracked concrete that will undergo subsequent movement Cracks to be injected with epoxy resins should be between 0.002 inch to 0.25 inch in width.

It is difficult or impossible to inject resin into cracks less than about 0.002 inch in width, and it is very difficult to retain injected epoxy resin in cracks greater than 0.25 inch in width, although high viscosity epoxies have been used with some success.

Epoxy resin bond strengths can easily exceed the shear or tensile strength of the concrete. If these materials are used to re bond cracked concrete that is subsequently exposed to loads that exceed the tensile or shear strength of the concrete, cracks will likely recur adjacent to the epoxy bond line. In other words, epoxy resin should not be used to re bond “working” cracks

Epoxy resins will bond with varying degrees of success to wet concrete. There are a number of special techniques that have been developed and used to re bond and seal leaking cracks with epoxy resins. These special techniques and Procedures are highly technical and, in most cases, are proprietary in nature.

They may have application on Reclamation projects, but only after a thorough
Analysis has been performed to ensure that the more standard repair procedures
will not be successful or cost effective.

Fig3.8.1High-volume water leaks can be repaired using Epoxy resins

- **Epoxy resin systems**

Epoxy resin systems can be formulated in many ways, depending upon the ultimate properties, application characteristics and in-service conditions.

The most commonly available systems are:

***(i) Solvent*/water based:** These systems are normally formulated with ease of application in mind or, in the case of water based epoxies; the overriding factor is one of health and safety or environmental factors.

These systems are normally low film build as they rely upon the evaporation of the carrier (solvent or water) to affect the cure of the system. These systems are normally used for non-immersion applications due to their high permeation rates and are more commonly referred to as 'paints' rather than coatings.

Limitations

- Low film builds.
- Considerable shrinkage during cure.
- Extended cure times.
- Susceptible to blistering in immersion conditions due to solvent entrapment.
- Limited immersion temperature resistance.

(ii) Solvent free epoxy resin systems: These materials are designed to have high mechanical strength and have negligible shrinkage. Pigments and fillers are also used in these types of resin systems to perform specific functions, as well as provide a barrier to liquid ingress. Fillers include spherical, lamellar and mixed particle shapes to increase corrosion resistance, abrasion resistance and erosion resistance.

- Limitations
- Low reactivity at low temperatures.
- High viscosity and poor application characteristics.
- Limited immersion temperature resistance.

3.3 Applying coverings concrete materials techniques

3.3.1. Concrete structure repair materials

There are various types of materials which are used for the repair of concrete structures. For instance, unmodified Portland cement mortar or grout, latex modified Portland cement mortar or concrete, quick setting non-shrink mortar, and polymer concrete. The choice of such

materials is based on their performance and cost. In addition to repair material compatibility with damaged structure and ease of application.

Selection Criteria for Repair Materials

- Ease of application
- Cost
- Available labor skills and equipment
- Shelf life of the material
- Pot life of the material
- Type of damage
- Compatibility of the repair material with damaged concrete
- Appearance of finished surface
- Co-efficient of thermal expansion of the material
- Co-efficient of permeability of the material
- Corrosion resistance property of the material
- Durability of such concrete repair material
- Speed of concrete repair

Common Repair Materials

Following are the some of the common repair materials used for repair or rehabilitation or strengthening of the concrete structures:

1. Unmodified Portland cement Mortar or Grout

Portland cement mortar or grout is the most common repair materials used for repairing damages to concrete structures. It is selected because it is readily available and has a low cost.

This material consists of ordinary Portland cement and suitable aggregate. Cement mortar is generally used for small repair works and cement concrete are commonly selected where a large area is to be repaired.

