DEVELOPMENT OF A DECISION MAKING TOOL FOR THE CONDITION ASSESSMENT OF BUILDING

A DISSERTATION SUBMITTED TOWARDS PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF

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Under the Guidance of

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CANDIDATE'S DECLARATION AND CERTIFICATE

This is to be declare that the thesis entitled **"DEVELOPMENT OF A DECISION MAKING TOOL FOR THE CONDITION ASSESSMENT OF BUILDING"** is a bonafide record work done by me under the guidance of Mr. Alok Verma, Associate Professor, Department of Civil Engineering, Delhi Technological University, Delhi for the partial fulfillment of requirement of the degree of **"Master of Technology"** in Civil Engineering with specialization in **Structural Engineering** from Delhi Technological University, Delhi.

The matter embodied in this dissertation has not been submitted for the award of any other degree.

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A B S T R A C T

The degradation and deterioration process occurring in buildings is physically inevitable. Inadequate maintenance, physical ageing and environment are the main causes for it. The condition assessment of a buildings such as its structural and non-structural components, Architectural treatments, Interior decorations and Exterior finishing, are helpful for valuation, repair, rehabilitation, strengthening, renovation and upgrading work. This will determine whether or not a distressed building should be demolished to build back better or whether it will be cost-effective to either repair or rebuild it, in the context of overall safety. The building is assessed in two categories, First one is categories from the exterior finishes due to distress or deterioration, and the second one is from the damageability of structural components due to lack of workmanship, deficiency of design and use of poor material.

Development of a decision making tool for condition assessment of building has been attempted for easy and quick assessment for the types of deterioration, degradation, degree of damageability, durability, life of structure and approximate cost of repair. In this tool grade are points introduced for the condition of buildings components, The tool would be useful for building owners, Contractors and chartered engineers. One can identify the types of deterioration with variety of sample photographs and causes of deteriorations, and can get the cost of repair by inputting the quantity of deterioration and its classification. An example study has been conducted to validate the decision making tool for the condition assessment of building.

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CHAPTER -1

I N T R O D U C T I O N

1.1 MOTIVATION AND BACKGROUND

Building is an essential part of human life. The development of civilization and growth of country is depends on the development of construction industries such as Infrastructures and Housing projects. A wide variety of building constructed in urban and rural areas of India. These buildings are constructed with various materials obtained from natural resources and manmade materials which include local materials such as mud, straw and wood, semi-engineered materials such as burnt brick and stone masonry and engineered materials such as concrete and steel. The damage of the different building parts depends on the choice of building materials and construction technology adopted. The building parts damages / deterioration are generally highest with the use of local materials without engineering inputs and lowest with the use of engineered materials and skills. It is required to reduce the use of natural resources by increasing durability of structures. It is possible to identify the various types of deterioration or damages, its causes and proper repair methods to the building components.

Fig. -1 Unattended repair works and poor maintenance of a building

1.2 IMPORTANT OF CONDITION ASSESSMENT OF BUILDINGS

The condition assessment of buildings is to be carried out for repair and upgrading work. This will determine whether or not a decay/deteriorated building should be demolished to build back better or whether it will be cost-effective to either repair or retrofit it, in the context of overall safety. The condition assessment are to place the building into one of the following three categories:

1. The building has not shown any signs of distress and It satisfies all the safety and serviceability requirements according to relevant Codes of practice, hence no action is needed towards retrofitting.

2. The building is seen to be deficient (or distressed) but it can be repaired and strengthened to satisfy the Codes safety requirements.

3. The building is badly damaged. It is to be demolished and a new building may be built, build back better.

Main steps of condition assessment will be

a) To record the damages if any, and find out the causes for distress

b) To assess the extent of distress and to estimate the residual strengths of structural components.

c) To plan the rehabilitation and retrofitting/strengthening of the building.

CHAPTER – 2

LITERATURE REVIEW

The following presents a literature review of the past research preformed in the areas of deterioration of structural components and finishing. An emphasis is placed on works involving the rehabilitation, maintenance and Rapid Visual Screening.

2.1 OVERVIEW

Scott D. Chamberlain, described about the *"Causes of and Solutions to Inevitable Deterioration"* [1] in the Journal of architectural technology that the first bricks were made from the mud of riverbanks and baked in the sun, as long ago as 10,000 B.C. Chopped straw and grass were added to prevent distortion and cracking. Around 4,000 B.C., brick manufacturers began producing uniform shapes and firing them in kilns. Firing caused the clay particles to bond chemically, hence improving brick's durability. As with all building envelope systems, deterioration is inevitable. The key to sustaining brick masonry exterior walls for as long as possible is preventative maintenance and repair. Preventing minor deterioration from escalating into bigger problems will ensure a structure's longevity.

Dr.A.Ghafar Ahmad presented a paper on "*The dilapidation survey report*" [2] A poor understanding regarding extend and nature of building defects would render an inappropriate approach and scope of repair work being carried out during renovation project leads to disagreement and substantial cost implication among building owner and contractor. A dilapidation survey is the practice of identifying and recording building defects through the means of Fig.graphic and digital documentation prior to any conservation work.

Ruta Miniotaite, Associate Professor has presented a paper on *"Destructive Factors Causing Deterioration of Paints on Buildings Walls"*[3] In his investigation, the external layer of walls and durability of different paints is carried out with water vapour flow rate. In case of bi-laminar system “paint film-the wall being painted” two opposite processes take place: water flow rate from outside towards the wall, It was foreseen before investigations of paints on durability that theoretical attitude: low vapour resistance – low rain penetration “good”; high vapour resistance - high rain penetration “bad”. Water vapour accumulated in the wall, when disturbed from escaping through a very dense film might cause blebs, or tear off the whole film or its parts.

2.2 METHODOLOGY OF CONDITION ASSESSMENT

Condition assessment and evaluation is generally carried out in two levels:

(i) Preliminary and

(ii) Detailed.

If we get adequate information to assess the safety of the building at the preliminary investigation level, detailed investigation, which involves considerable cost and time, may not be recommended.

2.2.1 RAPID (VISUAL) INVESTIGATION

There are mainly three components and steps:

• Collection of information and details about the building design, construction, utilization, and maintenance in the past

• Visual inspection of condition at site and recording details of distress

• Evaluation of safety against the provisions in building codes or specified performance criteria

2.2.2 INFORMATION NEEDED FOR RAPID INVESTIGATION

One needs a complete record of building design details and drawings, architectural details, construction details and drawings including the specifications of materials used, geotechnical details of the area and foundation particulars, details of any repair or retrofitting done from the time of construction, details of usage of the building including the loads. Some nondestructive testing may be required to check the strength of concrete masonry etc.

If the above information is not available, detailed investigations have to be conducted.

2.2.3 DETAILS IN VISUAL INVESTIGATION

The main purpose of visual investigation is to observe and note down all the items of distress or design deficiency and their locations, supported by sketches and drawings. The visual inspection includes:

• Verification of the accuracy of the original drawings or determination of basic building information, if no drawings are available.

• Identification of major alterations not shown on the original construction documents.

• Identification of visible structural damage, such as concrete cracking or peeling, and observations on quality of construction

• Identification of potential non-structural falling hazards, including ceilings, partitions, curtain Walls, parapets, fixtures, and other non-structural building elements.

• Observations on the condition of soil and the foundation

• Documentation of existing conditions with Fig. graphs at key locations.

Based on the data collected about the details of the building, visual observation of damage/distress in different structural components and the system, structural engineers experts can categorize the type and severity of damage and make judgments about further course of action. Rapid assessment of safety of buildings becomes necessary in the aftermath of natural disasters like earthquakes to take decisions about possible evacuation of unsafe buildings to save lives.

2.3 THE RAPID VISUAL SCREENING (RVS)

The rapid visual screening procedure was developed by the Federal Emergency Management Agency (FEMA) [4] to identify, inventory, and rank buildings that are potentially seismically hazardous. FEMA's RVS procedure was first published in two volumes in 1988 as FEMA 154 and FEMA 155 (FEMA, 1988a, 1988b). In the nearly 25 years since its publication, RVS has been widely used to evaluate thousands of buildings in many seismically active regions of the United States and most of the countries around the world. The RVS procedure was developed for a broad audience, including government officials, Engineers, inspectors and public & private-sector building owners. The procedure was designed to be the preliminary screening phase of a multi-phase procedure for identifying potentially hazardous buildings. Buildings identified as potentially hazardous by the RVS procedure should be analyzed in more detail by an experienced seismic design professional.

CHAPTER – 3

A I M S AND O B J E C T I V E S

3.1 OBJECTIVES

The primary objective of this research is to develop a decision making tool for the condition assessment of a building in excel work book to be use-full for common man to assess the influence of the deterioration of buildings and determine the physical condition of the building components and finishing, predict the implication of degree of damageability and cost of repair. This report will be performed in the context of a building parts considered Paints, Plastering, Dampness, Masonry, Flooring and RCC components.

3.2 RESEARCH METHODOLOGY

The research methods are to study the relevant codes/specifications in regard to deterioration of structures and explore various means of restricting decay of construction materials. Fig.graph are taken of the deteriorated parts from various buildings and different location. According to the degree of deterioration, Classified as Minor deterioration, Medium deterioration and Major deterioration. Compare the actual deteriorations with given Fig.graphs. Obtain the construction material cost from local markets. Analysis the rates for repair the deteriorated parts. By given inputs such as quantity of deteriorated part to chosen classification, and get the cost of repair. An example case is carried to validate the use and function of the tool. The example case attempted all the procedures and steps of the tool, which includes observation of deterioration, what could be the cause of the decay/deterioration, degree of damageability in grade points and cost of repair.

3.3 PROGRAMME OF STUDY

1. Introduction
2. Survey of various type of buildings
3. Literature Surveys
4. Study the use of excel for programming
5. Expert Tool in Excel format
6. Application of the expert tool as example case
7. Conclusion
8. Further scope of work

CHAPTER – 4

DETERIORATION ON BUILDING COMPONENTS

4.1 INTRODUCTION

Even a casual observation of buildings in any town or city reveal an array of different kinds of buildings in varying standards of physical condition and age. These include recently constructed new buildings to those more carefully categorized as historic monuments. Between these extremes are a range of buildings some of which will be in a decaying condition, to those that are also beyond repair and refurbished older buildings. Many of the buildings are also e being used for a purpose for which they were not originally designed. Over past thirty years, buildings development has been undertaken on a huge scale in both the public and private sectors and accompanied by a redesign of the infrastructure of towns and cities and interconnecting communications. The extensive building programs were in response to population expansion, the replacement of existing buildings that had out lived their usefulness, the results of poor building maintenance, the rising aspirations of individual and the need for modern buildings in a new society. As soon as buildings are started, deterioration and obsolescence being their life cycle.[5] The buildings and its services are under proved that a dilapidated and unhealthy building in a poor environment has a very low quality of life. Reliability of services has been a necessity in multi-storey building whether it is block of offices or residences.

The useful life of any building is governed by a number and coincidence of several different factors. These include the sufficiency of the design, constructional details and the methods used for its construction. It is also dependent upon the way that the building is used and the maintenance policies and practice undertaken during its life. The life of a building may be considered in several different and distinct ways. Table-4.1 identifies the different sorts of obsolescence that designers and users need to consider

TABLE 4.1 BUILDING LIFE AND OBSOLESCENCE [6]

Condition	Definition	Examples
Deterioration		
Physical	Deterioration beyond normal repair	Structural decay of building components
Obsolescence		
Technological	Advances in sciences and Office buildings unable to engineering results in accommodate modern outdated building	Office buildings unable to accommodate modern information and communications technology
Function	Original designed use of the building is no longer required	Cotton mills converted in shopping units or warehouses
Economic	Cost objectives are able to be achieved in a better way	Site value is worth more than the value of the current activities
Social	Changes in the needs of society result in the lack of use for certain types of buildings	Multi-storey flats unsuitable for family accommodation
Legal	Legislation resulting in the prohibitive use of buildings are unless major changes are introduced.	Asbestos materials, fire regulations.

