PHOTOS OF TYPICAL CONCRETE CRACKS
Crazing is a pattern of fine cracks that do not penetrate much below the surface and are usually a cosmetic problem only. They are barely visible, except when the concrete is drying after the surface has been wet.

Plastic Shrinkage Cracking: When water evaporates from the surface of freshly placed concrete faster than it is replaced by bleed water, the surface concrete shrinks. Due to the restraint provided by the concrete below the drying surface layer, tensile stresses develop in the weak, stiffening plastic concrete, resulting in shallow cracks of varying depth. These cracks are often fairly wide at the surface.

Drying Shrinkage: Because almost all concrete is mixed with more water than is needed to hydrate the cement, much of the remaining water evaporates, causing the concrete to shrink. Restraint to shrinkage, provided by the subgrade, reinforcement, or another part of the structure, causes tensile stresses to develop in the hardened concrete. Restraint to drying shrinkage is the most common cause of concrete cracking. In many applications, drying shrinkage cracking is inevitable. Therefore, contraction (control) joints are placed in concrete to predetermine the location of drying shrinkage cracks.

D-cracking is a form of freeze-thaw deterioration that has been observed in some pavements after three or more years of service. Due to the natural accumulation of water in the base and subbase of pavements, the aggregate may eventually become saturated. Then with freezing and thawing cycles, cracking of the concrete starts in the saturated aggregate at the bottom of the slab and progresses upward until it reaches the wearing surface. D-cracking usually starts near pavement joints.
Alkali-aggregate reaction: Alkali-aggregate reactivity is a type of concrete deterioration that occurs when the active mineral constituents of some aggregates react with the alkali hydroxides in the concrete. Alkali-aggregate reactivity occurs in two forms—alkali-silica reaction (ASR) and alkali-carbonate reaction (ACR).

Indications of the presence of alkali-aggregate reactivity may be a network of cracks, closed or spalling joints, or displacement of different portions of a structure.

Thermal cracks: Temperature rise (especially significant in mass concrete) results from the heat of hydration of cementitious materials. As the interior concrete increases in temperature and expands, the surface concrete may be cooling and contracting. This causes tensile stresses that may result in thermal cracks at the surface if the temperature differential between the surface and center is too great. The width and depth of cracks depends upon the temperature differential, physical properties of the concrete, and the reinforcing steel.

Loss of support beneath concrete structures, usually caused by settling or washout of soils and subbase materials, can cause a variety of problems in concrete structures, from cracking and performance problems to structural failure. Loss of support can also occur during construction due to inadequate formwork support or premature removal of forms.

Corrosion: Corrosion of reinforcing steel and other embedded metals is one of the leading causes of deterioration of concrete. When steel corrodes, the resulting rust occupies a greater volume than steel. The expansion creates tensile stresses in the concrete, which can eventually cause cracking and spalling.
SUGGESTED LOCAL REPAIR MATERIALS
FOR DIFFERENT PROBLEMS
(OR EQUIVALENT)
<table>
<thead>
<tr>
<th>Problem</th>
<th>Solution</th>
<th>Fosroc</th>
<th>Sika</th>
<th>BASF</th>
<th>Conmix</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protecting new or existing reinforced concrete structures against carbonation or chloride-induced corrosion</td>
<td>Applying of a penetrating reactive, hydrophobic primer and protective top coat system</td>
<td>Dekguard S</td>
<td>Sikagard 680 S</td>
<td>Masterseal 300H</td>
<td>ReForm W</td>
</tr>
</tbody>
</table>
| Carbonation in reinforced concrete-reinforcing steel within the carbonated zone | - Replacement of carbonated concrete by low permeability repair mortars  
- Application of a penetrating reactive hydrophobic primer and protective top coat system | RenderocT-Gxtra then Dekguard S | SikaRep or SikaTop 122F then Sikagard 680 S | Emaco S22 NB (Emaco S88CT) then Masterseal 300H | ReCon GP then ReForm W |
| Chloride-induced corrosion in reinforced concrete                      | - Removal of chloride contaminated concrete from the vicinity of the reinforcing steel  
- Replacement with low permeability repair mortars  
- Application of a penetrating reactive hydrophobic primer and protective top coat system | Nitobond EP then RenderocT-Gxtra then Dekguard S | SikaTopArmatec 110 EpoCem then SikaRep or SikaTop 122F then Sikagard 680 S | Concrese 1015 then Emaco S22 NB (Emaco S88CT) then Masterseal 300H | FitBond PVA then ReCon GP then ReForm W |
| Large areas of deeply honeycombed concrete or concrete damaged by physical forces such as impact or erosion | Concrete replacement using high strength free flowing cementitious micro concrete | RenderocLAxtra  | Sikacrete 114     | Emaco S23 NB (Emaco S66T) | ReCon MC          |
| Non-active cracks within concrete elements caused by shrinkage or other structural movement | Use of a low viscosity epoxy injection resin to fill and seal non-active cracks and restore structural integrity | Nitofill EPLV   | Sikadur 52 LP (Seal the surface with Sikadur 31) | Concrese 1315 (seal the surface with Concrese 2200) | ReCon LVE          |
| Cracks within concrete elements where a degree of future movement is anticipated | Use of a low viscosity polyurethane injection resin to fill and seal cracks | Nitofill UR63   | Sika injectoCem-190 | Wabocrete II     | ReCon PU R        |
| Large areas of deeply honeycombed concrete or concrete damaged at the soffit of slabs or at walls | Shotcrete the surface of the concrete | RendrocSPxtra   | SikaTop-gunite 103 | Shotpatch 10     | ReCon SM          |
| Reinforcing steel primer                                              | Epoxy based zinc rich primer                                              | Nitoprime Zinc rich | SikaTopArmatec 110 EpoCem | Concrese ZR     | ReCon Zinc        |