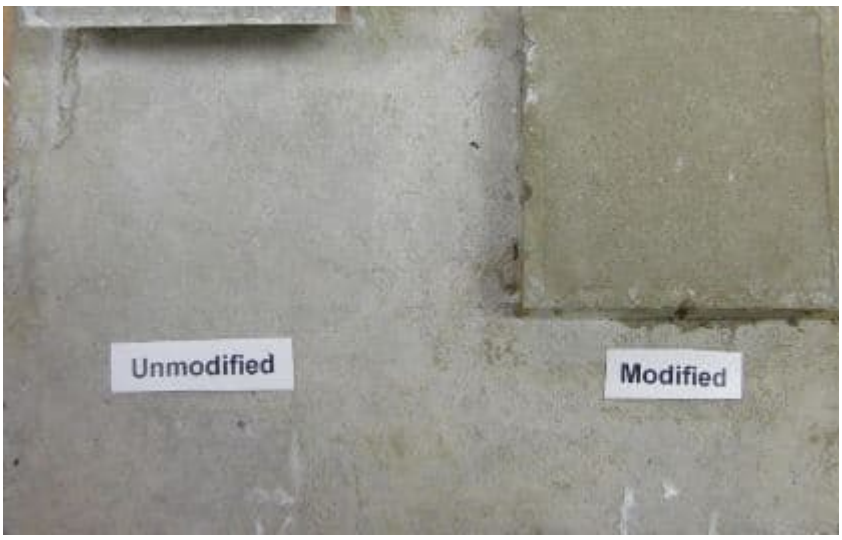


Fig.3.9: Unmodified Portland cement Mortar

2. Latex Modified Portland cement Mortar or Concrete

This repair material is used to prevent chloride attack on concrete structure due to the use of low water-cement ratio. This is the same as ordinary Portland cement mortar or grout with the addition of a latex emulsion. The strength of this material is same as ordinary mortar or grout. Ingress can be reduced due to lower water-cement ratio.

The addition of latex modifier influences the strength and durability of cement. The use of this material should be based on the service conditions of the structure.

Latex modifier concrete recommended for sections up to 30mm deep should have 1:3-3.5 as the ratio of cement and fine aggregates. Water ratio should be 0.3 with latex solid cement ratio of 0.1 to 0.2 by weight. Latex modifier concrete recommended for sections deeper than 30mm should have proportions of 1 part of cement to 2.5-3 parts fine aggregate to 1.5-2 parts coarse aggregate.

Fig3.10: Latex Modified Mortar

3. Quick Setting Non-shrink Mortar

Cracks on concrete surface due to shrinkage of concrete are repaired by this material. It develops a good bond with old concrete. The use of suitable admixtures combined with this repair material also increases strength and improve bond and workability while reducing curing time.

Fig3.11: Quick-set Non-shrinking Mortar

3.4 Cleaning Safely requirements

3.4.1. Cleaning Concrete

How-to tips for cleaning your concrete slabs, floors, and counter tops Cleaning concrete periodically will extend its service life and enhance its beauty. It can be difficult to tell when

concrete is in need of cleaning because the dirt and grime can build up so slowly. However, once the process is done, the results of freshly cleaned concrete are very noticeable.
There are multiple ways to clean concrete depending on the type of surface, such as exterior slabs, floors or countertops. Each requires a different procedure to avoid damaging surfaces.

Fig .3.12.Avoid damaging the surfaces.

Cleaning an old concrete slab so it will take an acid stain can be very difficult, but it is possible. The main thing is to NOT use any kind of acid wash or etching solution (including muriatic acid) to clean the slab. The stain will not take at all if you use acid as a cleaner.

A solution of TSP (tri sodium phosphate) and a lot of elbow grease with a scrub brush would be your best bet. Using a scrub brush with a long handle makes cleaning much easier. Another option would be to use a pressure washer to clean the concrete slab. For grease stains on concrete, try scrubbing the stain with lacquer thinner or mineral spirits.

Even with your best efforts, you may wind up with patches on a concrete slab that simply won't take an acid stain due to low lime content in the concrete (lime is what causes a chemical reaction with the acid stain). In those cases, you may have to resort to applying a faux finish to the spots to try and match the acid stain in the surrounding areas.

Concrete Acid Stain is a water-based liquid bearing minerals and acid. The acid stain penetrates the pores of the concrete forcing a chemical reaction between the muriatic acid and the available lime in the surface. Once acid stained, the color of the concrete is permanently altered. When sealed with an appropriate concrete sealer and for indoor applications, sealed and waxed, acid stain produces the unique, variegated finish associated with this process.

