Carpentry Level I I

Learning Guide-74

Unit of Competence: Repair and Rectify Concrete structures

Module Title: Repairing and Rectifying Concrete structures

LG Code: EIS CRP2 M16 LO3-LG-74

TTLM Code: EIS CRP2 M16 TTLM 0919v1

LO 3: Carry out rectification of cracks and other Major defect

Instruction Sheet	Learning Guide #74

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Determining and resolving source cause of the defect
- Preparing concrete & applying flexible epoxy resins
- Applying coverings to concrete using correct materials
- Applying cleaning safely

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, you will be able to:

- Determine and resolve Source cause of the defect
- prepare Concrete and applied flexible epoxy pitches to manufacturers' specification
- apply Cover to concrete using correct materials and techniques
- apply clean safely in accordance with manufacturers' requirements

Learning Instructions:

Read the specific objectives of this Learning Guide.

1. Follow the instructions described below 3 to 5
2. Read the information written in the information
3. Accomplish the "Self-check 1, Self-check, 2, Self-check 3" ,Self-check ,4in page 7, 12, 17, and, 23 respectively.
4. If you earned a satisfactory evaluation from the "Self-check check proceed to operation sheet 25
5. Do the "LAP test" 26

Information Sheet-1	Determining and resolving source cause of the defect

3.1. 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:

1. 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.

Fig1.1 cracking

2. 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.

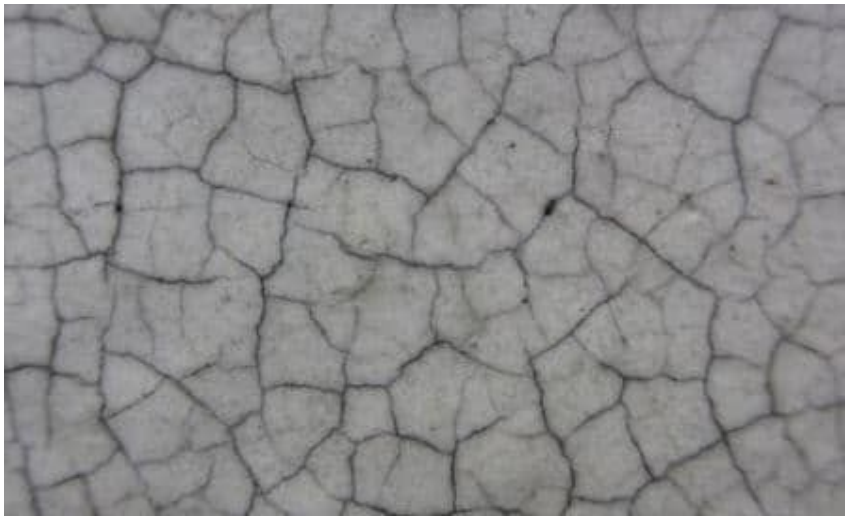

Fig1.2 Crazing or pattern cracking

3. 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.

Fig1.3 concrete blistering

4. 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

Fig1.4 Delamination

5. 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.

Fig1.5 Dusting

6. 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.

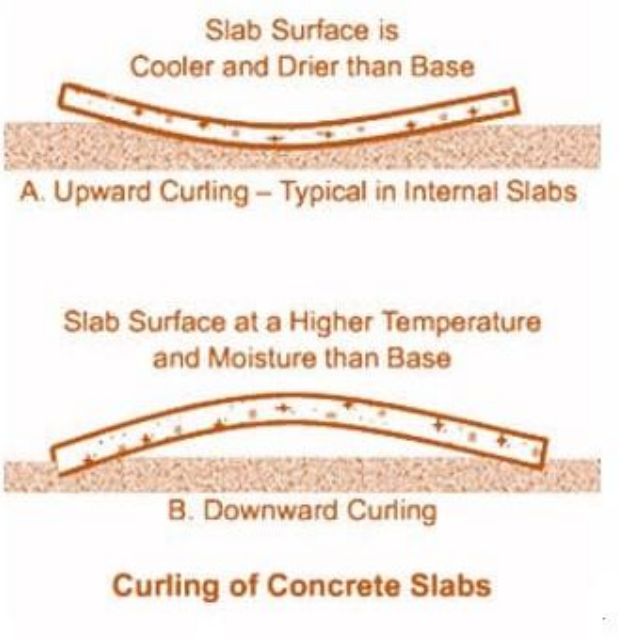

Fig1 6: Curling of Concrete Slab

7. 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.

Fig1.7 Efflorescence

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.

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Write the Types of Concrete Defects – Causes, Prevention [4pts]
2. What is cracking (4pts?)

Note: **Satisfactory above – 4 out of 8 points Unsatisfactory - below 4 out of 8 point**

Answer Sheet

Score = _____
Rating: _____

Name: _____ Date: _____

Short Answer Questions

1._____

_____-----

2._____

_____

Information Sheet-2	Preparing concrete & applying flexible epoxy resins

2.1. 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.

Fig2.1High-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.

2.2. Preparing concrete

What is concrete?