*Note: The applicator and consultant should refer to the material manufacturers to get use of their experience in solving problems.*
<table>
<thead>
<tr>
<th>Problem / Solution</th>
<th>Minimum Properties</th>
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<tbody>
<tr>
<td>Protecting new or existing reinforced concrete structures against carbonation or</td>
<td>Water vapour transmission = 26 gm/m²/24 hours</td>
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<tr>
<td>chloride-induced corrosion –</td>
<td></td>
</tr>
<tr>
<td>Applying of a penetrating reactive, hydrophobic primer and protective top coat</td>
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<tr>
<td>system</td>
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<tr>
<td>Carbonation in reinforced concrete -reinforcing steel within the carbonated zone –</td>
<td>Repair mortar:</td>
</tr>
<tr>
<td>- Replacement of carbonated concrete by low permeability repair mortars</td>
<td>Compressive strength = 55 N/mm² at 28 days</td>
</tr>
<tr>
<td>- Application of a penetrating, reactive, hydrophobic primer and protective</td>
<td>Tensile strength = 3.6 N/mm² at 28 days</td>
</tr>
<tr>
<td>top coat system</td>
<td>Flexural strength = 7 N/mm² at 28 days</td>
</tr>
<tr>
<td></td>
<td>Rapid Chloride permeability &lt; 650 coulombs</td>
</tr>
<tr>
<td></td>
<td>Water permeability &lt; 10 mm</td>
</tr>
<tr>
<td></td>
<td>Dry shrinkage &lt; 500 microstrain at 28 days</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Chloride-induced corrosion in reinforced concrete</td>
<td>Protective top coat:</td>
</tr>
<tr>
<td>- Removal of chloride contaminated concrete from the vicinity of the reinforcing</td>
<td>Water vapor transmission = 26 gms/m²/24 hours</td>
</tr>
<tr>
<td>steel - Replacement with low permeability repair mortars</td>
<td></td>
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<tr>
<td>- Application of a penetrating, reactive, hydrophobic primer and protective top</td>
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<tr>
<td>coat system</td>
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<td>Large areas of deeply honeycombed concrete or concrete damaged by physical forces</td>
<td>Compressive strength = 60 N/mm² at 28 days</td>
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<tr>
<td>such as impact or erosion –</td>
<td>Tensile strength = 2.8 N/mm² at 28 days</td>
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<tr>
<td>Concrete replacement using high strength, free flowing, cementitious micro concrete.</td>
<td>Flexural strength = 9 N/mm² at 28 days</td>
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<tr>
<td></td>
<td>Rapid Chloride permeability &lt; 650 coulombs</td>
</tr>
<tr>
<td></td>
<td>Water permeability &lt; 10 mm</td>
</tr>
<tr>
<td></td>
<td>Dry shrinkage &lt; 500 microstrain at 28 days</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-active cracks within concrete elements caused by shrinkage or other structural</td>
<td>Compressive strength (BS 6319-2) = 70 N/mm² at 7 days</td>
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<tr>
<td>movement - Use of a low Viscosity epoxy injection resin to fill and seal non-active</td>
<td>Flexural strength (BS 6319-3) = 23 N/mm² at 7 days</td>
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<tr>
<td>cracks and restore structural integrity.</td>
<td>Tensile strength (BS 6319-7) = 22 N/mm² at 7 days</td>
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<tr>
<td>Cracks within concrete elements where a degree of future movement is anticipated</td>
<td>Compressive strength (BS 6319) = 20 N/mm² at 28 days</td>
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<tr>
<td>Use of a low viscosity polyurethane injection resin to fill and seal cracks</td>
<td>Tensile strength (BS 2782) = 5 N/mm²</td>
</tr>
<tr>
<td></td>
<td>Flexural Strength (BS 6319) = 9 N/mm²</td>
</tr>
<tr>
<td></td>
<td>Elastic modulus (BS1881) = 750 N/mm²</td>
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<td></td>
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<tr>
<td>Large areas of deeply honeycombed concrete or concrete damaged at the soffit of</td>
<td>Meet the scope of BS 6319 part 3 &amp; 7 or ASTM C157</td>
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<tr>
<td>slabs or at walls - Shotcrete the surface of the concrete</td>
<td>Maximum aggregate size = 5 mm</td>
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<tr>
<td></td>
<td>Cube Compressive strength = 40 N/mm² at 28 days</td>
</tr>
<tr>
<td></td>
<td>Flexural strength = 7 N/mm² at 28 days</td>
</tr>
<tr>
<td>Reinforcing steel primer</td>
<td></td>
</tr>
<tr>
<td>Epoxy based zinc rich primer</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Meet the scope of BS 4652, 1971 Type 2.</td>
</tr>
<tr>
<td></td>
<td>Minimum Specific gravity of 1.8 at 25°C.</td>
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<td>No.</td>
<td>Remarks and Observations</td>
</tr>
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<td>-----</td>
<td>--------------------------</td>
</tr>
<tr>
<td>1</td>
<td>Description of Anchor Bolt</td>
</tr>
<tr>
<td>2</td>
<td>Condition of Bolt</td>
</tr>
<tr>
<td>3</td>
<td>Surface Present Condition</td>
</tr>
<tr>
<td>4</td>
<td>Corroded</td>
</tr>
<tr>
<td>5</td>
<td>Spalling</td>
</tr>
<tr>
<td>6</td>
<td>Spalling of Reinforcement</td>
</tr>
<tr>
<td>7</td>
<td>Spalling of Concrete</td>
</tr>
<tr>
<td>8</td>
<td>Spalling of Concrete (Cm)</td>
</tr>
<tr>
<td>9</td>
<td>Spalling of Concrete (M2)</td>
</tr>
<tr>
<td>10</td>
<td>Size of Crack (Cm)</td>
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### FINDINGS

<table>
<thead>
<tr>
<th>Component</th>
<th>Condition</th>
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<tbody>
<tr>
<td>Concrete</td>
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</tr>
<tr>
<td>Rebars</td>
<td>Corroded</td>
</tr>
<tr>
<td>Spalling</td>
<td>Spalling</td>
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</tbody>
</table>

### STRUCTURES DESCRIPTION

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Type of Structure</td>
</tr>
<tr>
<td>2</td>
<td>Dimensions (mm)</td>
</tr>
<tr>
<td>3</td>
<td>Identification</td>
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</table>

### PROJECT No.:  
CONTRACT No.:  
SHEET No.:  
PREPARED BY:  
DATE:  
UNIT No.:  
REF DRG:  
PLANT:  
AREA:  
VISUAL INSPECTION:  
APPENDIX C - VISUAL INSPECTION SHEET
SITE VISITS
Case 1: Tower under construction
Shrinkage and/or restraint cracks rather than structural cracks. This is indication that the slabs are restrained against shrinkage causing tension stresses which lead to these type of cracks.

The Restraint shrinkage cracks which are due to the restrained of the core walls and huge walls to the slabs causing cracks perpendicular to the core wall direction.

Without restraint, the concrete in the wall freely contracts to the shape indicated in figure (1b), but because the wall must remain compatible with its base, the actual finished shape is as indicated in figures (1c) or (1d), depending on whether the base is rigid or flexible. The forces needed to stretch the freely contracted shape into the actual shape indicate the directions of the main stresses set up in the concrete.
Case 2: Existing five years old building
Corrosion of the vertical bars in the ground floor columns specially if the ground floor is used as parking garage and exposed to the environment. The corrosion caused increase in volume of the reinforcing bar initiate the vertical cracks in the columns.
Case 3: New construction – design defect
In a tower under construction, the existing transfer slab was under designed to carry the expected loads which caused cracks before loading the full live load of the building. The cracks were monitored to identify the cracks as live or dead cracks then the slab was strengthened after injecting the cracks.

Case 4: Existing twenty years old building
Twenty years old in Diera was inspected to increase the life span of the building as per the owner requirement. During inspection, the concrete compressive strength was not low but does not satisfied the design values at the time of construction. Some corrosion was noticed in the ground floor columns and the first floor slab.
Case 5: Existing forty years old building
A forty years old building in Bur Dubai was inspected to increase the life span of the building as per the owner requirement. During inspection, the concrete compressive strength was very low which requires strengthening of the columns. Some corrosion was noticed in the ground floor columns and the wet areas of the different slabs.