4.2 PHYSICAL DETERIORATION OF BUILDINGS

Buildings wear out at different rates depending upon the type and quality of materials used and the standards and methods that were adopted for their construction. Ultimate physical deterioration is reached when a building is likely to collapse due to structural failure. However, in practice buildings rarely reach this stage since they are demolished, The various different components used within buildings each in themselves have different life spans and these are capable of life extension or reduction depending upon the it's needs and the care exercised over it.

Fig.s shows the example for poor maintenance:

Fig. - 4.1 Vegetation on roof slab

Fig. - 4.2 Vegetation at lintel level

In India, we come across many old buildings needing major repairs or go early in to a state of dilapidation condition to make them unfit for occupation. However, if a building has given about 25 to 30 years of service without much maintenance or major repair, then it is reasonable to expect that it would need some structural repair soon. The main cause for this is weathering and ageing effect or inadequate maintenance and care. (Fig. - 4.1 and 4.2) However, generally at an age of less than 10 years, many poorly designed and / or constructed buildings are found to be in a very bad structural and general health condition needing major structural repairs. This premature deterioration is largely due to poor construction or inappropriate design and / or neglect of timely repair.

It can be stated with pride that construction and maintenance technologies in ancient India were developed to a high extent. Structure in sound condition built 500 to 600 years back are commonly found spread all over India. Early construction technology was based upon simple, natural structural materials like clay, stone etc. These materials have been performing admirably well. The construction process was based on experience and empirical knowledge. The margins for structural safety were variable and often rather large.

In the 20th century even an ordinary person aspired to get a comfortable giving accommodation. To attain this goal it was essential to reduce costs. This could be achieved by refining design process, reducing the unnecessarily heavy sections of structural materials and bringing down the safety factor. This period also witnessed evolution of new material like steel etc. This could mean that the construction suffered from deficiencies of knowledge and unstableness as experience of durability of new materials was necessarily limited. Currently, expectations of standards of comfort and environmental performance are increasing. New materials based on new metals, new alloys, petro-chemicals have started coming and environment of buildings is changings fast. Pollution, which is man-made, is taking a heavy toll on buildings. Pollution levels are increasing every-day in most of the cities and new pollutants are coming up with the manufacture of new materials and these environmental conditions are producing unhealthy buildings. Factors affecting the deterioration of materials and components in buildings are:

Weathering factors: Radiation, Temperature, Water, Freeze-thaw, Wind.

Biological factors: Fungi, Bacteria.

Stress factors /Incompatibility factors: Chemical, Physical.

Use factors: Design, Manufacture and construction use, Maintenance

4.3 FOUNDATION OF A BUILDING.

Serious structural problems in houses are not very common, but they occur, they are expensive to repair. Some can't be fixed at all: this can happen when part of your foundation shifts (by moving sideways, downward or upward, or both) yet the whole structure doesn't move in the same direction at the same speed. In other words, part of the house has moved horizontally or vertically and the rest hasn't.

4.3.1. INTERIOR AND EXTERIOR WALL CRACKS:

It is not uncommon to find cracks in the structure as shown in Fig.s - 4.3 to 4.6 illustrate the defect of structure due to failure of foundation. A leaning foundation wall is not ideal, but may not be a significant defect if movement does not appear to be recent. Foundation movement may result from a wide range of factors which can include

Fig. - 4.3 Horizontal crack at plinth level

Fig. - 4.4 Major vertical crack in brick wall

Fig. - 4.5 Vertical cracks in brick masonry at window sill level.

Fig. - 4.6 Vertical crack at joint

The cracks occures by various factors are listed as below.

- Shrinking or swelling of clays caused by changes in moisture content
- Compression of a soft layer in the ground as a result of the applied foundation loads
- Soil softening
- Improper back filling and compaction
- Variation in groundwater levels
- Erosion
- Vibration from nearby construction
- Hydrostatic pressure
- Poor construction practices
- Drainage and leaks

Structural defects occur in foundations at construction or later stage. There can be many causes for these defects. The problems areas, effects in foundation and defects in structure due to those causes are presented here.

TABLE 4.2 PROBLEM AREAS AND DEFECTS IN STRUCTURE DUE TO FOUNDATION FAILURE.

Problem area	Effect on foundation	Defects in foundation
Insufficient depth of foundation(mostly in soft clay soil)	Movement of foundation due to changes in water table seasonally, and movement due to trees and vegetation	Cracks in walls at natural lines of structural weakness at junctions of windows and doors.
Insufficient width of foundation	Settlement of foundation occurs due to insufficient distribution of load	Cracking of walls above ground level
Soft-spot in sub-soil	Foundation settles due to insufficient support from sub-soil	Cracking in walls above affected section of foundation
Insufficient steps in strip foundation on sloping ground	Building may slide or creep in case there is soil erosion	Displacement movement of building or section of building, Cracking in walls
Trees and large shrub close to building	Water-content of soil changes with season	Cracking in walls in line of weakness in structure
Clayey soil with high sulphate content	Sulphate attack in concrete foundation and cement mortar below ground level.	Movement in walls above ground level and expansion and deterioration of cement mortar and concrete below ground level.
Inadequate support to foundation from land-fill	Excessive settlement of foundation which continues for a long time	Cracking in walls complete collapse of buildings

TABLE 4.3 IS CODES RELATED TO FOUNDATION

Sl.No.	IS Code No.	Description
1	IS: 1080	Code of practice for Design and construction of shallow foundation in soils
2	IS: 1893	Criteria for earthquake resistant design of structures.
3	IS: 1904	Code of practice for design and construction of foundation – General requirement
4	IS: 2911 (Part-I)	Code of practice for design and construction of pile foundation – bored cast-in-situ piles
5	IS: 2911 (Part IV)	Code of practice for design and construction of pile foundation – Load test on pile
6	IS: 2950 (Part I & II)	Code of practice for design and construction of raft foundation
7	IS: 8009 (Part I)	Code of practice for calculation of settlement of foundation – Shallow foundation
8	IS: 8009 (Part II)	Code of practice for calculation of settlement of foundation – Deep foundation

4.4 BRICK WORK IN BUILDINGS

As with all elements of a traditional building, brick work will deteriorate and decay if not properly maintained. Such deterioration can be caused by a number of factors and can take various forms. The main signs that brickwork is suffering are:

- Surface growth and staining
- Efflorescence
- Soft, Loose or crumbling mortar
- Spalling
- Loose bricks becoming dislodged
- Cracks appearing through the bricks or mortar

Fig. - 4.7 Loose or crumbling mortar

If a brick structure begins to exhibit any of these signs it is important to identify the cause and rectify it as soon as possible. This will prevent the problem from spreading and further damage being caused.

4.4.1. CAUSES OF DETERIORATION IN BRICK WORK:

Fig. - 4.7 illustrate the deterioration visible in brick work of walls in a building. Major causes of deterioration in brick work of a building are:

4.4.1.1 WATER ACCESS: One of the most common and serious problems which can affect brickwork is uncontrolled water ingress. This can be a particular problem on exposed areas of a building such as upper floors and in the vicinity of leaking rain water pipes. Once water has begun to penetrate brickwork it can quickly spread to affect a large area.

The following can be causes of water penetration and associated deterioration

- Rising damp from subsurface moisture

- Condensation caused by lack of ventilation
- Failure of roof systems or rainwater goods
- Infiltration through failed mortar
- Inadequate surface drainage
- Encroaching vegetation
- Defective copings and flashings or damp proof courses

Fig. – 4.8 deterioration of brick masonry due to rising of dampness

4.4.1.2 STRUCTURAL FAULTS: The most common sign of a structural fault in brickwork is cracking. This can be caused by structural movement, unstable foundation, tree roots or defects in the original construction. Minor cracking will be superficial and restricted to a few isolated bricks but extensive cracking can be an indication of a serious problem. There are also a number of structural elements which can fail and lead to associated deterioration.

Fig. - 4.9 Deterioration of brick masonry due to structural fault

4.4.1.3 ORIGINAL CONSTRUCTION DEFECTS: Sometimes brick work was poorly constructed and defects inherent in the original construction can lead to later problems. Typical defects of this type are

- Poor bonding between walls or into existing masonry where a brick addition has been executed.
- Poor quality bricks utilized
- Frog turned upside down to reduce mortar requirements

Fig. – 4.10 Original construction defects

4.4.2. GOOD CONSTRUCTION PRACTICES FOR BRICK MASONRY

As per IS 2212 -1991 (code of practice for Brick works) [6] Good brick masonry should utilize bricks which are sound, hard, well burnt and tough with uniform color shape and size. The bricks should be compact, homogeneous, and free from holes, cracks, flaws, air-bubbles and stone lumps. These bricks should be properly soaked in water for at least two hours before use. The bricks should be laid on their beds with the frogs pointing upwards. As far as possible the brick walls should be raised uniformly with proper bond. Generally the height of brick masonry construction in a day should be less than 1.5m. In order to ensure continuous bond between the old and the new, the walls should be stopped with a toothed end.

TABLE 4.4 IS CODES RELATED TO BRICK WORK

Sl.No.	IS Code No.	Description
1	IS: 4885	Specification for sewer bricks
2	IS: 1725	Specification for soil based blocks used in general building construction
3	IS: 2212	Brick works – code of practice
4	IS: 2222	Specification for burnt clay perforated building bricks
5	IS: 11650	Guide for manufacture of common burnt clay building bricks by semi-mechanized process

4.5 PLASTERING FOR BRICK OR CONCRETE WALL

Deterioration of plaster is perhaps the most common masonry problem. The exposure of a building to the weather and the way it is used, inevitably cause deterioration over time, with disintegration and the loss of surface quality characteristics. Deterioration can be caused by direct or induced mechanical stress. Much of these depend on changes linked to the humidity present in the masonry. Both due to external cause (rainwater) and internal (diffusion of vapor from inside to outside). These phenomena are linked with consequent micro-variations in volume (freezing-thawing), chemical phenomena (efflorescence, oxidation, incompatibility of a chemical type) and biophysical phenomena (moulds, algae). The presence of considerable amount of damp behind the facing can be caused by particular geometry of the face, that facilitate water penetration and lead to water stagnation, capillary rising and saline migration towards the rendered surface. Fig. - 4.11 to 4.13 Illustrate some of the deterioration visible in plastering sources brick/concrete wall s in building: The deterioration of plaster is due to several causes, which may be divided into physical and chemical origin.

Fig.-4.11 Plastering deterioration due to dampness under slab

Fig.4-12 Plastering deterioration due to dampness on walls

Fig.4-13 Plastering deterioration due to salt effect

TABLE 4.5 SHOWING TYPE OF DETERIORATION, THE INTRINSIC CAUSES AND THE VISIBLE EFFECTS

Origin	Types of deterioration	Causes	Effects
Physical	Loss of adherence to substrate	• Substrata not properly prepared • Incompatibility with substrata • Vibrations	• Flakes • Brakes • Crakes
	Freezing/Thawing	Low porosity	• Micro-cracks • Disintegration • Swelling
	Crystallization of salt	Salt dissolved in mixing water	• Micro-cracks • Disintegration
Chemical	Chemical corrosion	• Acid rain • Pollution	• Disintegration • Flacks

The failure often takes the form of a progressive de-bonding of the plaster from the surface of the concrete and usually stars with the formation of small hollow areas. This condition usually deteriorates until the plaster on a whole wall becomes unbounded and bulges outwards. On soffits, unbounded plaster may simply fall down in large pieces. The hollowness can normally be detected by tapping the surface with a metal object. The mechanisms of failure are obscure but normally relate to plaster being unable to form good adhesion to dense concrete due to the very low absorption of the surface. Lightweight concrete/brick may have a high suction which also creates adhesion problems. Stresses set up subsequently, due to differential thermal or moisture movement between the plaster and substrata will easily break the weak bond between the two materials and cause cracking. Separation and bulging. Similarly deterioration of plaster because of efflorescence due to crystallization of salt present in mixing water or due to salt present in bricks.