- **Before Acid Staining: Surface Preparation**

Surface preparation is the most important step in the acid staining process. Prior to staining, a slab must meet the following criteria:-

- ✓ The concrete must be free of debris, dirt and oils, paint, dry wall mud, adhesive, sealers, stains of any kind or similar materials. Acid stain cannot react properly with the concrete if these conditions are present.
- ✓ The slab should not have been treated with a waterproofing agent, cleaned with muriatic acid or a heavy trisodium phosphate (TSP) solution. The acid stain reaction cannot occur on surfaces treated with these products
- ✓ Newly poured concrete can be acid stained anytime from 20-28 days after the pour or once the concrete has achieved a uniform light gray color.
- ✓ For older, excessively power-washed, or mechanically-profiled concrete, the surface must be completely intact with no exposed aggregate or sand particles. Concrete acid stain does not stain rocks, sand or aggregate.

Exposed aggregate or otherwise depleted concrete may cause the acid stain to take irregularly, react weakly or produce a color inconsistent with the acid stain color chart

- ✓ Slick, machine-troweled concrete requires mechanical or chemical etching for a complete acid stain reaction to occur. If water beads on the surface or dark gray areas caused by excessive troweling are visible caused by excessively troweling, DCI Hard Troweled Floor Prep should be sprayed on the concrete or the surface should be sanded using an 80-grit sanding pad prior to application.
- ✓ Newly poured concrete slabs and countertops should include less than 10% fly ash to insure a good chemical reaction with the acid stain. Check with your ready mix company or read the countertop mix MSDS for concrete additive information.
- ✓ Concrete poured with excessive water in the mix can create a thin, unstable layer of concrete on the slab surface. To test for instability, press the tip of nail into the concrete. If breaking or damage of any kind occurs, the slab must be profiled with a concrete grinder or a high-speed buffer using a 60-80 grit sanding disc before staining.

How to care for concrete floor

No type of flooring material is truly maintenance free, and the same holds true for decorative concrete. Concrete floors are relatively easy to care for when compared with other types of flooring, especially carpet, but they do require regular attention. How much maintenance your floor will need largely depends on the amount of traffic it receives.

Some of the many maintenance-related advantages to concrete flooring are:

- No joints, grout lines or fibers to trap dirt.
- Stain, water, and abrasion resistant when properly sealed.
- Pet-friendly, easy clean-up for muddy paws and accidents.
- Simple cleaning of dry or damp mopping.
- Minimal routine maintenance of reapplying sealer every few years.

How to clean concrete floors

People who have concrete flooring love how quick and easy it is to clean. The basic steps are as follows:

1. Dry mop daily to remove dirt and debris
2. Damp mop with a pH-neutral cleaner as needed
3. Clean spills from the floor as quickly as possible so they don't stain the surface

Fig3.13.clean concrete floors

3.5 Replacing and Rectifying masonry structure

3.6 Brushing rusted reinforcement

3.7 Rectification and reparation timber stair components

3.8 Installing and replacing windows and doors

Self-Check 3	Short Answer writing

Test I: Short Answer writing

Instruction: write short answer for the given question. You are provided 3 minute for each question and each point has 5Points.

1. Write the Types of Concrete Defects – Causes, Prevention [4pts]
2. What is cracking (4pts?)
3. What is Epoxy resins (4pts)
4. Write the Common types of Repair Materials? (5pts)
5. Write the Selection Criteria for Repair Material? (2points)
6. What is cleaning? (5 points)
7. Write basic step clean concrete floors? (3point

Operation sheet 3

Operation Title	Cleaning concrete floors

Purpose:- To care for concrete floor

Instruction: - Using the right tools to perform your task within the given time. You have given 10Minut for the task.

Equipment and Tools

- Shovel
- Chisel
- Trowel
- Concrete Saw
- Hammer
- Wire brush
- Broom
- Bucket

precaution:-

- ✓ Safe working area environment
- ✓ Ensure the work area hazard free
- ✓ Avoid horse play
- ✓ Availability of proper tools and equipment
- ✓ The required drawing or plan

Procedure:-

Step 1. Wear your PPE properly.