Case 6: Existing fifty years old building
A fifty years old building in Al Ras Dubai was inspected as a heritage building to maintain the building and increase the life span of it as per the owner requirement. During inspection, the concrete compressive strength was good. Severe corrosion was noticed in the first floor slabs as well as the wet areas of the different slabs.
STRENGTHENING METHOD STATMENTS
1- INTRODUCTION
Many strengthening techniques are available depending on the purpose needed from strengthening.

2- STRENGTHENING OF R.C. SLABS
In some cases, and due to increasing the applied loads on slabs or their unsafe design, or corrosion of the reinforcing steel bars, or cracks in the slabs, one of the following solutions should be made:

1. If the slab is unable to carry the negative moment and the lower steel is sufficient, upper steel mesh should be added with a new concrete layer.
2. If the slab is unable to carry the positive moment or when the dead load (that will be added to the slab) is much less than the live load carried by the slab, a new concrete layer on the bottom of the slab should be added.

In order to implement the previous solutions, the following steps should be made as shown in Fig. 1 and Fig. 2:

1. Removing the concrete cover.
2. Cleaning the reinforcing steel bars using a wire brush or a sand compressor.
3. Coating the steel bars with an epoxy material that would prevent corrosion.
4. If a high percent of corrosion was found in the steel bars, a new steel mesh, designed according to the codes’ requirements, must be added.
5. The new reinforcing steel mesh is then installed and fastened vertically to the slab of the roof and horizontally to the surrounding beams, using steel dowels.
6. Coating the concrete surface with an appropriate epoxy material that would guarantee the bond between the old and new concrete.
7. Before the epoxy dries, the concrete is poured with the required thickness. Additional materials that would lower the shrinkage should be added to the concrete.
Figure 1: Strengthening a slab by increasing its depth from bottom
3- STRENGTHENING OF R.C. BEAMS

Reinforced concrete beams need strengthening when the existing steel bars in the beam are unsafe or insufficient, or when the loads applied to the beam are increased. In such cases, there are different solutions that could be followed: (In all cases sufficient probing for the element and surrounding elements should be protected).

Figure 2: Strengthening a slab by increasing its depth from top
I- ADDING REINFORCEMENT STEEL BARS TO THE MAIN STEEL WITHOUT INCREASING THE BEAM’S CROSS SECTIONAL AREA

This solution is carried out when the reinforcing steel bars are not capable to carry the stresses applied to the beam. The following steps should be followed:

1. The concrete cover is removed for both the upper and lower steel bars.
2. The steel bars are well cleaned and coated with an appropriate material that would prevent corrosion.
3. Holes are made, in the whole span of the beam under the slab, as shown in Fig. 3, 1525-cm apart, a diameter of 1.3cm and extend to the total width of the beam.

![Figure 3: Holes in the span of the beam](image)

4. The holes are filled with an epoxy material with low viscosity and installing steel connectors for fastening the new stirrups.
5. Steel connectors are installed into the columns in order to fasten the steel bars added to the beam.
6. The added stirrups are closed using steel wires and the new steel is installed into these stirrups.
7. The surface is then coated with a bonding epoxy material.
8. The concrete cover is poured over the new steel and the new stirrups.

The previous steps are illustrated in Fig. 4.

![Figure 4: Strengthening a beam without increasing the cross sectional area](image)
II- INCREASING BOTH THE REINFORCING STEEL BARS AND THE CROSSSECTIONAL AREA OF CONCRETE

This solution is chosen when both the steel and concrete are not able to carry the additional loads applied to the beam. In such cases the following steps should be followed as in Fig. 5.

1. Removing the concrete cover, roughing the beams surface, cleaning the reinforcement steel bars and coating them with an appropriate material that would prevent corrosion.
2. Making holes in the whole span and width of the beam under the slab at 1525-cm.
3. Filling the holes with cement mortar with low viscosity and installing steel connectors for fastening the new stirrups.
4. Installing the steel connectors into the columns in order to fasten the steel bars added to the beam.
5. Closing the added stirrups using steel wires and the new steel is installed into these stirrups.
6. Coating the concrete surface with an appropriate epoxy material that would guarantee the bond between the old and new concrete, exactly before pouring the concrete.
7. Pouring the concrete jacket using low shrinkage concrete.

Figure 5: Strengthening a beam by increasing the cross sectional area and the bars
III- ADDING STEEL PLATES TO THE BEAM

When it is required to strengthen the beam’s resistance against the applied moment or shear stress, steel plates are designed with the appropriate size and thickness.

Then those plates are attached to the beam as follows:

1. Roughing and cleaning the concrete surfaces where the plates will be attached.
2. Coating the concrete surfaces with a bonding epoxy material.
4. Putting a layer of epoxy mortar on top of the plates with a 5mm thickness.
5. Attaching the steel plates to the concrete using bolts.
6. In case the beam is over stressed in shear, the plates will be fixed to the vertical surface of the beam.

The previous steps are illustrated in Fig. 6.

Figure 6: Strengthening a beam by adding steel plates

In some cases, it is needed to reduce the load on the beam either partially or completely.
This is made by putting steel beams on top or below the concrete beams, as shown in Fig. 7.

Figure 7: Reducing the load on the beam using steel beams
The following photos (14-) were taken during strengthening an existing building; they present the practical method of implementing some strengthening techniques.

**Photo 1: Strengthening a beam, slab and column**

**Photo 2: Strengthening a beam and slab**

**Photo 3:** Strengthening a beam by increasing bars and cross section

**Photo 4:** Strengthening by steel plates

### 4 - STRENGTHENING OF R.C.COLUMNS

Strengthening of reinforced concrete columns is needed when:

1. The load carried by the column is increased due to either increasing the number of floors or due to mistakes in the design.
2. The compressive strength of the concrete or the percent and type of reinforcement are not according to the codes’ requirements.
3. The inclination of the column is more than the allowable.
4. The settlement in the foundation is more than the allowable.

There are two major techniques for strengthening reinforced concrete columns:

#### 4.1 Reinforced Concrete Jacket

The size of the jacket and the number and diameter of the steel bars used in the jacketing process depend on the structural analysis that was made to the column. In some cases, before this technique is carried out, we need to reduce or even eliminate temporarily the loads applied to the column; this is done by the following steps:

- Putting mechanical jacks between floors.
- Putting additional props between floors.
Moreover, in some cases, where corrosion in the reinforcement steel bars was found, the following steps should be carried out:

• Remove the concrete cover.
• Clean the steel bars using a wire brush or sand compressor.
• Coat the steel bars with an epoxy material that would prevent corrosion.

*If there was no need for the previous steps, the jacketing process could start by the following steps:*

1. Adding steel connectors into the existing column in order to fasten the new stirrups of the jacket in both the vertical and horizontal directions at spaces not more than 50cm. Those connectors are added into the column by making holes 34-mm larger than the diameter of the used steel connectors and 1015-cm depth.
2. Filling the holes with an appropriate epoxy material then inserting the connectors into the holes.
3. Adding vertical steel connectors to fasten the vertical steel bars of the jacket following the same procedure in step 1 and 2.
4. Installing the new vertical steel bars and stirrups of the jacket according to the designed dimensions and diameters.
5. Coating the existing column with an appropriate epoxy material that would guarantee the bond between the old and new concrete.
6. Pouring the concrete of the jacket before the epoxy material dries. The concrete used should be of low shrinkage and consists of small aggregates, sand, cement and additional materials to prevent shrinkage. The previous steps are illustrated in Fig 8.