TABLE 4.6 IS CODES RELATED TO PLASTERING

Sl.No	IS Code No.	Description
1	IS: 383	Specification for coarse and fine aggregates for natural sources for concrete
2	IS: 1542	Specifications for sand for plaster
3	IS: 2645	Specifications for integral cement water proofing compound
4	IS: 8112	Specification for 43 grade OPC
5	IS: 1661	Code of practice for application of cement and cement-lime plaster finishes

4.6 DETERIORATION OF PAINT IN BUILDING

Oil bound paints sometimes fail when used on certain building materials. When an acid and alkali react together, a salt is formed. If the acid is fatty such then the result is soap and water. Many building materials such as lime mortar and plasters, Portland cement and asbestos cement develop alkalis. If such surfaces are coated with oil bound paint particularly in the presence of even small quantities of moisture, scarification will take place.

4.6.1 COMMON DEFECTS

4.6.1.1. BLISTERING: The paint may blister as a mild attack or slow yellow-soapy runs in a sever attack as visible in fig – 4.14.

Causes:

- Painting in direct sunlight or on a surface that is too hot
- Application of an oil-based or alkyd paint over a damp, wet surface
- Exposing a fresh paint fill to dew, high humidity or rain
- Moisture passing through interior walls from common household sources such as bathrooms and kitchens

Fig.-4.14 Blistering of paint

4.6.1.2. PEELING OR FLAKING Loss of adhesion can occur through a number of other causes. The effect may be slow and appearance of blistering, peeling or flaking of the paint film as visible in Fig 4.15.

Causes

- Inability of the top coat to bond smoothly to the substrata
- Applying an extremely hard, rigid coating over a more flexible coating
- Natural aging of oil-based paints in extreme climates, when subjected to continuous freezing and thawing, which results in loss of paint elasticity.
- Applying another coat before the previous coat has dried
- Applying too much paint per coat

Fig.-4.15 Peeling of paint.

Fig.-4.16 Flaking of Paints

TABLE 4.7 LIST OF IMPORTANT IS CODES RELATED TO PAINTING

Sl.No.	IS Code No.	Description
1	IS: 384	Specification for Brushes, Paint and Varnishes.
2	IS: 428	Specification for Distemper, Oil Emulsion and color as required.
3	IS: 1477 (Part-1)	Code of practice for Painting of Ferrous Metals in Buildings – Pretreatment
4	IS: 1477 (part-2)	Code of practice for Painting of Ferrous Metals in Buildings – Painting
5	IS: 2395 (Part-1)	Painting of Concrete, Masonry and Plastered surfaces- Code of practice for operation and workmanship.

4.7 DEFECTS OF FLOORING

Flooring is essentially required for any building, for a building to look good it is very much necessary that proper flooring patterns is selected. While deciding the flooring pattern one must also consider the function of the particular space. For example flooring pattern used for kitchen of a house may not be suitable for bedroom of the same house. Similarly flooring pattern for exterior use and interior use are also different. For flooring various types of material are available. Considering the need one may the select any of the options available that is Tiles(Ceramic/Glazed, Porcelain, Vetrified) Stones (Kota, Dholpur, Marble, Sandstone, Jaisalmer, Granite) Wooden flooring, concrete flooring.

4.7.1.CONCRETE FLOORS

Concrete floors are very low maintenance flooring. They are used primarily in industrial, warehouse, and other applications where appearance is not important. Floors can be unfinished or finished, with the most common finish being an epoxy coating. Coatings are used to protect the concrete against abrasion and chemical spills, as well as to improve the appearance of the flooring. The service life of concrete flooring is generally the life of the structure. The service life of the coating applied to concrete floor ranges from 5 to 20 year, depending on the application. The most common defects found in concrete flooring include the following.

Fig.-4.17 Defect of concrete Flooring

4.7.1.1. CRACKS: Cracks are the most common defect found in concrete flooring. They range from small hairline cracks are barely visible to ones where two sections of the floor slab have completely separated and moved apart. They are caused by a number of factors including settlement of the building, insufficient or improperly located expansion joints, overloading, or defects in the concrete materials itself.

4.7.1.2. DETERIORATION: Concrete floors that are exposed to heavy abuse, chemicals, and frequent wetting can deteriorated. Small pieces of concrete can wear off or break away from the flooring resulting in a rough surface. Once the surface is damaged, the rate of deterioration will accelerate. Deteriorated concrete floors can be top coated to restore their surface. Badly deteriorated concrete floors may require replacement.

4.7.1.3. HEAVING: Heaving occurs when unequal forces on different sections of concrete floors cause one of the sections to shift in height with respect to the surrounding sections. Heaving can be caused by improper construction techniques or the floor being subjected to loads that exceed its capacities. Heaving creates uneven floors that result in tripping hazards and problems in moving equipment.

TABLE 4.8 LIST OF IMPORTANT IS CODES RELATED TO FLOORING

Sl.No.	IS Code No.	Description
1	IS: 1237	Specification for cement concrete flooring tiles
2	IS: 1443	Code of practice for laying and finishing of concrete flooring tiles
3	IS: 2114	Code of practice for laying in-suit terrazzo floor finish
4	IS: 2571	Code of practice for laying in-suit cement concrete flooring
5	IS: 4457	Specification for cement unglazed vitreous acid resisting tiles
6	IS: 5491	Code of practice for laying in-situ granolithic concrete floor topping

4.8 DETERIORATION OF RCC COMPONENTS:

Concrete is a relatively durable and robust building material, but it can be severely weakened by poor manufacture or a very aggressive environment. Concrete degradation can be a cause for concern on its own, or in reinforced structures it may lead to decreased protection to the steel. This in turn encourages corrosion of the steel, often followed by cracking and spalling of the concrete.

Deterioration of concrete is due to either:

- Chemical degradation of the cementious matrix
- Corrosion of the reinforcement steel
- Physical damage (Impact, Abrasive and fire damage)

4.8.1 CAUSES OF DETERIORATION IN REINFORCED CEMENT CONCRETE

TABLE 4.9 CAUSES OF DETERIORATION OF CONCRETE DUE TO DESIGN FAULT

Causes of the problem	Results
Poor reinforcement details, for example congested or inadequate reinforcement, inadequate cover to reinforcement	Leads to cracking, poor compaction, loss of alkaline environment and voids around the steel
Poor detailing of fixings, window frames, handrails supports and expansion joints	Water penetration, localized cracking and balcony weakness
Long, slender components	Excessive flexing may lead to cracking
Inadequate design for creep	Deflection due to strain under continued stress that can result in cracking
Decorative finishes, such as acid etching and fluting	Result in varying depth of cover around the bush hammering, steel and localized corrosion
Poor drainage	Leads to water pounding and localized
Incorrect concrete grade for purpose	Can produce concrete that is too weak/too strong
Mixes that result in high drying shrinkage	Can result in cracking

4.8.1.1. DESIGN PROBLEMS: There are a number of design and specification problems that can result in reinforced- concrete deterioration.

4.8.1.2 WORKMANSHIP: Care and attention during construction is crucial to the long-term durability of reinforced concrete. Current IS codes, give guidance appropriate to the exposure conditions, and on mix design (particularly the water/cement ration and amount of cement binder) additives, compaction, detail and thickness of cover, the type of cement binder. concrete are summarized in the following table.

TABLE 4.10 CAUSES OF DETERIORATION DUE TO POOR WORKMANSHIP.

Causes of problem	**Results**
Poor mixing	Leads to in homogeneous concrete, localized weakness, and reinforcement corrosion
Incorrect water- cement ratios	Can lead to variable strength, inadequate durability, increased drying shrinkage, excessive permeability
Poor compaction/Vibration	Results in honeycombing voids, excessively permeable concrete, segregation, localized reinforcement corrosion.
Varying and inadequate cover depths around the steel	Leads to localized reinforcement corrosion, penetration of damaging substances.
Poor curing techniq2ues	Results in shrinkage cracks, increased permeability, poor durability
Premature stripping of form work	Can result in cracking
Poor shuttering techniques	Can result in bulging, poor surface

4.8.1.3 MATERIALS: Lack of knowledge about the importance of careful selection and specification of materials and the use of additives has created a number of durability problems for historic concrete structures. They can be the result of the use of the following

TABLE 4.11 CAUSES OF DETERIORATION DUE TO MATERIALS

Causes of the problem	Results
Too low cement content	Result in weakened and poor durability concrete, resulting in breaking of corners
Too high cement content	Can result in excessive shrinkage / poor workability and cracking
Additives, such as calcium chloride	Chloride ions destroy the protective passive oxide layer on the steel
High alumina cement	Weakening concrete in wet environments
Too finely-ground cements	Causing excessive shrinkage and cracking that compromises the permeability of the concrete
Poor quality aggregates	Resulting in alkali-aggregate reaction, poor workability of the concrete, poor compaction, high drying shrinkage and weak concrete
Poorly shaped and badly graded aggregates	Results in poor workability often necessitating extra water or vibration during forming which can lead to segregation, bleeding etc.

4.8.1.4 ENVIRONMENTAL INFLUENCES: These play an important part in reinforced concrete deterioration and include the following:

TABLE 4.12 CAUSES OF DETERIORATION DUE TO ENVIRONMENTAL FACTORS

Causes of the problem	Results
Carbon dioxide and acidic gases	Lower P^H around the steel that enables corrosion to progress.
Water	Can introduce depassivating chloride ions into concrete
Freeze / Thaw in coder zones	Breakdown of surface, progressive cracking, water penetration to reinforcement that enables corrosion to progress
Salt ingress	Marine salt introduces deapssivating chloride ions into the surface of the concrete
Chemical attack	Chemical attack by chlorides can cause corrosion of steel or sulphates that can cause degradation of the cementitious matrix
Vibration	Causes cracking, spalling and delimitation.
Impact damage	Causes weakening of structural components, exposure of reinforcement, cracking

4.8.1.5. OTHER CAUSES OF DAMAGE TO CONCRETE

- **Excess water:** The use of excessive water in concrete mixture s is the single most common causes of damage to concrete. Excessive water reduces strength, increases curing and drying shrinkage, increases porosity, increases creep and reduces the abrasion resistance of concrete. High durability is associated with low water-cement ratio and the use of entrained air. Damage caused by excessive mix water can be difficult to correct diagnose because it is usually masked by damage from other causes. Freezing and thawing cracking abrasion erosion deterioration of drying shrinkage cracking.

- **Faulty design**: It can create many types of concrete damage. Discussion of all the types of damage that are result from faulty design is beyond the scope of this research. However, one type of design faulty that is somewhat common is positioning embedded metal such as electrical conduits or outlet boxed too near the exterior surfaces of concrete structures. Cracks form in the concrete over and around such metal features and allow accelerated freeze-thaw deterioration to occur. Bases of handrails or guardrails are placed too near the exterior corners of walls always and parapets with similar result. These base or instruction into the concrete expand and contract with temperature changes at a rate different from the concrete. Tensile stresses, created in the concrete by expanding metal cause cracking and subsequent freeze thaw damage. If sufficient slip joints are not provided in the metal, the expansion and contraction cause cracking at the points where the metal attachment base enter the concrete. This cracking also allows accelerated damage to the concrete from freezing and thawing.

- **Construction Defects:** Some of the more common types of damage to concrete caused by construction defects are rock pockets and honeycombing,

Form failure, dimensional errors and finishing defects. Honeycomb and rock pockets are areas of concrete where voids are left due to failure of the cement mortar to fill the spaces around and among coarse aggregate particles. These defects, if minor, can be repaired with cement mortar if less than 24 hours has passed since form removal. If repair is delayed longer than 24 hours after form removal, or if the rock pocket is extensive that are must be prepared and the defective concrete must be removed and replaced with dry pack or replacement concrete. Some minor defects resulting from form movement or failure can be repaired with surface grinding. There are many opportunities to create dimensional error in concrete construction. Whenever possible, it usually is best to accept the resulting deficiency rather than attempt to repair it. If the nature of the deficiency is such that it cannot be accepted, then complete removal and reconstruction is probably the best course of action. Occasionally, dimensional errors can be corrected by removing the defective concrete and replacing it with epoxy-bonded concrete or replacement concrete. Finishing defects which are visible usually involve over finishing or the addition of water and/or cement to the surface during the finishing procedure. In each instance, the resulting surface is porous and permeable and has low durability. Poorly finished surfaces exhibit surface spalling early in their service life. Repair of surface spalling involves removal of the weakened concrete and replacement with epoxy-bonded concrete.