Step 2. Prepare all the necessary material & equipment

Step 3. Dry mop daily to remove dirt and debris

Step 4. Damp mop with a pH-neutral cleaner as needed

Step 5. Clean spills from the floor as quickly as possible so they don't stain the surface

Quality Criteria: Assured to follow the proper application of Occupational Health and Safety requirements

LAP Test 3	**Practical Demonstration**

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instruction I: Given necessary templates, tools and materials you are required to perform the following tasks within 10 min.

Task 1: Clean concrete floors

5. Unit Four: Clean up

This unit to provide you the necessary information regarding the following content coverage and topics:

- Clearing work area
- Disposing , reusing and recycling materials
- Cleaning, checking, maintaining and storing plant, tools and equipment

This guide will also assist you to attain the learning outcomes stated below. Upon completion of this learning guide, you will be able to:

- Clear work area
- Dispose, reuse and recycle materials
- Clean, check, maintain and store plant, tools and equipment

4.1. Clearing work area

A clean, well-ordered, attractive work environment sets the tone of your establishment. It encourages tidy work habits in employees. It helps reduce fatigue. It promotes good worker-management relations. It also gives a lift to morale, which is reflected in the quality of production and overall efficiency. Good housekeeping is also a good advertisement for your company. Customers and clients have more confidence in an organization when they we work being carried out efficiently in clean, pleasant, well ordered surroundings. There's an even more important reason why good housekeeping matters — it makes the undertaking a safer place to work in

4.1.1. Keep Floors Clean

Every year thousands of work injuries are caused by people falling. Floor conditions are responsible for many of these accidents. When floors are given the right treatment they are much easier to keep clean and hygienic.

Spilt oil and other liquids should be cleaned up at once. Chips, shavings, dust, and similar wastes should never be allowed to accumulate. They should be removed frequently, or better still, be suitably trapped before they reach the floor

4.2. Disposing, reusing or recycling material

Definition

Disposing Removing and destroying or storing damaged, used or other unwanted domestic, agricultural or industrial products and substances

Recycling means turning an item into raw materials which can be used again, usually for a completely new product. This is an energy consuming procedure

Reusing refers to using an object as it is without treatment. This reduces pollution and waste, thus making it a more sustainable process.

Purpose

When looking into environmental sustainability, cutting consumption or reducing rubbish during a house clearance, it's more than likely that you'll come across the following 3Rs: reduce, reuse and recycle. Learn how Disposing, reusing(R), and recycling(R) can help you, your community, and the environment by saving money, energy, and natural resources.

Recycling is the process of collecting and processing materials that would otherwise be thrown away as trash and turning them into new products. Recycling can benefit your community and the environment.

Recycling reduces waste disposal by transforming useful materials such as plastic, glass and paper into new products

The reusing process is not just about re-purposing materials, but the object as it is. This includes buying and selling used goods and repairing items rather than discarding them. Reusing is better than recycling because it saves the energy that comes with having to dismantle and re-manufacture products. It also significantly reduces waste and pollution because it reduces the need for raw materials, saving both forests and water supplies.

Waste that cannot be reused or recycled in some form eventually finds its way to disposal. This disposal includes landfills, but an increasing number of municipalities have elected to divert waste into resource recovery. These recovery methods use the waste to generate electricity or produce raw materials for industry

4.3. Cleaning, checking, maintaining and storing plant, tools and equipment

4.3.1. Cleaning of Tools and Equipment

Tools and equipment used at the construction site undergo rigorous handling. From initial foundation development, to the final construction of the exterior trim, these tools are exposed to large amounts of dirt and abuse. Proper maintenance of construction tools and equipment is critical to preserving them for future construction jobs. Failure to maintain the tools properly results in unnecessary expense.

Clean the construction tools and equipment after each day's work. While a thorough cleaning is not required each day, a general wipe-down and removal of the heaviest construction dirt is key to extending the life of the tools.

4.3.2. Checking Hand tools

- Mechanical failure or loss of control when using a tool with defective parts.

Examples of unsafe tools are hammers with loose or damaged heads, screwdrivers with broken handles or blunt edges, chisels with mushroomed heads, and blunt saws.