*Figure 8: Increase the cross sectional area of a column by RC Jacketing*
4.2 Steel Jacket
This technique is chosen when the loads applied to the column will be increased, and at the same time, increasing the cross sectional area of the column is not permitted.

This technique is implemented by the following steps as shown in Fig 9:
1. Removing the concrete cover.
2. Cleaning the reinforcement steel bars using a wire brush or a sand compressor.
3. Coating the steel bars with an epoxy material that would prevent corrosion.
4. Installing the steel jacket with the required size and thickness, according to the design, and making openings to pour through them the epoxy material that would guarantee the needed bond between the concrete column and the steel jacket.
5. Filling the space between the concrete column and the steel jacket with an appropriate epoxy material.

In some cases, where the column is needed to carry bending moment and transfer it successfully through the floors, one should install a steel collar at the neck of the column by means of bolts or a suitable bonding material. Photo 5 shows a column which was strengthened with steel angles.
5 - STRENGTHENING OF R.C.WALLS

The dimensions of the wall and its reinforcement are increased by the following steps:

1. Roughing the total area of the concrete surface.
2. Installing steel connectors for the whole surface at 2530-cm spaces in both directions. The diameter of the steel connectors is determined according to the design and their depth should be 57- times their diameter.
3. Installing steel connectors into the wall footings, with the same number and diameter of the main vertical steel bars, using an epoxy material.
4. Installing the steel mesh and fasten it by steel wires to the steel connectors.
5. Coating the surface of the wall with an appropriate epoxy material.
6. Pouring the concrete jacket using low shrinkage concrete before drying of the epoxy material.

The previous steps are illustrated in Fig 10.
6- STRENGTHENING OF FOUNDATIONS

Columns foundations need strengthening in the case of applying additional loads. Widening and strengthening of existing foundations may be carried out by constructing a concrete jacket to the existing footings. The new jacket should be properly anchored to the existing footing and column neck in order to guarantee proper transfer of loads. The size of the «jacket» shall be selected such that the average maximum foundation pressure does not exceed the recommended allowable value. Attention shall be given during construction in order that the excavations for the new «jackets» do not affect the existing adjacent foundations.

An isolated footing is strengthened by increasing the size of the footing and the reinforcement steel bars as follows:

1. Excavating around the footing
2. Cleaning and roughening the concrete surface.
3. Installing dowels at 2530-cm spacing in both directions using an appropriate epoxy material.
4. Fastening the new steel bars with the dowels using steel wires. The diameter and number of steel bars should be according to the design.
5. Coating the footing surface with a bonding agent in order to achieve the required bond between old and new concrete.
6. Pouring the new concrete before the bonding agent dries. The new concrete should contain a non-shrinkage material.

The previous steps are illustrated in Fig 11.

![Figure 11: Strengthening of an isolated footing](image)
The following photos (69-) illustrate the practical way of jacketing a footing by reinforced concrete.

*Photo 6: Excavating around the footing*

*Photo 7: Roughing the surface and installing the dowels*

*Photo 8: Installing the main steel*

*Photo 9: Completing the jacket*
PREVENTIVE MAINTENANCE
Objectives of the PM are as follows:
1. To protect the buildings and structures (facilities) from deterioration
2. To ensure that buildings and structures adequately support their assigned missions.
3. To perform necessary minor maintenance and repair promptly.
4. To schedule and perform necessary maintenance and repair in a timely and expeditious manner to minimize downtime.

The goal of any PM program is to reduce the number of service orders to a point where buildings and structures are being maintained by scheduled work as much as possible.

PM is most effective when the work is accomplished on a cyclic basis. The length of the cycle must be determined; PM areas must be properly sized, similar facilities grouped accordingly, and adequate manpower levels calculated. The recommended inspection/service frequencies by building mission are as follows:

<table>
<thead>
<tr>
<th>Type of Facility</th>
<th>Inspection Frequency (days)</th>
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<tbody>
<tr>
<td>Hospitals and Medical Facilities</td>
<td>90 – 120</td>
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<tr>
<td>Training Facilities</td>
<td>120 – 180</td>
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<tr>
<td>Dining facilities</td>
<td>90 – 120</td>
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<tr>
<td>Troop Housing</td>
<td>90 – 120</td>
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<tr>
<td>Administrative</td>
<td>120 – 180</td>
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<td>Recreational Facilities</td>
<td>90 – 180</td>
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<td>Maintenance Facilities</td>
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<td>Research &amp; Development</td>
<td>90 – 120</td>
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<td>Storage</td>
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Sample of calculating the manpower required for preventive maintenance for a hospital of size 627,000 square foot is as follows:

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<th>Hospital</th>
<th>Sized Building (sq. ft.)</th>
<th>Labor Standard (man-hour/1000 sq. ft)</th>
<th>Man-Hours required per cycle</th>
<th>Personnel required per year</th>
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<td>120 day cycle</td>
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# Buildings & Structures PM Checklist / Record

<table>
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### Key to Symbols

- **SH**: Referred to Occupant as Self-help
- **A**: Adjusted as Required
- **R**: Repaired
- **RP**: Replaced Part
- **J**: Forward Job Order Request

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### The buildings and structures PM checklist/record format is as follows:

<table>
<thead>
<tr>
<th>Area:</th>
<th>Time In:</th>
<th>Time Out:</th>
<th>Total Man-Hr</th>
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PM reminder sheet is as follows:

<table>
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<tr>
<th>Preventive Maintenance Reminder Sheet</th>
<th>Building No.</th>
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<tr>
<td>Date</td>
<td>Deficiency</td>
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The typical defects frequently found in buildings and structures which require correction by PM units are listed below:

### Building components

Sample inspection/work guides which enables PM to inspect and repair the interior and exterior of buildings systematically are:

1. **Roofing Elements:**
   - **a. State and Tile Roofs**
     - (1) missing adequately
     - (2) flashing failures
     - (3) loose or broken
     - (4) deteriorated fasteners
   - **b. Metal Roofs**
     - (1) holes, looseness, punctures, broken seams
     - (2) rust or corrosion
     - (3) inadequate side or end lap (corrugated roofing)
     - (4) inadequate expansion joints
     - (5) damage resulting from contact between dissimilar metals
     - (6) needs painting
     - (7) inadequate or improper fastening
   - **c. Asphalt Strips and Roll Roofing**
     - (1) loss of granules and coating asphalt
     - (2) bare areas with exposed and deteriorating felt
     - (3) tabs curled, clawed or missing
     - (4) shingles or roll roofing brittle
     - (5) laps of roof roofing not cemented
   - **d. Cement Asbestos**
     - (1) missing shingles
     - (2) loose, broken, or cracked shingles
     - (3) insufficient side or end lap of corrugated sheets
   - **e. Built-Up Roofs**
     - (1) bituminous coating exposed due to loss of gravel
     - (2) coating weathered, felts exposed
     - (3) felts disintegrated and disbanded
     - (4) blisters, splits
     - (5) wet insulation
   - **f. Flashings**
     - (1) deteriorated, rust, corrosion
     - (2) insecurely fastened, damaged
     - (3) open joints
   - **g. Roof Decking**
     - (1) deteriorated
     - (2) improper drainage
   - **h. Parapets and Copings**
     - (1) cracks, spilling, damaged, missing
     - (2) open joints
   - **i. Lighting Rods and Grounds**
     - (1) broken, corroded
     - (2) insecurely fastened
     - (3) missing components
   - **j. Roof Vents**
     - (1) insecurely fastened
     - (2) corrosion, deterioration, damaged
     - (3) lack of weather tightness of seams and joints
   - **k. Installed Equipment on roof**
     - (1) rust, corrosion
     - (2) loose or worn guy wires, braces roof supports and flashings
   - **l. Gutters and Downspouts**
     - (1) clogged gutters and outlets
     - (2) sections missing or damaged
     - (3) rust or corrosion
     - (4) improper slope