- **Cyclic Freezing and Thawing:** deterioration is a common cause of damage to concrete constructed in the colder climate. Water experiences about 15 % volumetric expansion during freezing, the expansion exerts tensile forces that fracture the cement mortar matrix. This deterioration occurs from the outer surfaces inward in almost a layering manner. The rate of progression of freeze-thaw deterioration depends on the number of cycles of freezing and thawing, the degree of saturation during freezing, the porosity of the concrete, and the exposure conditions.

- **Environmental effect** Concrete is heterogeneous as well as porous material. It allows ingress of air and moisture. In our country, 80% of the rainfall takes place in two months of the monsoon season. Furthermore, we are having very long coastal area. Coastal area is comparatively more corrosive than the other are. Increase of moisture, air or chloride reaches reinforcement of RCC structure. It corrodes the reinforcement. Corroded product is having much more volume than its original volume. To make space for its increased volume, it causes crack in the concrete. Cracked concrete provides easy access to corroding agents, which further corrodes the reinforcement at accelerated rate resulting further deterioration of structure.

4.8.1.6 CAUSE DUE TO CORROSION: Cement concrete reinforced with steel bars is an extremely popular construction material. One major flaw, namely its susceptibility to environmental attack, can severely reduce the strength and life of these structures. In humid conditions atmospheric moisture percolates through the concrete cover and reaches the steel reinforcement. The process of rusting of steel bars is then initiated. The steel bars expand due to the rusting and force the concrete cover out resulting in spalling of concrete cover. This exposes the reinforcement s to direct environmental attack and the rusting process is accelerated. Along with unpleasant appearance it weakens the concrete structure to a high degree. The spalling reduces the effective thickness of the concrete. In addition, rusting reduces the cross sectional are of steel bars, thereby reducing the strength of the reinforcements. Moreover, the bond between the steel and the concrete is reduced which increases the chances of slippage. The rusting related failure of reinforced concrete is more frequent in a saline atmosphere because salinity leads to a faster corrosion of the steel reinforcements.

- **Inadequate concrete cover:** The blacksmiths who fix reinforcement bars are neither trained to bend the bars accurately nor to fix them effectively to ensure that the specified cover is left between bars and the formwork. Quite often, not only the bars themselves touch form work but also the binding wire loose ends and the steel bars are seen at the surface of the concrete and they are subjected to early carbonation of concrete.

- **Honeycombed concrete** is a major source of weakness in concrete and cause of safety concern especially in multi storied buildings, due to inadequate vibration/compaction in columns, walls, beams, and slabs in which compaction is done manually in place of a needle vibrator. Use of form vibrator is essential for narrow walls, partitions and architectural fins.

- **Initially rust steel bars:** Often steel bars are stored in open areas, exposed to rain and atmospheric moisture resulting in rusting of them. The corrosion process stars rapidly in the presence of moisture. The steel bars are rarely wire-brushed and cleaned thoroughly before being placed in shuttering prior to concreting. In other cases, due to suspension of work due to reasons whatsoever, structural frame remains exposed to sun, rain and misuse for a long duration. Such prolonged exposure to weather can cause rusting of bars and carbonation to adversely affecting durability of the building frame. This can be reduced somewhat by anticorrosive treatment (epoxy coating) of bars.

4.8.2. REVIEW OF THE CONVENTIONAL REHABILITATION PROCEDURES:

- Removal of the deteriorated materials and repairing of the structure with fresh concrete.
- Section addition
- Providing external reinforcement with the help of steel plates
- External pre-stressing
- Using FRP

TABLE 4.13 LIST OF IMPORTANT IS CODES RELATED TO CONCRETE.

Sl.No.	IS Code No.	Description
1	IS 269	Specification for ordinary Portland cement, 43 grade
2	IS 383	Specification for coarse and fine aggregates from natural sources for concrete
3	IS 456	Code of practice for Plain and reinforced concrete
4	IS 516	Method of test for strength of concrete
5	IS 1199	Methods of sampling and analysis of concrete
6	IS 1343	Code of practice for pre-stressed concrete
7	IS 2386 (Part 1 to 8)	Methods of test for aggregates for concrete
8	IS 2502	Code of practice for bending and fixing of bars for concrete reinforcement
9	IS 2645	Integral water proofing compounds for cement mortar and concrete
10	IS 3558	Code of practice for use of immersion vibrators
11	IS 4926	Code of practice for ready mixed concrete
12	IS 9103	Specification for admixtures for concrete

CHAPTER - 5

EXPERT TOOL IN EXCEL FORMAT

5.1 INTRODUCTION

This tool is developed with the following objectives as visible observation of types of the deterioration of parts like paints, Plastering, Dampness, Masonry, Flooring and RCC member such as Column. Beam and Slab. According to the visible observation, It categories as Minor deterioration, Medium deterioration and Major deterioration. The grade points are provided with degree of deterioration / damageability, Once the grade point are entered, the tool will show the percentage of deterioration of the building and approximate percentage of repair cost. This cost can be modified by changing the basic prevailing rates at any time.

5.2 VISIBLE OBSERVATIONS

The observation of deteriorations could be compared with the given category of the deterioration and one may choose its degree of damageability.

TOOL Table 5.1

VISIBLE OBSERVATION

Description of items	Degree of damage/ deterioration		
Paint	Minor	Medium	Major
Plastering	Minor	Medium	Major
Dampness	Minor	Medium	Major
Masonry	Minor	Medium	Major
Flooring	Minor	Medium	Major
RCC columns	Minor	Medium	Major
RCC Beams	Minor	Medium	Major
RCC slabs	Minor	Medium	Major

5.2.1 PAINT

Click on the category which is required to compare with the actual deterioration of Paint, the tool will leads to the Identification folder, which has three files Minor deterioration of paints, Medium deterioration of paint and Major deterioration of paint and particular category will be displayed as follows.

5.2.1.1 MINOR - DETERIORATION OF PAINTS

Type – 1

Type – 2

5.2.1.2.MEDIUM - DETERIORATION OF PAINTS

Type – 1

Type - 2

5.2.1.3 MAJOR - DETERIORATION OF PAINTS

Type – 1

Type – 2

5.2.2 PLASTERING

Click on the category which is required to compare with the actual deterioration of plastering, the tool will leads to the Identification folder, which has three files Minor deterioration of Plastering, Medium deterioration of plastering and Major deterioration of plastering and particular category will be displayed as follows.

5.2.2.1 MINOR - DETERIORATION OF PLASTERING

Type – 1

Type – 2

5.2.2.2 MEDIUM - DETERIORATION OF PLASTERING

Type – 1

Type – 2

5.2.2.3 MAJOR – DAMAGES / DETERIORATION OF PLASTERING

Type – 1

Type – 2

5.2.3 DAMPNESS

Click on the category which is required to compare with the actual deterioration due to dampness, the tool will leads to the Identification folder, which has three files Minor deterioration due dampness, Medium deterioration due dampness and Major deterioration due dampness and particular category will be displayed as follows.

5.2.3.1 MINOR – DAMPNESS ON BUILDING

Type – 1

Type – 2

5.2.3.2 MEDIUM - DAMPNESS IN BUILDINGS

Type - 1

Type - 2

5.2.3.3 MAJOR - DAMPNESS ON BUILDING

Type - 1

Type – 2

5.2.4 BRICK MASONRY

Click on the category which is required to compare with the actual deterioration of brick masonry, the tool will leads to the Identification folder, which has three files Minor deterioration of brick masonry, Medium deterioration of brick masonry and Major deterioration of brick masonry and particular category will be displayed as follows.

5.2.4.1. MINOR - DAMAGE / DETERIORATION OF BRICK MASONRY

Type – 1

Type -2

5.2.4.2 MEDIUM - DETERIORATION OF BRICK MASONRY

Type -1

Type -2

5.2.4.3 MAJOR – DAMAGES /DETERIORATION OF BRICK MASONRY

Type - 1

Type - 2

5.2.5 FLOORING

Click on the category which is required to compare with the actual deterioration / damages of flooring, the tool will leads to the Identification folder, which has three files Minor deterioration / damages of flooring, Medium deterioration/ damages of flooring and Major deterioration / damages of flooring and particular category will be displayed as follows.

5.2.5.1 MINOR - DAMAGES OF FLOORING

Type - 1

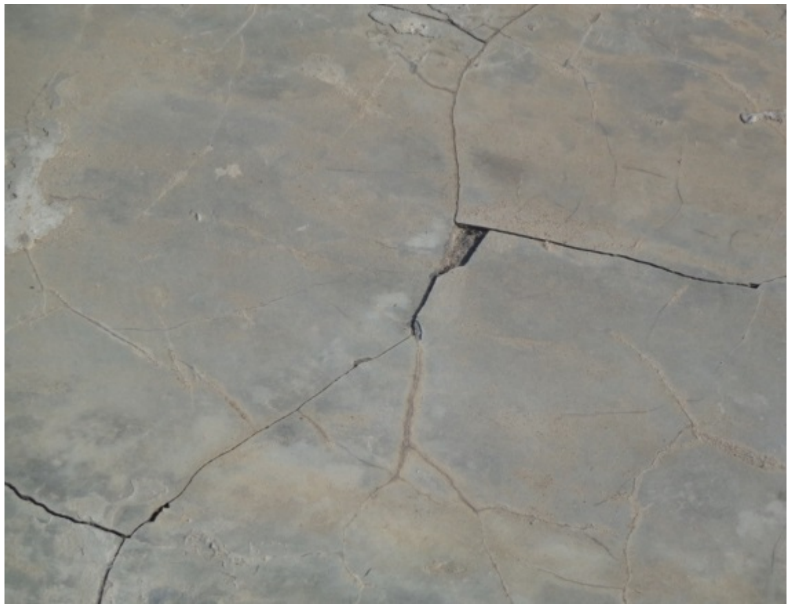
Type – 2

5.2.5.2 MEDIUM - DETERIORATION OF FLOORING

Type -1

Type - 2

5.2.5.3 MAJOR - DAMAGES OF FLOORING



Type – 1

Type -2

5.2.6 RCC COLUMN

Click on the category which is required to compare with the actual deterioration / damages of RCC Column, the tool will leads to the Identification folder, which has three files Minor deterioration / damages of RCC Column, Medium deterioration/ damages of RCC Column and Major deterioration / damages of RCC Column and particular category will be displayed as follows.

5.2.6.1 MINOR-DAMAGE/DETERIORATION OF RCC COLUMN

Type – 1

Type – 2

5.2.6.2 MEDIUM - DETERIORATION OF COLUMN

Type – 1

Type – 2

5.2.6.3 MAJOR – DAMAGES/DETERIORATION OF RCC COLUMN

Type - 1

Type - 2

5.2.7 RCC BEAM

Click on the category which is required to compare with the actual deterioration / damages of RCC Beam, the tool will leads to the Identification folder, which has three files Minor deterioration / damages of RCC Beam, Medium deterioration/ damages of RCC Beam and Major deterioration / damages of RCC Beam and particular category will be displayed as follows.

5.2.7.1 MINOR – DAMAGES OF RCC BEAM

Type – 1

Type – 2

5.2.7.2 MEDIUM–DAMAGES/DETERIORATION OF RCC BEAM

Type - 1

Type - 2

5.2.7.3 MAJOR–DAMAGES/DETERIORATION OF RCC BEAM

Type – 1

Type – 2

5.2.8 RCC SLAB

Click on the category which is required to compare with the actual deterioration / damages of RCC Slab, the tool will leads to the Identification folder, which has three files Minor deterioration / damages of RCC Slab, Medium deterioration/ damages of RCC Slab and Major deterioration / damages of RCC Slab and particular category will be displayed as follows.