4.3.3. Checking Power tools

- Malfunctioning of safety devices such as emergency button (red button), protective covers, guards, etc. In case of emergency these devices will not work properly or will provide limited protection to the worker, which in some cases can be worse than no protection at all because it gives a false sense of security.
- Risks of electrocution, shock or burns due to electrical malfunctions, torn cables and lack of proper insulation or proper earthing.
- Cracked or broken grinding wheels or cracked blades can cause injuries. E.g. cracked abrasive wheels could fly apart in operation, which could lead to serious injury or death.
- Emissions of chemical substances such as toxic fumes or dust, etc.
- Noise and vibration emitted by almost all portable tools that can lead to hearing loss and hand–arm vibration syndrome respectively. Vibration can cause "white-finger" disease, which arises from damage to the muscles and nerves that control the blood flow. Poorly maintained tools can cause a significant increase in noise and vibration emissions (e.g. a cutting tool that is not sharp emits higher levels of vibration). Also, damaged anti-vibration mountings in a tool can increase transmission of vibration to the worker.

4.3.4. Maintaining and storing of tools and equipment

Lubricate air tools and pneumatic equipment before each day's use. Condensation in the airline creates an environment for corrosion inside pneumatic tools. Coating the internal components of these tools with air-tool oil will displace the moisture and prevent tool corrosion.

Inspect and repair all construction equipment and tools at the completion of each job. Make all repairs to the equipment that are necessary for future construction work. This will prevent time being wasted repairing faulty equipment at future construction job sites.

Self-Check 4	**Multiple choice**

Instruction: Select the best answer and encircle the letter

1. What is the advantage of reusing and recycling construction products

   A/ Avoids waste

B/Reduces waste

C/Saves primary resources

D/ All of the above are correct

2. -------is contribute to more sustainable development by eliminating or reducing waste

A/ Recycling

B/ Technology

C/ Learning

D/ All of the above

3. What is the dis advantage if someone left Keeping Floors Clean?

A/ It will be attractive

B/ It will be good for working

C/ It will be caused of people falling

D/ All of the above

4. Which one is true about clear area?

A/ It will be benefit by providing safe working area

B/ Expense will be saved

C/The working area and learning classes will be a better place in which to work

D/ All of the above

5. What is the advantage of maintaining construction tools and equipment?

A/ Increase the service life of the equipment

B/ The performance of the equipment

C/Decrease the price of the equipment

D/ A & B are correct

6. Why we maintain construction tools and equipment?

.A/ Because it make tools and equipment good performance

B/ Because tools and equipment suffer a lot of wear and tear

C/ Because working with broken tools and equipment lead to injure

D/ All of the above

Note:

- Satisfactory rating – above 3 points

- Unsatisfactory - below 3 points

Test II: short Answer writing

Instruction: write short answer for the given question. You are provided 3 minute for each question and each point has 5Points.

1. why we dispose waste materials?
1. Mention at least two points about the advantage of cleaning of tools and equipment
2. Write the benefits of recycling of waste materials

Reference

1. /stnemucoD yrarbiL/stnemucod/dorp_simi/ua.moc.aacc.www//:sptth C

.2 gnitniap/ledomer/moc.cigolesuoh.www//:sptth - etercnoc/gnithgil - /gnitniap

BYCA=frsxs?hcraes/moc.elgoog.www//:sptth

651:wWy5ryiH4E5UH8REWVLV5oO0iUHQNG

+gniylppA+si+tahw=q&1793390499

Participants of this Module (training material) preparation

No	Name	Qualification (Level)	Field of Study	Organization/ Institution	Mobile number	E-mail
1	Tesfaye Assegidew	Msc	Construction Mgt	Butajira PTC	+251913442444	tesfayeassegidew@gmail.com
2	Melsew Keba	Msc	Construction Mgt	Assosa PTC	+251913283335	melsewkeba@gmail.com
3	Dawit showafera	Msc	Construction Mgt	DDPTC	+251986314667	dawitshowafera835@gmail.com
4	Muluken Solomon	Msc	Construction Mgt	Batu PTC	+2519-12289146	mulecot99@gimal.com
5	Tiruneh Asebe	Msc	Construction Mgt	Hossana PTC	+251911422557	tirunehasebe@gimial.com


የሥራ እና ክህሎት ሚኒስቴር
MINISTRY OF LABOR
AND SKILLS