2. **Structural:**
   - **a. Foundations and Exterior Walls**
     - (1) concrete, masonry
       - (a) spilling, breaks, salt attack
       - (b) leaking, moisture penetration
       - (c) movement due to frost heaves and differential settlement
       - (d) binding of door and windows
       - (e) wall or slab separated from footing
       - (f) exposed reinforcing
       - (g) out-of-plumb
     - (2) timber
       - (a) warped, checked, split, bowed
       - (b) sagging, broken members
       - (c) rotting fungus growth
(d) termite or other insect infestation
(e) dampness
(f) bolts missing, loose or faulty
(g) split rings, other connections

(3) vents
(a) damaged screens: missing
(b) wooden parts rotten. Broken
(c) hardware damage
(d) vent openings obstructed

(4) drainage
(a) failure to connect downspout to available storm sewers.
(b) failure to terminate on properly installed splash blocks
(c) improper surface grading around structure
(d) trash, debris, or other accumulations resulting in water ponding

(5) stucco
(a) deterioration or disintegration
(b) alligator cracks
(c) water stains
(d) broken areas

(6) cement – asbestos
(a) missing or broken sheets
(b) stains
(c) loose fastenings
(d) broken sheets or shingles

(7) aluminum and sheet steel siding
(a) scars, scuffs
(b) rust, corrosion
(c) breaks in protective coating
(d) puncture of metal
(e) loose, missing or broken fastenings

(8) exterior trim
(a) deterioration of protective coating
(b) loose, warped. Cracked, checked or broken boards
(c) swelling of joints
(d) rotting
(e) fungus or termite infestation
(f) evidence of continued dampness

(b. Interior Walls and Ceilings
(1) wood
(a) damaged condition
(b) support failure
(c) rot

(2) wallboard. Plasterboard and fiberboard
(a) open joints
(b) cracked, buckling, sagging
(c) support failure
(d) abrasions, breaks, holes
(e) discoloration from utility leaks

(3) plaster
(a) cracking, buckling, support failure
(b) spilling, moisture absorption
(c) discoloration from leaks

(4) ceramic tile
(a) chipped, cracked, loose, missing, holes, defective joints.
(b) etched, pitted, or dull surface caused by use of abrasive cleaners

(5) synthetic coverings and wallpaper
(a) element missing
(b) insecurely fastened, adhesive failure
(c) curling, abrasions, indentations, punctures, tears
(d) etched, pitted, or dull surface caused by use of abrasive cleanser

(6) wainscots
(a) loose nails
(b) cracked, missing
(c) paint deterioration

(7) metal grills
(a) corrosion, other damage
(b) deterioration of protective coating
(c) insecurely fastened

c. Chimneys and Stacks
(1) masonry and concrete
(a) spilling, weather and cracking
(b) deteriorated paint
(c) damage from gases
(d) cracks from expansion and contraction
(e) eroded or sandy mortar joints

(2) linings and baffles
(a) cracks, spilling
(b) damaged from gases
APPENDIX F - PREVENTIVE MAINTENANCE

(3) ladders
   (a) insecure rungs, poor anchorage
   (b) rust
   (c) paint scaling

(4) frames and jambs
   (a) loose fitting, broken
   (b) warped, cracked
   (c) paint deterioration

(5) door hardware
   (a) missing, missing or loose screws and bolts
   (b) broken, poorly functioning
   (c) rust deterioration
   (d) improper installation or adjustment
   (e) lack of lubricating, misalignment
   (f) loss of finish coating

(6) casing, baseboards and moldings
   (a) loose
   (b) water and wax damage
   (c) paint deterioration
   (d) scratches, indentations

(7) doorstops
   (a) missing
   (b) broken

f. Structural Element. X-Trusses, roof framing and other structural member will be inspected by a qualifies engineer to assure structural adequacy.

(1) timber trusses
   (a) twisted and bowed members
   (b) dry rot
   (c) checks and splits in ends at web members
   (d) sag, overloading
   (e) separation or slippage at joints
   (c) damage splice plates
   (d) insecurely fastened

(2) Steel trusses
   (a) twisted, bowed, deformed, broken
   (b) loose bolts, rivets, defective welds
   (c) rust, corrosion
   (d) rupture, shearing or crushing of steel plated, members, bolts and rivets.

(3) bar joists
   (a) corrosion, welding defects
   (b) bends, deflection, overloading

(4) timber members
   (a) loose, warped, cracked or broken
   (b) support failure
   (c) rot
   (d) termite, insect or fungus infestation
   (e) excessive deflection
(5) steel members
   (a) loose bolts, rivets
   (b) rust, corrosion
   (c) defective welds, connection failure
   (d) bends, deflection

(6) concrete members
   (a) exposed reinforcement
   (b) moisture penetration
   (c) cracks, spilling, breaks
   (d) expansion joint deterioration

(7) post
   (a) insecure foundation
   (b) deterioration, rotted or corroded
   (c) paint deterioration
   (d) out-of-plumb

(8) girders
   (a) splits, cracks, rot
   (b) insufficient bearing or fastening
   (c) bends, deflection
   (d) welds failure
   (e) rust, corrosion

(9) floor joists
   (a) loose bridging
   (b) deterioration
   (c) excessive deflection
   (d) insecure nailing
   (c) insect damage

(10) roof rafters and purlins
   (a) loose bolts and nails
   (b) cracked, split and broken
   (c) open joints
   (d) loose boards
   (e) insect damage
   (f) sag of members

i. Sub floors
(1) loadings
   (a) deflection, warping, cracking
   (b) lack of conformance to posted loadings

(2) wood
   (a) sagging, splintered, loose, warped,
       rotted, moisture, insect damage
   (b) faulty connections-nails, screws
   (c) protruding nails

(3) concrete
   (a) wear, pitting, roughness
   (b) settlement, shrinkage cracks

(4) steel
   (a) wear, rusted, loose, bent
   (b) support damage
   (c) missing, loose or damaged bolts, rivets,
       screws, broken welds

(5) finish
   (a) absence of protective coatings
   (b) insect infestation in finish and sub-flooring
   (c) dampness-fungus growth
   (d) lack of nonslip finish