5.2.8.1 MINOR – DAMAGES OF RCC SLAB

Type – 1

Type – 2

5.2.8.2 MEDIUM – DETERIORATION OF RCC SLAB

Type - 1

Type - 2

5.2.8.3 MAJOR – DETERIORATION OF RCC SLAB

Type - 1

Type - 2

5.3 GRADE POINTS

Grade points are pre-decided based on the total cost of construction of the particular item of work. The points are considered only the maximum expenses can be made for repair of that item is taken as 50 % of the cost of new construction of the particular item. Accordingly the grade points will show the cost of repair after entering the number of location. The quantity for one location is considered as a unity / surface. The grade points generated in excel work sheet.

5.3.1 CALCULATION OF PERCENTAGE OF DETERIORATION

Step - 1

The maximum locations pre decided with assuming the number of surfaces like inside room has four wall surfaces and over all outer building wall has four surfaces, accordingly maximum locations decided for various category proportional to the total building.

Percentage of visible location $= (No. of\ visible\ location \div Maximum\ location) \times 100$

Step – 2

The Grade points are pre decided with considering the 50% of Total cost of construction may spend for various repair works and the grade points allotted to each category based on its important of structural functions.

Percentage of deterioration

$$= (\%\ of\ visible\ location \times Total\ grade\ points\ of\ item) \div 100$$

Grade point

$$= (\%\ of\ visible\ location \times Max. grade\ point\ of\ category) \div 100$$

TOOL Table 5.2 GRADE POINTS

Description of items	Grade points (Maximum)			Total Points (Max)	Grade points based on assessment			Total Points
	Minor	Medium	Major		Minor	Medium	Major	
Paintings	0.50	1.00	2.00	3.50	0.00	0.00	0.00	0.00
Plastering	1.00	3.00	4.00	8.00	0.00	0.00	0.00	0.00
Dampness	3.00	4.00	6.00	13.00	0.00	0.00	0.00	0.00
Brick masonry	3.00	4.00	6.00	13.00	0.00	0.00	0.00	0.00
Flooring	1.00	2.50	4.00	7.50	0.00	0.00	0.00	0.00
RCC Columns	6.00	8.00	10.00	24.00	0.00	0.00	0.00	0.00
RCC Beams	4.00	5.00	8.00	17.00	0.00	0.00	0.00	0.00
RCC slabs	3.00	4.00	7.00	14.00	0.00	0.00	0.00	0.00
			Total points	100.00			TOTAL	

5.4 CAUSES FOR DETERIORATION

The causes for the deterioration of the various building components/ items are shown in separate work sheet with links of word document file. One can view the causes of the particular item by clicking title of that item. Once click the item a new word document will open which shows the causes of the deterioration of that item.

TOOL Table 5.3 CAUSED OF DETERIORATION

Causes of damages / deteriorations	
Item No.	Description
1	Paintings
2	Plastering
3	Dampness
4	Masonry
5	Flooring
6	RCC Members

5.5 ESTIMATION FOR REPAIR

In this excel work sheet one has to enter the quantity of the particular item of the category, The approximate cost of repair will show immediately on the same sheet. The rate per unit for the repair is calculated with the help of Analysis of rates.

TOOL Table 5.4

ESTIMATION FOR REPAIR WORKS

Item No.	Description of items		Qty.			Units	Rate per unit			Cost of repair			Total (Rs.)
			Minor	Medium	Major		Minor	Medium	Major	Minor	Medium	Major	
1	Paints	Int.	0.00	0.00	0.00	sq.m	36	53	80	0	0	0	0
		Ext.	0.00	0.00	0.00	sq.m	34	86	131	0	0	0	0
2	Plasters		0.00	0.00	0.00	sq.m	201	868	1026	0	0	0	0
3	Dampness		0.00	0.00	0.00	sq.m	82	307	3603	0	0	0	0
4	Brick Masonry		0.00	0.00	0.00	sq.m / Cu.m	186	617	4127	0	0	0	0
5	Flooring		0.00	0.00	0.00	sq.m	255	408	1266	0	0	0	0
6	RCC Beams (size 300 x 450 mm)		0.00	0.00	0.00	sq.m / Cu.m	577	688	877	0	0	0	0
7	RCC column (size 300 x 300 mm)		0.00	0.00	0.00	sq.m / Cu.m	236	1037	905	0	0	0	0
8	RCC Slab (Thickness 150 mm)		0.00	0.00	0.00	sq.m	561	1349	1986	0	0	0	0
								Total Cost	Rs.	0	0	0	0

5.5.1 DATA

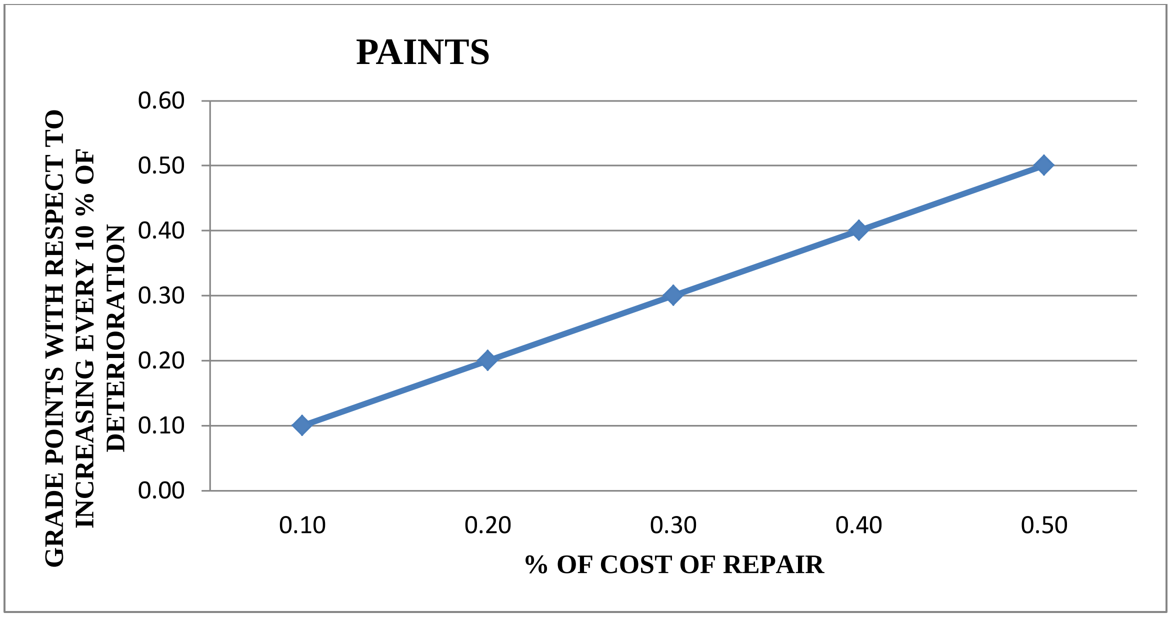
Data calculated with the help of standard Data book of CPWD, The cost of materials and wages of labours can be modified according to the prevailing rates at any time. The data has prepared for modification once change the basic rates at any time.

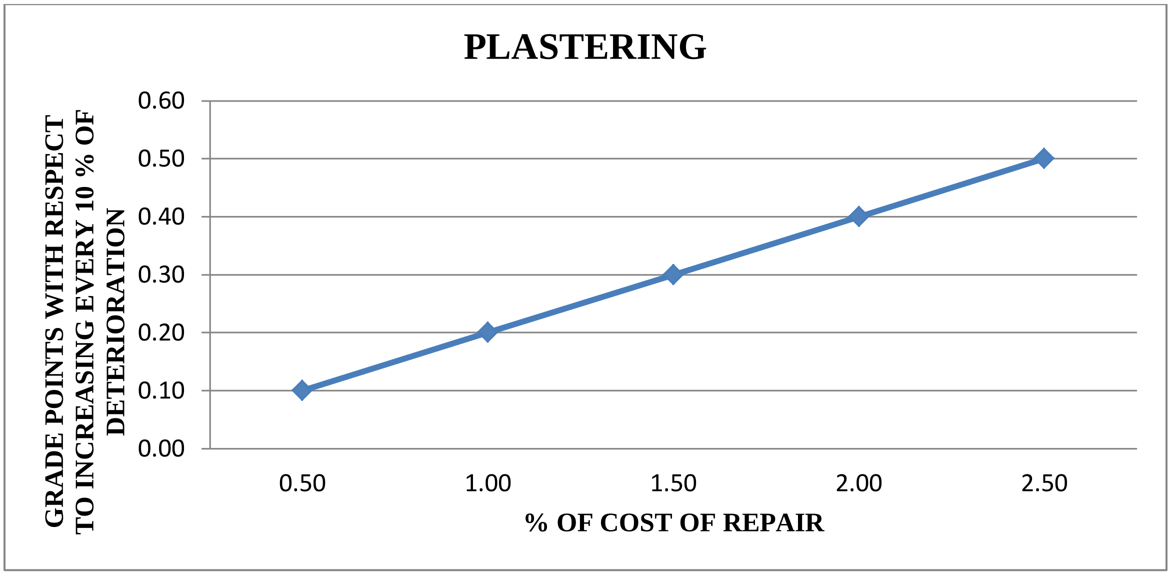
5.5.2 BASIC RATES

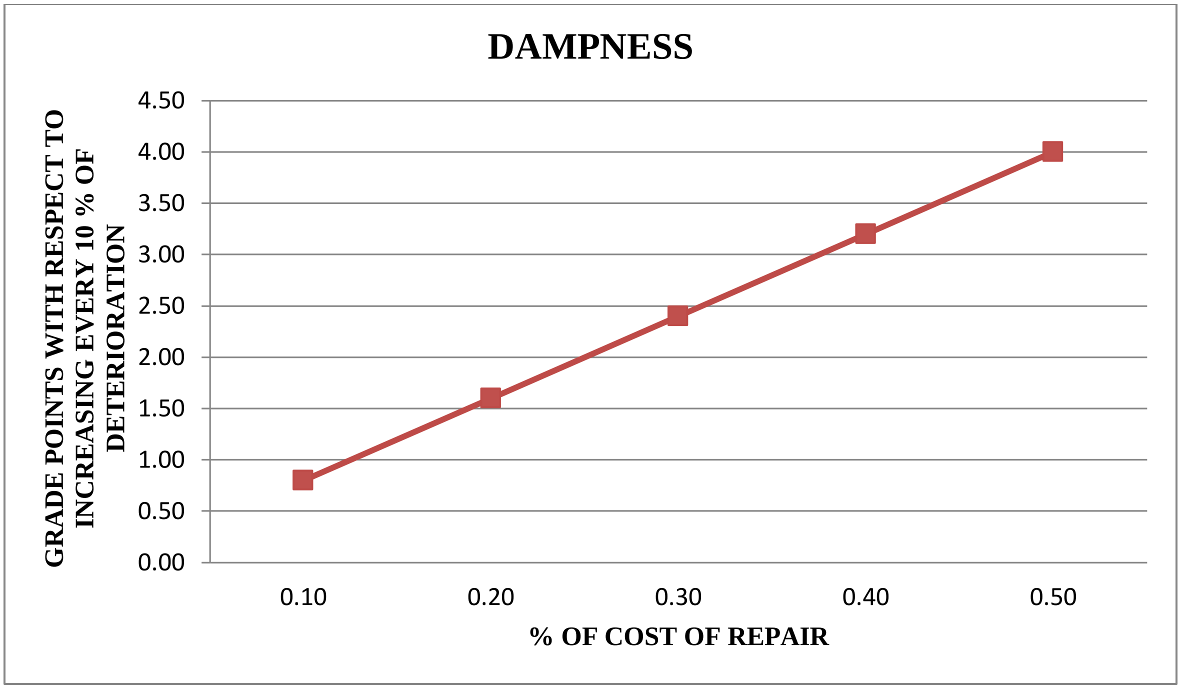
The present cost of the materials and wages of labour are adopted as per the prevailing market rate. This may also change based on the need of time by the individual.