In its simplest form, concrete is a mixture of paste and aggregates. The paste, composed of Portland cement and water, coats the surface of the fine and coarse aggregates. Through a chemical reaction called hydration, the paste hardens and gains strength to form the rock-like mass known as concrete. Within this process lies the key to a remarkable trait of concrete: it‘s plastic and malleable when newly mixed, strong and durable when hardened. These qualities

Explain why one material, concrete, can build skyscrapers, bridges, sidewalks and superhighways, houses and dams. The key to achieving a strong, durable concrete rests in the careful proportioning and mixing of the ingredients. A concrete mixture that does not have enough paste to fill all the voids between the aggregates will be difficult to place and will produce rough, honeycombed surfaces and porous concrete. A mixture with an excess of cement paste will be easy to place and will produce a smooth surface; however, the resulting concrete is likely to shrink more and be uneconomical.

Types of concrete

Plain and Reinforced concrete

Plain concrete is very strong in compression but at the same time, it is very weak in tension. Hence, plain concrete cannot be used at place where tensile force may develop. Steel is equally strong in compression and tension. But long steel bar can develop its fully tensile strength where as it cannot carry equal amount of compressive force due to its buckling which is caused by the slenderness. **A combination of concrete and steel** is ideally suited because the two materials are employed to resist

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Write the Types of concrete (3pts)
2. What is Epoxy resins (4pts)

Note: **Satisfactory above – 3.5 out of 7 points Unsatisfactory - below 3.out of 7point**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1._____

_____

2_____

_____

Information Sheet-3	Applying coverings to concrete using correct materials

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.

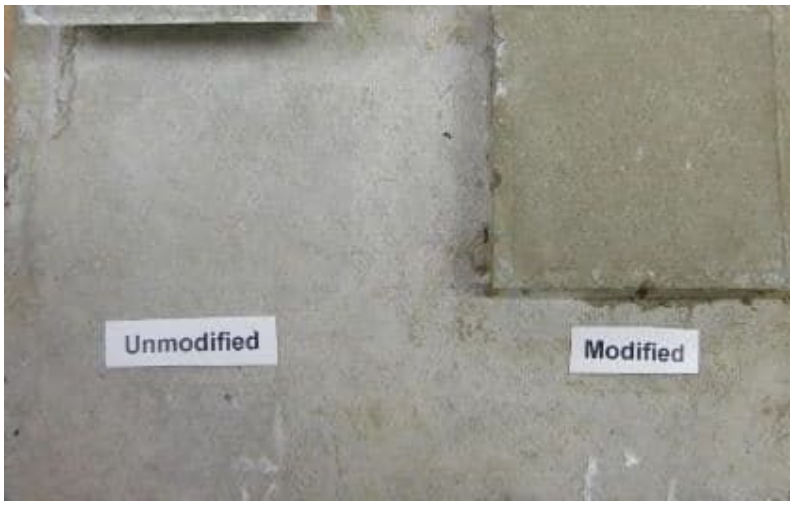

Fig.3.1: Unmodified Portland cement Mortar

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.

Fig3.2: 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.

Fig3.3: Quick-set Non-shrinking Mortar

Self-Check -3	**Written Test**

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Write the Common types of Repair Materials? (5pts)
2. Write the Selection Criteria for Repair Material? (2points)

Note: **Satisfactory above – 3.5 out of 7 points** **Unsatisfactory - below 3.out of 7point**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

1._____

_____

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2_____

Information Sheet-4	Applying cleaning safely

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 the surfaces.

avoid damaging the surfaces.

Fig 4.1Avoid 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

Fig4.2clean concrete floors

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is cleaning**? (**5 points)

2. Write basic step clean concrete floors? (3point**)**

Note: **Satisfactory above_4 out of 8 points** **Unsatisfactory - below 4out of 8 point**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

1._____

_____

_____

2._____

_____

Operation Sheet 1	**Applying coverings to concrete using correct materials rete**

- Applying coverings to concrete using correct materials rete Procedure:

Step1.apply safety requirement

Step 2- .determine Unmodified Portland cement Mortar or Grout

Step 3 Latex Modified Portland cement Mortar or Concrete

Step 4 – Quick Setting Non-shrink Mortar

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 3hour.

Task1 Applying coverings to concrete using correct materials rete

List of Reference Materials

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1. https://theconstructor.org/concrete/building-cracks-causes-remedies/5392/
2. https://www.sciencedirect.com/topics/engineering/epoxy-mortar
3. https://www.sciencedirect.com/topics/engineering/epoxy-resin-system
4. ttps://www.usbr.gov/tsc/techreferences/mands/mands-pdfs/Guide2ConcreteRepair2015_Final.pdf
5. https://masonandassociates.us/2018/11/defects-in-concrete-structures-in-idaho-types-causes-and-prevention

https://theconstructor.org/concrete/concrete-defects-types-causes-prevention/8581/

Annex I

Answer keys for learning guide -74

Answer key

Self-check

Information Sheet-1

1. Cracking, crazing, blistering, delamination

2 Cracks are formed in concrete due to many reasons but when these cracks are very deep

Information Sheet-2

1, plain and reinforcement concrete

2. Epoxy resins cure to form solids with high strength and relatively high modulus of elasticity.

Information Sheet-3

1. Unmodified Portland cement Mortar or Grout, Latex Modified Portland cement Mortar or Concrete, Quick Setting Non-shrink Mortar
2. Ease of application

   Cost

   Available labor skills and equipment

   Shelf life of the material

Information Sheet-4

1 Cleaning an old concrete slab so it will take an acid stain can be very difficult, but it is possible

2. Dry mop daily to remove dirt and debris

   Damp mop with a pH-neutral cleaner as needed

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

The trainers prepare TTLM

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