(6) railing and balustrades
   (a) insecurely fastened
   (b) splits, chips, broken
   (c) paint deterioration
   (d) rot, termite damage

j. Windows
(1) wood sash
   (a) lack of weather tightness
   (b) loose or missing caulk
g. Loading Ramps and Platforms
   (1) warehouse platforms
      (a) cracks, breakage
      (b) sunken, platform slabs
      (c) hazards

   (2) retaining walls
      (a) out-of-plumb, settled
      (b) spilling

h. Exterior and Interior Stairs
   (1) no obstructions
   (2) wood

   (a) sagging, rotted, splintered, loose, warped.
   (b) stains, moisture
(e) binding, missing

(2) metal sash
   (a) rust, corrosion
   (b) warping, binding, poor fit
   (c) non-weather tightness

(3) storm windows
   (a) binding jamming
   (b) poor frame fit
   (c) rust and corrosion of metal parts
   (d) termite rottting of wood parts

(4) shutters, awnings and canopies
   (a) splitting, rotting, cracking
   (b) loose, missing
   (c) freedom of swing
   (d) damage to supports
   (e) misalignment damage

(5) insect screens
   (a) loose, broken, missing
   (b) misalignment
   (c) binding jamming
   (d) holes in screening material
   (e) rust, corrosion of metal parts
   (f) rotting, stain, damage to wooden parts

(6) louvers and Venetian blinds
   (a) loose, missing, broken
   (b) misalignment
   (c) improper installation
   (d) corrosion, abrasion
   (e) lack of lubrication

(7) shades
   (a) operation, improper fit
   (b) tears, broken, missing

(8) window hardware
   (a) loose, missing, broken parts
   (b) rust, corrosion, abrasion
   (c) loss of finish coating
   (d) binding, misalignment
   (e) improper installation or adjustment
   (f) lack of lubrication

(9) glass
   (a) broken, chipped panes, missing
   (b) putty missing or disintegrated

(10) weather stripping (seasonal)
     (a) tightness of fit

     (b) broken missing
     (c) moisture, rot

k. Glazing

(1) fixed single and double glazing, insulating glass
   (a) weather tightness
   (b) cleaning and maintenance
   (c) cracks, breaks
   (d) missing panes

(2) interior glass panes
   (a) cleaning, maintenance
   (b) chips, breaks, cracks
   (c) fit, connections

(3) roof lights
   (a) leaks, weather tightness
   (b) cleaning, maintenance

3- Floor Covering

a. Wood Flooring
   (1) abrasion, indentations, scuffmarks
   (2) absence of protective coatings
   (3) insect infestations
   (4) loading
   (5) Dampness, fungus growth
   (6) Knots, sagging, stains, discolorations
      Scratches, warped

b. Concrete
   (1) stains, discolorations
   (2) shrinkage cracks, settlement
   (3) absence of treatment or waxing that would prevent surface dusting
   (4) wear, pitting, roughness

c. Oxychloride/ Cementitious
   (1) moisture
   (2) abrasion resistance
   (3) protection against chemical damage
   (4) chips, cracks, pitting, roughness

d. Terrazzo
   (1) pitting, roughness
   (2) discolorations
   (3) settlement cracks, loose or broken segment

e. Clay and Masonry Tile
   (1) broken, chipped or loose resulting in uneven surfaces
   (2) stains discolorations
   (3) sandy and eroded joints
f. Vinyl-asbestos Tile
   (1) loose at seams
   (2) tears, indentations
   (3) chipping, breaking, cracking
   (4) furniture supports to prevent indentations
   (5) damage from solvents or excessive
       water in cleaning.
   (6) metal protection strips

g. Asphalt Tile
   (1) missing, loose or broken tiles
   (2) indentations, furniture supports to prevent
       indentations
   (3) loose edged
   (4) damaged from solvents or excessive
       water in cleaning
   (5) improper wax

h. Resilient Floor covering
   (1) wear, cracking, chipping, breaking
   (2) scratches, tears, indentations
   (3) lack of bonding and unevenness of underlayment
   (4) damage from solvents or excessive
       water in cleaning
   (5) absence of protective wax coatings

i. Mastic
   (1) depressions, indentations
   (2) absence of protective wax coatings

j. Carpets and Rugs
   (1) wear, tear, cuts, raveling
   (2) discolorations, fading
   (3) beetle or moth damage
   (4) wear, damage, failure of binding or anchoring strips.
   (5) wear or missing tractive substance on backing of small rugs or carpet on polished floors.

4- Exterior Painting
   a. peeling, efflorescence
   b. rust, corrosion, absence of paint
   c. weather damage
   d. deterioration
   e. excessive chalking or mildew

5- Interior Painting
   a. scuffs, abrasions
   b. deterioration
   c. absence of paint

6- Heating
   a. Hot Air Furnaces
      (1) Operation
         (a) complaints of operators
         (b) improper cleaning
         (c) poor flue connections
      (2) filters
         (a) dust, grease deposits
         (b) missing, improper fit
         (c) replacement of throwaway types
         (d) washing of permanent types
      (3) electrical controls
         (a) loose connections
         (b) charred, frayed, broken or wet insulation
         (c) low voltage
      (4) combustion chambers and smoke pipes
         (a) deposits, dirt
         (b) abrasions, wear, misalignment
         (c) breaks in thermal insulation casings
         (d) leakage of gases
         (e) lack of weather tightness of seams and joints.
      (5) adjustments and connections
         (a) missing or damaged connections
         (b) clogged jets, valves, fuel supply lines.
         (c) Insufficient oil or gas pressures
         (d) Misalignment, non-uniform flame or heat spread.
         (e) Wrong fuel – air mixture
         (f) Incorrect position of pilot light.
         (g) improper baffle adjustment causing impingement
         (h) defects in multiple-step heating device
   b. Steam and Hot Water Furnaces
      (1) complaints of operators
      (2) improper cleaning
      (3) dust, scaling, corrosion, other deposits clogging
      (4) leaks, air-binding or water hammer
      (5) misalignment and improper slope of units
          resulting in inadequate drainage and heating efficiency
   c. Hot Water Tanks
      (1) corroded surfaces
      (2) leaks
      (3) open seams
      (4) insufficient, improper or damaged insulation
      (5) improperly set aqua stat
d. Air Handlers, Pumps, and Hot Air Blowers
   (1) dust, dirt, other accumulations
   (2) defective operation, indicated from observation through operating cycle.
   (3) loose, missing or damaged connections and connectors.
   (4) bent blades, worn or loose belts
   (5) misalignment, imbalance.
   (6) excessive noise and vibration
   (7) excessive end play of shaft
   (8) ineffective sound isolators

e. Space Heaters
   (1) lack of wall and floor protection
   (2) incorrect firing

f. Air Ducts
   (1) soot, dust and other deposits, clogging
   (2) deformations, broken, loose or missing parts
   (3) loose seams and joints
   (4) breaks in vapor barriers
   (5) improper air distribution at branch ducts
   (6) improper seasonal damper or register settings

g. Radiators
   (1) broken parts
   (2) leaking valves and connections, condensations, clogging
   (3) vibrations, excessive noise
   (4) corrosion, metal defects