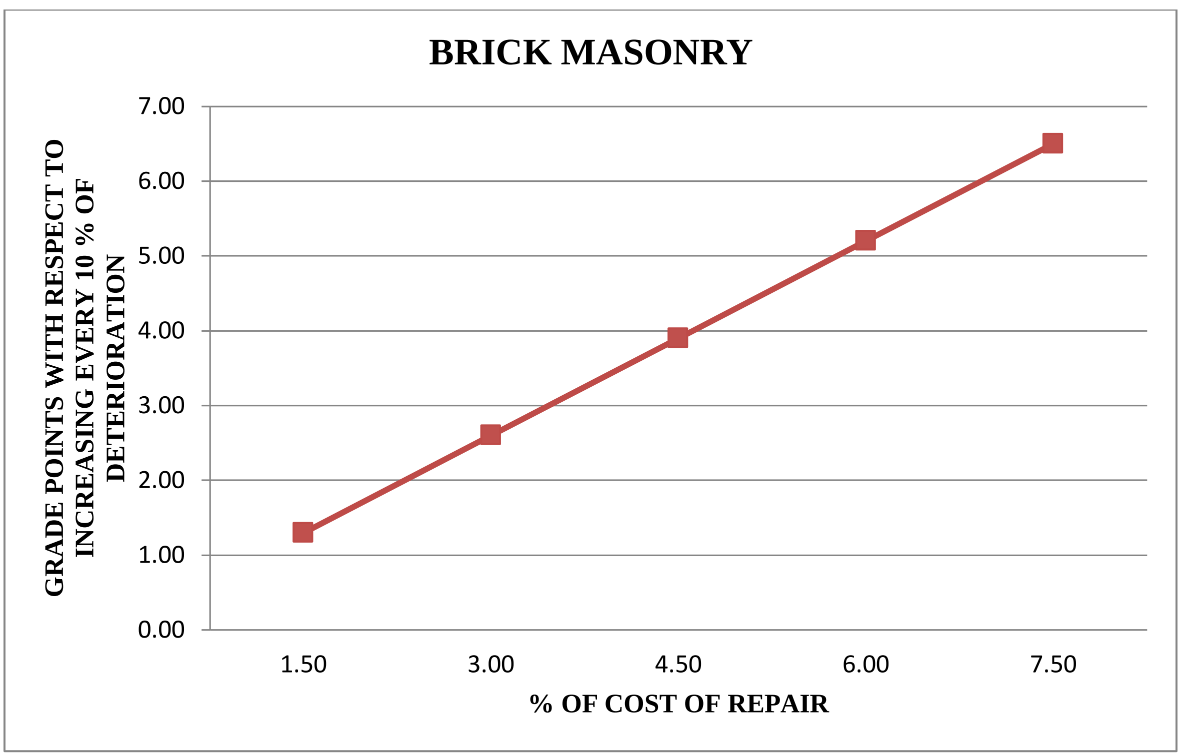
5.6 COMPARISON OF GRADE POINTS AND COST OF REPAIR

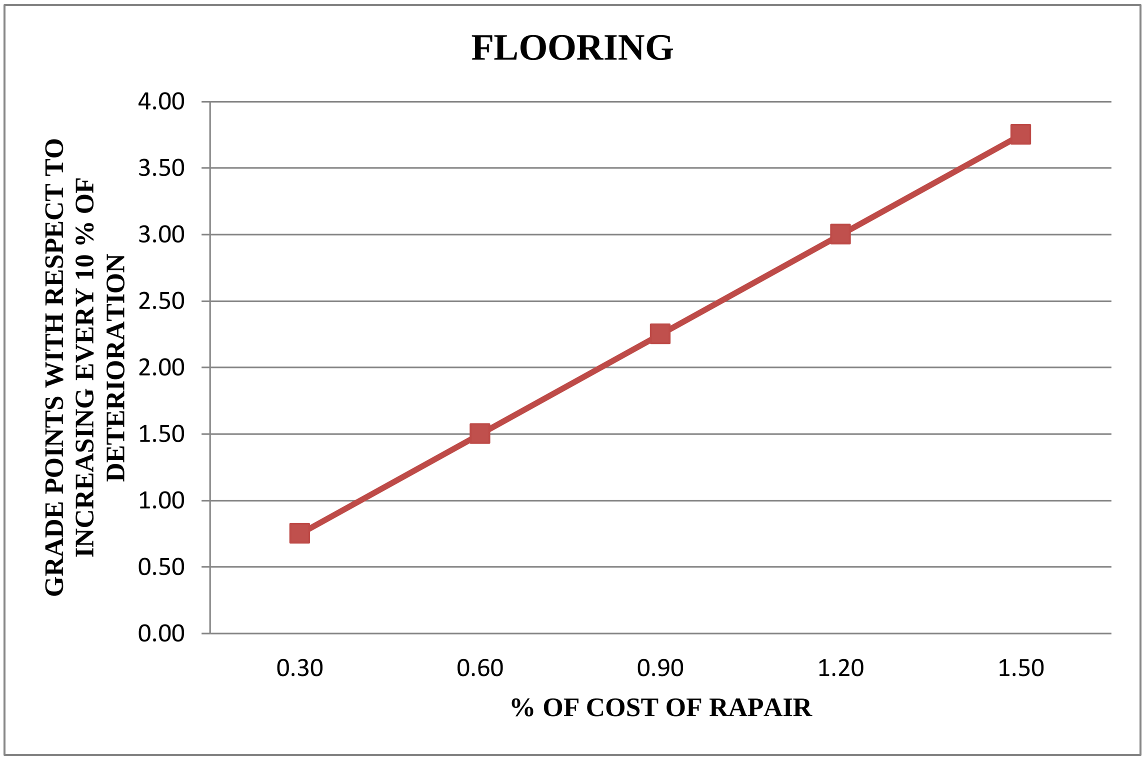
Based on the comparison of the grade points with cost of repair, The tool shows that whenever the increasing grade points which is based on degree of deterioration of different item of building, correspondingly The cost of repair also increased. These comparisons are shown in graphical form as below.

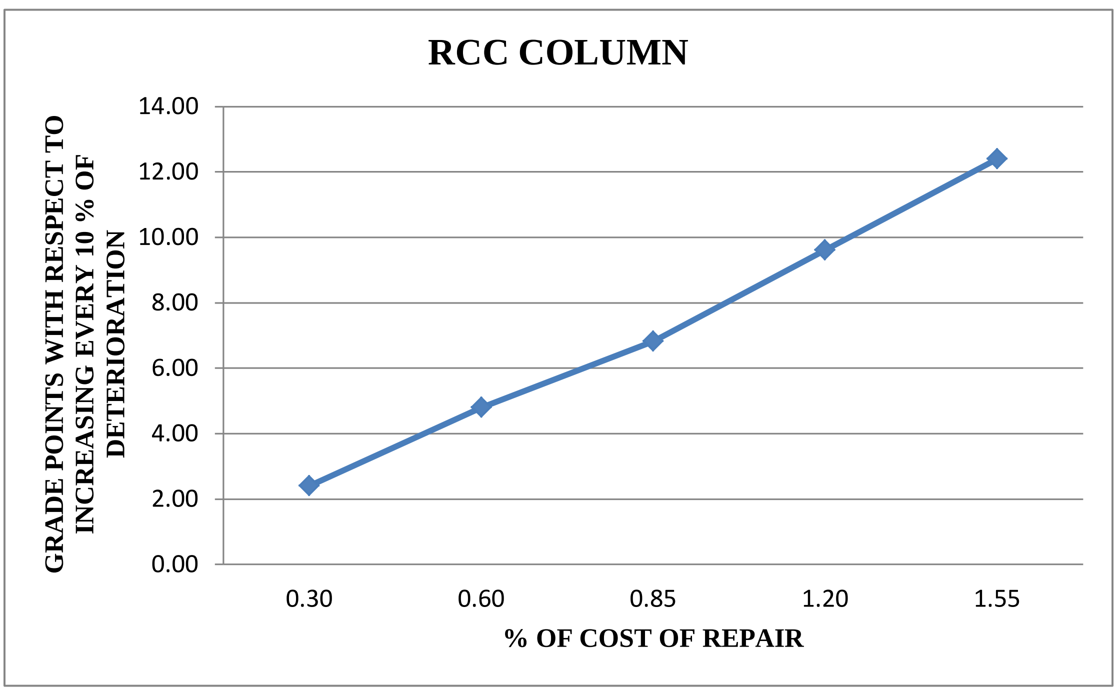


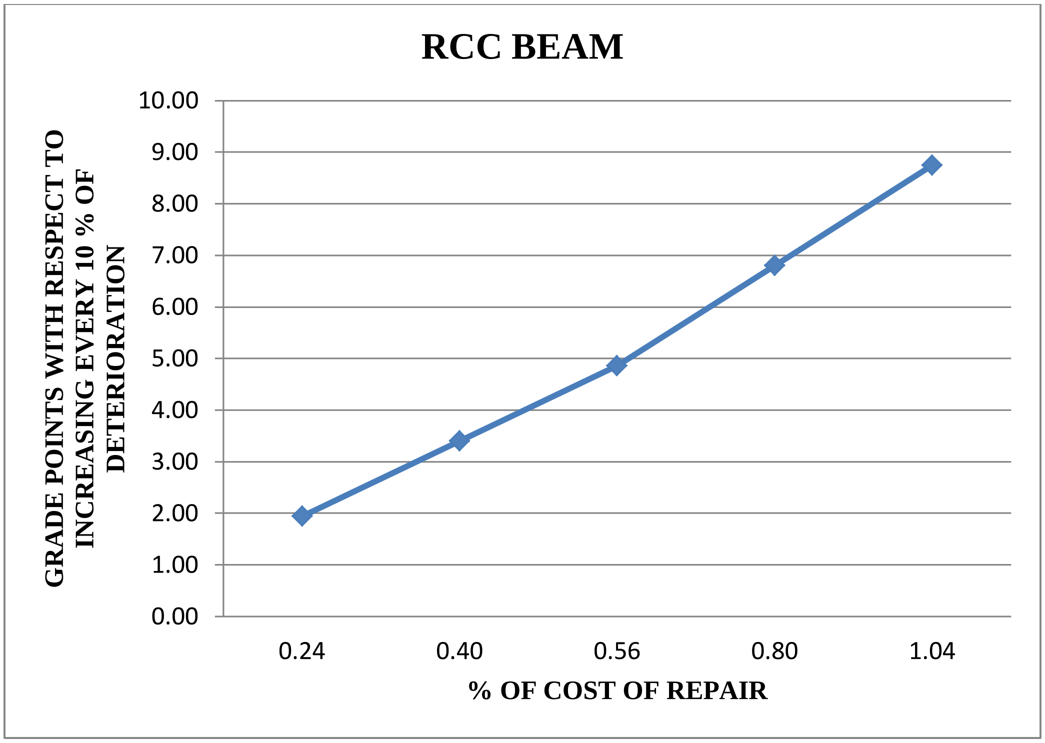



DAMPNESS
GRADE POINTS WITH RESPECT TO INCREASING EVERY 10 % OF DETERIORATION
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.10
0.20
0.30
0.40
0.50
% OF COST OF REPAIR