h. Piping
   (1) defective operation
   (2) leaks, clogging
   (3) moisture
   (4) vibration

i. Thermostats and Controls
   (1) complaints of operators
   (2) partially or fully inoperable
   (3) improper “on” and “off” operation

j. Ventilating Fans
   (1) dirty
   (2) lack of lubrication
   (3) noisy, excessive vibration
   (4) defective
   (5) bent blades
   (6) imbalance
   (7) Air Conditioning

a. Wiring and Electrical Controls
   (1) loose connections
   (2) charred, broken or wet insulation
   (3) short circuits

b. Temperature and Humidity Controls
   (1) improper setting
   (2) loose connections
   (3) defective operation noted in observing operation through complete cycle

c. Air Ducts, Dampers, Registers, Grills, Louvres and Bird and Insect Screens
   (1) soot, dirt, dust and other deposit
   (2) leaks, broken, loose or missing connections and parts
   (3) excessive vibration
   (4) material defects
   (5) defective operation of movable parts
   (6) improper seasonal or operating settings of dampers

d. Thermal Insulation and Vapor Barriers
   (1) wet, damaged or missing
   (2) broken tie wires
   (3) loose bands
   (4) torn canvas jackets

e. Air Filters
   (1) dust, grease, other deposits
   (2) missing
   (3) improper fit

f. Piping
   (1) leaks, corrosion
   (2) material defects of fittings, copper tubing, steel piping

8- Plumbing

a. Lavatory Services
   (1) bowl
      (a) unsanitary
      (b) broken, leaks, material defects
      (c) insecurely fastened
   (2) seat
      (a) unsanitary
      (b) broken, missing, insecurely fastened
      (c) splintered (if applicable)
      (d) paint or protective coating
   (3) fixtures, flush valves and parts
      (a) improper functioning
Design Life Extension of RC Structure

(b) leaks, broken or insecurely fastened
(c) missing

b. Sinks and Basins
(1) bowl
   (a) unsanitary, odors
   (b) broken, insecurely fastened
   (c) leaks, material defects

(2) faucet
   (a) worn washers
   (b) blouse, leaking, broken

(3) traps and drains
   (a) dirty, drains
   (b) corrosion
   (c) grease
   (d) leaks

(4) stopper
   (a) missing or deteriorated
   (b) inoperative

c. Bathtubs and showers 9 Figure 830-
(1) General
   (a) hazards
   (b) unsanitary conditions

(2) showerhead
   (a) insecurely fastened
   (b) leaking
   (c) fixed
   (d) base and back plate

   d. Urinals
   (1) bowl
      (a) unsanitary
      (b) broken, insecurely fastened
      (c) leaks
      (d) missing strainer

   (2) fixtures, flush valves and parts
      (a) improper functioning
      (b) broken, damaged

e. Piping
   (1) water piping
      (a) external rust
      (b) leakage, clogging, loose connections
      (c) insufficient water flow
      (d) water hammer

   (2) sanitary and drain
      (a) solid accumulation in strainers
      (b) slow drainage
      (c) odors and sewer gas from loss of water seal in traps

   (d) back pressure caused by clogging
   (e) ground water through leaky joint or broken pipe

f. Drinking Fountains
(1) bowl
   (a) cracked
   (b) clogged

   (2) valve
      (a) worn washer
      (b) leaking
      (c) insecurely fastened

9- Electrical
a. Conservation of Energy
(1) unnecessary lights, excessively high lighting levels
(2) unnecessarily high voltage bulbs
(3) unoccupied areas lighted
(4) signs posted to remind occupants to turn off lights

b. Lighting including Sockets
(1) improper lamps installed in hazardous locations
(2) inadequately s located upported, insecure and improperly
(3) evidence of unauthorized removal and relocation
(4) cracked or broken luminaries and fixture parts
(5) missing pullcords, metal pullchains not provided with insulating
(6) indications of objects being supported from hund or stored in fixtures
(7) evidence of overheating, under-sized or other Damage to socket, exposed or damaged connecting Wiring

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c. Wiring and Cable
(1) dirty, poor ventilation
(2) broken conduit
(3) presence of moisture, grease, oil, chemical fumes
(4) improper or unauthorized connection and dangerous temporary connections
(5) damaged wiring devices, defective insulators, damaged support (figure 8-4)
(6) broken or missing parts or exposed live parts
(7) excessive cable sag and vibration
(8) crowded cable spacing
(9) evidence of overheating, ground and short Circuits.
(10) overheated splices, damaged or defective insulation

d. Electric Heaters
(1) unauthorized location
(2) evidence of overheating
(3) exposed or damaged connecting writing

e. Motors and Fans
(1) excessive vibration and noise
(2) lack of excessive lubrication
(3) evidence of overheating
(4) exposed or damage connecting writing

f. Fuse boxes
(1) dirty, corroded
(2) evidence of overheating
(3) un-posted or illegible instructions, identification charts, circuit diagrams, and feeder schedules
(4) loose or inadequate connections
(5) lack of lubrications for switches
(6) knife switches and fuse clips improperly aligned
(7) dangerous temporary connections

g. Distribution Ducting
(1) torn, insecure, hazardous insulation damage

h. Switches
(1) defective operation
(2) broken or missing parts
(3) loose wires

i. Convenience Outlets
(1) dirty, defective contacts
(2) missing or damaged cover plates
(3) difficult plugging
(4) overheating
(5) evidence of overloading on multiple sockets servicing lamps or appliances
(6) lack of grounding terminal

j. Cords Cord Extensions, and plugs
(1) inadequate
(2) unsafe
(3) incorrect types being used
(4) lengths excessive
(5) poor insulation
(6) twisted, spliced
(7) exposed to damage underfoot
(8) laying on floor or across heated surfaces or lamps

(9) cracks, breaks, loose connection wires improperly attached and in danger of pulling away from plug when removing cover on male ends
(10) missing protective cover on male ends
(11) no longer terminal or ground wire with clamp
(12) cable clamps missing loose on power plugs.

10- Equipment
a. Food Services Systems
(1) ranges
(a) dirty or loose canopy
(b) poor flue connections
(c) improper operation of doors
(d) loose units or bolts
(e) slanting or wrapped cooking surfaces
(f) evidence of leaking gas
(g) burner grills broken or missing
(h) defects reported by users
(2) refrigerators and Cold Storage Lockers
(a) excess noise, vibration
(b) missing, damaged or inefficient thermal insulation
(c) paint chipped or peeling
(d) insufficient cooling
(e) complaints of operator
(3) Exhaust fans
(a) excess noise, vibration
(b) grease, dirt, other deposits
(c) protective grille missing
(d) loose connections
(4) Counter Tops
(a) scratched, stained, other damage
(b) pulling away from cabinet or other structure
(5) Cupboards and storage Compartments
(a) sagging doors
(b) broken or missing hinges
(c) broken or missing locks
(d) insufficient supports
(e) broken glass
(f) combustible materials
(6) Sinks
(a) Insecurely fastened
(b) Slow drainage
(c) Chipped enamel
(7) Steam and hot water tables  
   (a) defective units, switched and pilots  
   lamps and similar equipment  
   dented, scratched surface  

b. Laundry facilities  
   (1) washing machines  
      (a) leaking door  
      (b) malfunctioning hinges  
      (c) loose or faulty electrical and  
          plumbing connections  
      (d) evidence of imbalance  
      (e) excess noise, vibration  

(2) dryers  
   (a) loose, damaged or missing vent ductwork  
   (b) insufficient clearance between  
       dryers and wall  
   (c) faulty electrical connection  

(3) Ducting  
   (a) loose, damaged or missing  
   (b) located in areas prone to damage  

(4) exhaust fans  
   (a) inoperable, disfunctioning  
   (b) dirt, grease, other deposits  
   (c) excessive hazards, i.e., opportunity  
       for electric shock, injuries from  
       rotating blade  

(5) tubs, trays  
   (a) damaged, missing, leaking  
   (b) insecurely fastened  
   (c) cabinetry  

(1) Cupboards and cabinets  
   (a) sagging doors  
   (b) missing hinges or locks  
   (c) insufficient supports  

(2) chalkboards, bulletin, other damage  
   (a) cracked, broken, other damage  
   (b) insecurely attached  

(3) shelving  
   (a) hazards  
   (b) insufficient supports  
   (c) sagging  

(4) counters  
   (a) insecurely fastened  

(b) silvers  
   (c) loose nails  
   (d) warped surface covering  

(5) butcher block surface  
   (a) chipped, silvers  
   (b) wood in need of oiling or other refinishing  
   (c) laminated fastened  
   (d) smoke alarms—test operation  

Structures Component  
Sample inspection/work guides which enable  
Components above:  

11-General This section of the inspection/Work  
Guides contains special components of structures.  
PM, personnel will find that use of these guides will  
Cable them to cover most structures not addressed In  
Section II  

12-Special Structures  
(a) Storage Bins and Tanks  
   (1) Foundations  
      (a) settling, movement, upheaving  
      (b) inadequate soil coverage  
      (c) cracking  

   (2) exterior concrete and leakage  
      (a) spalling, cracking and leakage  
      (b) exposed reinforcing  

   (3) exterior steel surface  
      (a) rust, corrosion  
      (b) distortion or other structural failure  
      (c) leakage  
      (d) deteriorated paint  

   (4) roofs  
      (a) defects in weatherproofing heat-  
          reflecting coatings, coverings  
      (b) rust, corrosion  
      (c) deteriorated paint  
      (d) structural or mechanical damage caused  
          by freezing weather conditions  

   (5) structural supports  
      (a) rust, corrosion, rot  
      (b) broken, cracked, distorted  
      (c) loose, missing  
      (d) deteriorated paint
(6) Vents
   (a) rust, corrosion
   (b) dirty, damage or missing screens

(7) relief valves
   (a) defective operation
   (b) leakage
   (c) improper adjustment

(8) ladders and stairs
   (a) rust, corrosion, rot
   (b) broken cracked loose missing members or connections
   (c) deteriorated paint

(9) leakage
   (a) evidence of fuel loss
   (b) water infiltration

b. Storage Sheds
1. Metal
   (a) rust, corrosion
   (b) dents, punctures
   (c) loose connections
   (d) improperly functioning doors and hinges

2. Wood
   (a) rot, deterioration
   (b) insect infestation
   (c) leaks

C. Tower
   (1) general defects
      (a) out of plumb
      (b) paint deterioration
      (c) deficient support or guys
      (d) rust, corrosion, loose, missing, twisted, bowed, bent or broken members
      (e) termite or other insect infestation
      (f) corroded, loose or missing conduits

2. Grandstands, Bleachers
   (1) structural supports
      (a) corrosion, rot
      (b) damaged, loose or missing members

   (2) Seats
      (a) splintered, chipped
      (b) insecurely fastened
      (c) peeling, cracking paint

(3) Steps
   (a) sagging, bowed
   (b) insecurely fastened, missing
   (c) improperly or illegibly identified

(4) Wooden
   (a) termite or other insect infestation
   (b) silvers, splinters, chipped, rotten
   (c) damage, loose or missing members
   (d) peeling, cracked paint

(5) Steel
   (a) corrosion, rust
   (b) damaged, loose or missing members
   (c) peeling, cracked paint

(6) Concrete
   (a) cracking, appalling, settling
   (b) exposed reinforcing rods
   (c) paint deterioration

E. Playground Structure
   (1) Structural Supports
      (a) corrosion, rot
      (b) damaged, loose or missing members
      (c) abrasive edges
      (d) instability

   (2) Climbing apparatuses
      (a) rust or abrasive surfaces
      (b) sharp edges
      (c) splinters
      (d) missing rungs or supports

   (3) Seats and Benches
      (a) splinters, chipped
      (b) chain supports damaged or fouled
      (c) cloth seats frayed or torn
      (d) sharp edges
      (e) insecurely fastened

   (4) Paint
      (a) cracked, peeling, chipped
      (b) weathered
      (c) vandalized
      (d) blistered

   (5) Hazards
      (a) loose members
      (b) dangerous edges
      (c) rough surfaces
      (d) damaged retaining fences
13- Swimming Pools
a. Walls and Floor.
   (1) Cranked
   (2) Dirt and Stains
b. Secum gutters and Drains
   (1) Broken
   (2) Sluggish and Clogged
   (3) corrosion
c. Gratings
   (1) Cracked
   (2) Paint deterioration
d. Spring Boards, Diving Towers and Platforms
   (1) Insecurely fastened
   (2) Metal-Rust or Corrosion
   (3) Wood-Cracked, Broken or other Damage
   (4) Absence of Non-Slip Coverings
d. Concrete
   (1) Settling
   (2) Cracks, Breaks and Spalling
   (3) Exposed Reinforcing Steel
e. Tile
   (1) Chipped and Cracked
   (2) Loose and Missing Pieces
   (3) Defective mortar Joints
f. Expansion Joints
   (1) Leakege
g. Depth Marker and Lane Stripes
   (1) Leakege
h. Depth Marker and Lane Stripes
   (1) Illegible
   (2) Deterioration

14- Docks, Piers and Wharves
a. Concrete Members
   (1) Cracks, breaks, aplling settling
   (2) Exposure of reinforcing steel
b. Timber Members
   (1) infestation
   (2) loose, missing, broken, split, warped
   (3) rotted bolt holes
c. Plings
   (1) holes, abrasions
   (2) infestation
   (3) mechanical damage
   (4) loose or missing wedges
d. Branches
   (1) loose, missing, broken, spilt
   (2) warped, dacay.
   (3) termite and other pest infestation
e. Steel Members
   (1) rust, corrosion
   (2) loose, missing, bent, broken
   (3) defective connections
f. Ballards, cleats
   (1) broken r loose hardware
   (2) paint deterioration
   (3) infestation

15- Mechanical Movers
a. Elevators
   (1) paint deterioration
   (2) loose or broken hardware
   (3) excessive wear of floor covering
   (4) broken, insufficient or missing lighting
b. Escalators
   (1) paint deterioration
   (2) loose or broken hardware
   (3) excessive wear of treated material
   (4) broken, insufficient or missing lighting
   (5) deteriorated hand rail
   (6) hazards

REFERENCES