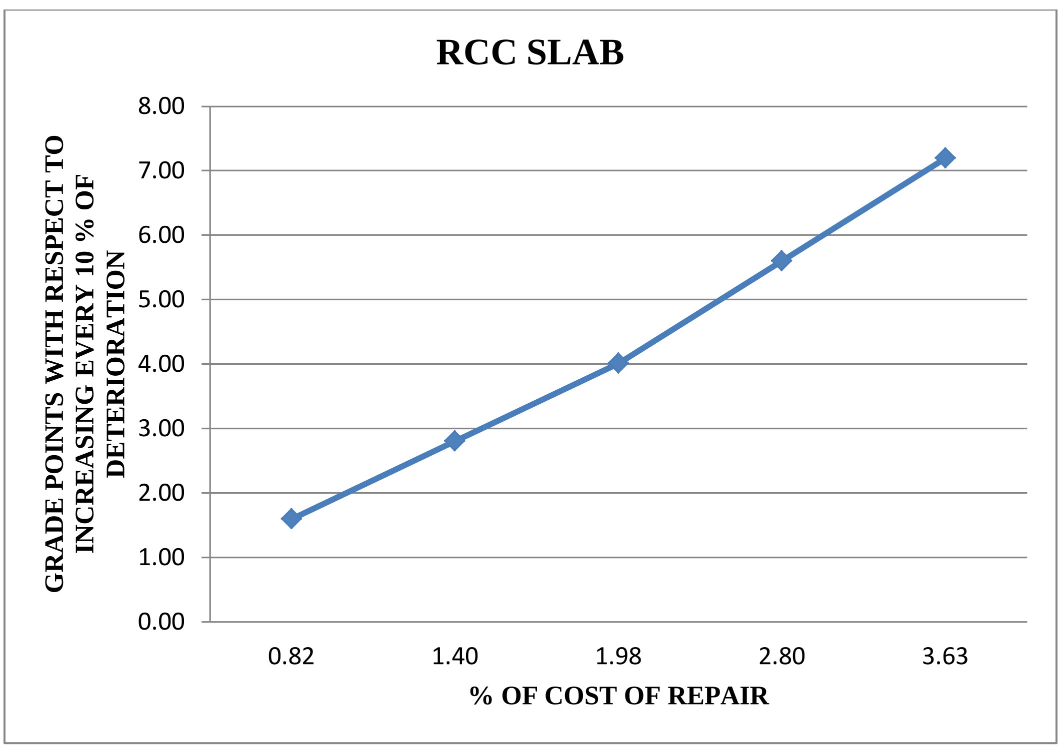

BRICK MASONRY
GRADE POINTS WITH RESPECT TO INCREASING EVERY 10 % OF DETERIORATION
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
1.50
3.00
4.50
6.00
7.50
% OF COST OF REPAIR


FLOORING
GRADE POINTS WITH RESPECT TO INCREASING EVERY 10 % OF DETERIORATION
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0.30
0.60
0.90
1.20
1.50
% OF COST OF RAPAIR


RCC COLUMN
GRADE POINTS WITH RESPECT TO INCREASING EVERY 10 % OF DETERIORATION
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0.30
0.60
0.85
1.20
1.55
% OF COST OF REPAIR



RCC BEAM
GRADE POINTS WITH RESPECT TO INCREASING EVERY 10 % OF DETERIORATION
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.24
0.40
0.56
0.80
1.04
% OF COST OF REPAIR



RCC SLAB
GRADE POINTS WITH RESPECT TO INCREASING EVERY 10 % OF DETERIORATION
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
0.82
1.40
1.98
2.80
3.63
% OF COST OF REPAIR

CHAPTER – 6

APPLICATION OF THE EXPERT TOOL AS AN EXAMPLE CASE

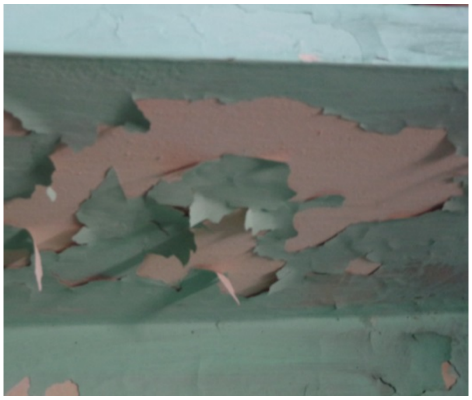
6.1 INTRODUCTION

The application of expert tool is needed to verify its authenticity, to verify its user friendly and accuracy. An example building is taken for its application to assess its grades and cost of repairs. In this example all the damaged / deteriorated parts has been taken Fig.s, This Fig.s are compared with the tool images to classify the category of damage like minor, medium or major. According to the degree of damageability, grade points has been given. After the grade points its assessed its percentage of damages/deterioration and approximate cost of repair in percentage to the half of its newly construction cost of that particular item. The quantity (area) of deterioration is measured and the same is entered in the estimation sheet, immediately approximate cost of repair work in rupees has come for conclusion to the user whether go for repair or reconstruction. The basic rates are given for the materials and labour which can be modified at any time as per the prevailing market rates. Once modifying the basic rates accordingly this tools is calculate the present cost of repair rates.

The following excel sheets shown as

- Visible observations
- Identification of the category
- Grade points
- Estimation for repair
- Basic rates for materials and labour
- Analysis of rates

6.2 PHOTOS SHOWN THE PARTS OF DETERIORATION BUILDING



Interior **Exterior**

MINOR - DETERIORATION OF PAINTS

MEDIUM - DETERIORATION OF PAINTS

MAJOR - DETERIORATION OF PAINTS

MINOR - DETERIORATION OF PLASTERING

MEDIUM - DETERIORATION OF PLASTERING

MAJOR - DAMAGES OF PLASTERING

MINOR EFFECT OF DAMPNESS

MEDIUM EFFECT OF DAMPNESS

MAJOR EFFECT OF DAMPNESS

MINOR - DETERIORATION OF BRICK MASONRY

MEDIUM DETERIORATION OF BRICK FLOORING

MAJOR DETERIORATION OF FLOORING

MINOR DETERIORATION OF RCC COLUMN

MEDIUM DETERIORATION OF RCC COLUMN

MAJOR DETERIORATION OF RCC COLUMN

MINOR DETERIORATION OF RCC BEAM

MEDIUM DETERIORATION OF RCC BEAM

MAJOR DETERIORATION OF RCC BEAM

MINOR DETERIORATION OF RCC SLAB

MEDIUM DETERIORATION OF RCC SLAB

MAJOR DETERIORATION OF RCC SLAB

Example Table 6.1

ASSESSMENT LOCATIONS

Quantity to be filled by Observer			Percentage of deteriorations			TOTAL
Minor (convert to medium, if reach max. value)	Medium (convert to major, if reach max. value)	Major (recon-struct, if reach max. value)	Minor (in %)	Medium (in %)	Major (in %)	
4	5	2	1.14	4.76	5.71	11.62
2	3	2	0.50	3.75	5.00	9.25
1	2	1	0.46	2.05	2.31	4.82
6	0	0	2.77	0.00	0.00	2.77
0	2	1	0.00	2.22	2.67	4.89
2	2	1	2.00	4.44	4.17	10.61
4	2	2	3.76	3.92	9.41	17.10
1	1	1	0.86	1.90	5.00	7.76

Example Table 6.2

GRADE POINTS

Grade points based on assessment			Total Points	cost of repair (in % of total cost of new construction)
Minor	Medium	Major		
0.04	0.17	0.20	0.41	0.12
0.00	0.30	0.40	0.74	0.40
0.06	0.27	0.30	0.63	0.05
0.36	0.00	0.00	0.36	0.60
0.00	0.17	0.20	0.37	0.12
0.48	1.07	1.00	2.55	0.31
0.64	0.67	1.60	2.91	0.33
0.12	0.27	0.70	1.09	0.48
		TOTAL	9.04	2.40

Example Table 6.3

ESTIMATION FOR REPAIR WORKS

Item No.	Description of items		Qty.			Units	Rate per unit			Cost of repair			Total Amount (Rs.)
			Minor	Medium	Major		Minor	Medium	Major	Minor	Medium	Major	
1	Paints	Interior	20	0	0	sq.m	33	44	277	660	0	0	660
		Exterior	20	15	20	sq.m	52	63	296	1040	945	5920	7905
2	Plasters		10	30	24	sq.m	296	278	522	2960	8340	12528	23828
3	Dampness		10	20	18	sq.m	378	5101	5360	3780	102020	96480	202280
4	Brick Masonry		15	0	0	sq.m	338	522	768	5070	0	0	5070
5	Flooring		0	18	6	sq.m	446	1298	1744	0	23364	10464	33828
6	RCC Beams (size 300 x 450 mm)		6	6	12	sq.m	526	1990	5310	3156	11940	63720	78816
7	RCC column (size 300 x 300 mm)		4	4	4	sq.m	752	1764	5093	3008	7056	20372	30436
8	RCC Slab (Thickness 150 mm)		3	3	6	sq.m	522	996	2234	1566	2988	13404	17958
								Total Cost	Rs.	21240	156653	222888	400781

Example Table 6.4

BASIC RATES - MATERIALS

Sl.No.	Description	Rate	Per unit
1	Bricks Ist class	5.50	1 No.
2	Bricks 2nd class	5.00	1 No.
3	River sand	1,000.00	Cu.m
4	Stone crushed powder	840.00	Cu.m
5	Marble dust	900.00	Cu.m
6	Coarse aggregate - 6mm	1,400.00	Cu.m
7	Coarse aggregate - 10mm	1,300.00	Cu.m
8	Coarse Aggregate -12mm	1,200.00	Cu.m
9	Coarse Aggregate -20mm	1,200.00	Cu.m
10	Coarse Aggregate -40mm	1,100.00	Cu.m
11	Dehradun White Lime	500.00	Quintal
12	Slake Lime	600.00	Quintal
13	Unslake Lime	300.00	Quintal
14	White Cement	15,000.00	Tonne
15	White Cement	21,600.00	Cu.m
16	White Cement	15.00	Kg
17	Ordinary Portland cement	5,500.00	Tonne
18	Portland cement	7,920.00	Cu.m
19	OPC	5.50	Kg
20	Primer	40.00	kg
21	Brick aggregate	500.00	Cu.m
22	Dry Distemper	35.00	Kg
23	Oil bound washable distemper / Acrylic distemper	50.00	Kg
24	White Cement base putty	25.00	Kg
25	Enamel paint	160.00	Litre
26	Synthetic enamel paint	140.00	Litre
27	Epoxy paint	200.00	Litre
28	Acrylic emulsion	180.00	Litres
29	Weather sealant	460.00	600 ml
30	Primer for cement paint	90.00	Litre

BASIC RATES – MATERIALS contd..

Sl.No.	Description	Rate	Per unit
31	Water proofing Cement paint	50.00	Kg
32	Water proofing materials	32.00	kg
33	Tile fixing chemical adhesive	34.00	kg
34	Cement Polymer Grout Compound	34.00	kg
35	Acid for cleaning tiles	16.00	Litre
36	Vitrified floor tile 50x50 cm	745.00	sq.m
37	Sundries etc items	5.00	LS
38	twisted steel bar	4,700.00	quital
39	centering, shuttering	145.00	sq.m
40	Epoxy grouting	550.00	Kg
41	Polyvinyl chloride sheet 400 micron thick	40.00	sq.m
42	Chemical ASTMC-type I Coverage of chemical 5 sqm per kg.	120.00	Kg

Example Table 6.5

BASIC RATES – LABOUR

Sl.No.	Descrition	Rate per day
1	Mazdoor (skilled)	350
2	Blacksmith 1 st class	400
3	Blacksmith 2nd class	350
4	Mazdoor (semi-skilled)	300
5	Coolie	300
6	Mason 1 st class	550
7	Mason 2nd class	500
8	Mate	350
9	Painter	400
10	White Washer	350

6.6 ANALYSIS OF RATES

6.6.1 PAINTS

Item No.	DESCRIPTION OF ITEM	Qty.	Per	Rate	Amount
1	Removing dry or oil bound distemper, water proofing cement paint and the like by scrapping, sand papering and preparing the surface smooth including necessary repairs to scratches etc. complete				
	Details of cost for 10 sqm.				
	Mazdoor - semi skilled (Belder)	0.11	day	300.00	33.00
	Coolie	0.05	day	300.00	15.00
	Mazdoor - skilled (Bhisti)	0.05	day	350.00	17.50
	Scrapper, sand paper etc.	6.24	LS	5.00	31.20
	Sundries including mortar to repair th surface	1.82	LS	5.00	9.10
					105.80
		Rate for 1 sq.m		**Rs.**	**11.00**
2	Distempering with oil bound washable distemper of approved brand and manufacture to give an even shade on old work (one or more coats).				
	Details of cost for 10 sqm.				
	Oil bound washable distemper/ Acrylic distemper	1.00	kg	50.00	50.00
	Brushes, putty etc.	0.52	LS	5.00	2.60
	Sundries including carriage	10.79	LS	5.00	53.95
	Painter	0.33		400.00	132.00
	Coolie	0.17		300.00	51.00
	Sundries	7.15		5.00	35.75
					325.30
		Rate for 1 sq.m		**Rs.**	**33.00**

3	Finishing walls with water proofing cement paint of required shade. Old work (one or more coats applied @ 2.20 kg/10 sqm) over priming coat of primer applied @ 0.80 litrs/ 10 sqm complete including cost of Priming coat.				
	Details of cost for 10 sqm.				
	Water proofing cement paint	2.20	kg	50.00	99.00
	Primer for cement paint	0.80	lit	90.00	72.00
	Painter	0.46	day	400.00	184.00
	Coolie	0.23	day	300.00	69.00
	Bhisti	0.05	day	350.00	17.50
	Brushes, sand paper etc	7.15	LS	5.00	35.75
	Sundries	8.06	LS	5.00	40.30
					517.55
		Rate for 1 sq.m		**Rs.**	**52.00**

6.6.2.PLASTERING

4	Repairs to plaster of thickness 12 mm to 20 mm in patches of area 2.5 sq meters and under, including cutting the patch in proper shape, raking out joints and preparing and plastering the surface of the walls complete, including disposal of rubbish to the dumping ground within 50 metres lead. With cement mortar 1:4				
	Details of cost for 10 sqm.				
	Cement mortar 1:4 (1 cement: 4 fine sand)	0.183	cu.m	4531.00	829.17
	Mason 1st class	1.21	day	550.00	665.50
	Coolie	1.29	day	300.00	387.00
	Beldar	0.54	day	300.00	162.00
	Bhisti	0.92	day	350.00	322.00
	Scaffolding and sundries	15.21	LS	5.00	76.05
					2,441.72
		Rate for 1 sq.m		**Rs.**	**244.00**
5	Flush pointing with cement mortar 1:3 (1 cement : 3 fine sand) mixed with 2% of integral water proofing compound by weight of cement for flat tile bricks on top of mud phaska With F.P.S. brick tiles.				
	Details of cost for 10 sqm.				
	Cement mortar 1:3 (1 cement: 3 fine sand)	0.015	cu.m	5561.00	83.42
	Water proofing materials 2% of wt. of cement	0.153	kg	32.00	4.90
	Coolie	0.36	day	300.00	108.00
	Mason 2nd class	0.36	day	500.00	180.00
	Bhisti	0.36	day	350.00	126.00
	Sundries	18.85	LS	5.00	94.25
					596.56
		Rate for 1 sq.m		**Rs.**	**60.00**
6	Grouting the craks of Plastering having of 3 mm width, using epoxy grout mix of 0.70 kg of organic coated filler of desired shade (0.10 kg of hardener and 0.20 kg of resin per kg), including filling/ grouting and finishing complete				
	Details of cost for 1 sqm.				
	Epoxy Grout	0.21	kg	550.00	115.50
	Mason 1st class	0.10	day	550.00	55.00
	Coolie	0.10	day	300.00	30.00
	Sundries including carriage	5.00	LS	5.00	25.00
					225.50
		Rate for 1 sq.m		**Rs.**	**226.00**

6.6.3 BRICK MASONRY

7	Brick work with common burnt clay machine moulded perforated bricks of class designation 12.5 conforming to IS: 2222 in superstructure above plinth level up to floor five level in cement mortar 1:6 (1 cement : 6 coarse sand). With F.P.S. (non modular) bricks.				
	Details of cost for 1 cum.				
	MATERIAL:				
	bricks of 1st class	494.00	Nos.	5.50	2,717.00
	Cement mortar 1 :6	0.25	cu.m	3502.00	875.50
	Sundries	2.73	LS	5.00	13.65
	LABOUR:				
	Mason 1 st class	0.47	day	550.00	258.50
	Mason 2nd class	0.47	day	500.00	235.00
	Coolie	1.80	day	300.00	540.00
	Bhisti	0.20	day	350.00	70.00
	Scaffolding	22.36	LS	5.00	111.80
	Coolie	1.13	day	300.00	339.00
					5,160.45
		Rate for 1 sq.m		**Rs.**	**5,160.00**

8	Brick work 7 cm thick with common burnt clay F.P.S. (non modular) brick of class designation 12.5 in cement mortar 1:3 (1 cement : 3 coarse sand) in superstructure above plinth level and upto floor five level.				
	Details of cost for 10 sqm.				
	MATERIAL:				
	bricks 2nd class	377.00	Nos.	5.00	1,885.00
	Cement mortar 1:3	0.18	cu.m	5561.00	1,006.54
	LABOUR:				
	Mason 1st class	0.72	day	550.00	396.00
	Mason 2nd class	0.72	day	500.00	360.00
	Coolie	1.76	day	300.00	528.00
	Bhisti	0.36	day	350.00	126.00
	Sundries and scaffolding	7.15	LS	5.00	35.75
	Coolie	1.29	day	300.00	387.00
					4,724.29
		Rate for 1 sq.m		**Rs.**	**472.00**

6.6.4 CONCRETE

10	Providing and laying cement concrete in columns, pillars, parapets, coping, window sills, fillets, sunken floor, etc. up to floor five level, excluding the cost of centering, shuttering and finishing. 1:1½:3 (1 cement : 1½ coarse sand :3 graded stone aggregate 20 mm nominal size)				
	Details of cost for 1 cum.				
	Stone Aggregate : 20 mm	0.57	cu.m	1200.00	684.00
	Stone Aggregate : 10 mm	0.28	cu.m	1300.00	364.00
	River sand	0.43	cu.m	1000.00	425.00
	Portland Cement	0.40	Tonne	5500.00	2,200.00
	Mazdoor (semi-skilled)	0.90	day	300.00	270.00
	Coolie	0.78	day	300.00	234.00
	Mazdoor (skilled)	0.70	day	350.00	245.00
	Mason 1st class	0.06	day	550.00	33.00
	Mason 2nd class	0.06	day	500.00	30.00
	Hire charges of Concrete Mixer	0.07	LS	5.00	0.35
	Vibrator (Needle type 40 mm)	0.07	LS	325.00	22.75
	Scaffolding	114.40	LS	5.00	572.00
	Sundries	14.30	LS	5.00	71.50
				TOTAL	5,151.60
		Rate for 1 sq.m		**Rs.**	**5,152.00**
11	Reinforced cement concrete work in beams, suspended floors, roofs having slope up to 15° landings, balconies, lintels, window sills, staircases and up to floor five level excluding the cost of centering, shuttering, finishing and reinforcement, with 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size).				
	Details of cost for 1 cum.				
	Stone Aggregate : 20 mm	0.67	cu.m	1200.00	804.00
	Stone Aggregate : 10 mm	0.22	cu.m	1300.00	286.00
	Coarse sand	0.45	cu.m	1000.00	445.00
	Portland Cement	0.32	Tonne	5500.00	1,760.00
	LABOUR:				0.00
	Mason 2nd class	0.24	day	500.00	120.00
	Mazdoor (semi-skilled)	2.75	day	300.00	825.00
	Mazdoor (skilled)	0.90	day	350.00	315.00
				TOTAL	4,555.00
		Rate for 1 sq.m		**Rs.**	**4,555.00**

12	Reinforced cement concrete work in vertical and horizontal fins individually or forming box louvers, facias and eaves boards up to floor five level excluding the cost of centering, shuttering, finishing and reinforcement, with 1:1½:3 (1 cement : 1½ coarse sand : 3 graded stone aggregate 20 mm nominal size).				
	Stone Aggregate : 20 mm	0.62	cu.m	1200.00	744.00
	Stone Aggregate : 10 mm	0.18	cu.m	1300.00	240.24
	Coarse sand	0.28	cu.m	1000.00	280.50
	Portland Cement	0.26	Tonne	5500.00	1,452.00
	Mazdoor (semi-skilled)	0.79	Day	300.00	237.00
	Coolie	0.56	Day	300.00	168.00
	Mazdoor (skilled)	0.60	Day	350.00	210.00
	Mason 1st class	0.06	Day	550.00	33.00
	Mason 2nd class	0.06	Day	500.00	30.00
	Scaffolding	30.16	LS	5.00	150.80
				TOTAL	3,545.54
		Rate for 1 sq.m		**Rs.**	**3,546.00**
13	Smooth finishing of the exposed surface of RCC work with 6mm thick cement mortar 1:3 (1 cement : 3 fine sand).				
	Details of cost for 10 sqm.				
	Cement mortar 1:3	0.07	cu.m	5561.00	400.39
	Mason 2nd class	0.51	Day	500.00	255.00
	Coolie	0.75	Day	300.00	225.00
	Mazdoor (skilled)	0.92	Day	350.00	322.00
	Extra for removing burrs, cleaning with wire brushes pock marking with pointed tool etc. complete	13.39	LS	5.00	66.95
	Scaffolding and Sundries	11.70	LS	5.00	58.50
				TOTAL	1,327.84
		Rate for 1 sq.m		**Rs.**	**133.00**
14	Supplying and applying pre tested and approved water based concrete curing compound to concrete/ masonry surface, all as per manufacturer's specification and direction of Engineer-in-charge.Non pigmented wet curing compound.				
	Details of cost for 10 sqm.				
	Chemical ASTMC-type I Coverage of chemical 5 sqm per kg.	2.00	Kg	120.00	240.00
	Mason 2nd class	0.46	Day	500.00	230.00
	Coolie	0.23	Day	300.00	69.00
	Mazdoor (skilled)	0.10	Day	350.00	35.00
	Scaffolding and sundries	8.06	LS	5.00	40.30
	Mazdoor (semi-skilled)	0.75	Day	300.00	225.00
	Extra machinery, hand pump, compressor etc.	80.00	LS	5.00	400.00
				TOTAL	1,239.30
		Rate for 1 sq.m		**Rs.**	**124.00**

15	Grouting the craks of Plastering having of 3 mm width, using epoxy grout mix of 0.70 kg of organic coated filler of desired shade (0.10 kg of hardener and 0.20 kg of resin per kg), including filling/ grouting and finishing complete				
	Details of cost for 1 sqm.				
	Epoxy Grout	0.21	kg	510.00	107.10
	Mason 1st class	0.10	day	550.00	55.00
	Coolie	0.10	day	300.00	30.00
	Sundries including carriage	5.00	LS	5.00	25.00
					217.10
		Rate for 1 sq.m		**Rs.**	**217.00**

16	Dismantling and Demolishing Disposal of Chipping / Dismantling of contaminated concrete and guide wall etc. with all leads as per item no.	1	cu.m	1238	1,238.00

6.6.5 DAMP PROOF COURSE

17	Providing and laying water proofing treatment to vertical and horizontal surfaces of depressed portions of W.C., kitchen and the like consisting of: i) Ist course of applying cement slurry @ 4.4 Kg/ sqm mixed with water proofing compound conforming to IS : 2645 in recommended proportions including rounding off junction of vertical and horizontal surface. ii) IInd course of 20 mm cement plaster 1:3 (1 cement : 3 coarse sand) mixed with water proofing compound in recommended proportion including rounding off junction of vertical and horizontal surface. iii) IIIrd course of applying blown or residual bitumen applied hot at 1.7 kg per sqm of area. iv) IVth course of 400 micron thick PVC sheet. (Overlaps at joints of PVC sheet should be 100 mm wide and pasted to each other with bitumen @ 1.7 Kg/sqm).				
	Details of cost for 10 sqm.				
	Portland Cement	0.044	T	5500.00	242.00
	Cement plaster 1:3 (20 mm thick)	0.224	cu.m	5561.00	1,245.66
	Mason 2nd class	0.94	day	500.00	470.00
	Coolie	1.02	day	300.00	306.00
	Bhisti	1.1	day	350.00	385.00
	Scafolding and sundries	12.61	LS	5.00	63.05
	Polyvinyle chloride sheet 400 micron thick	10	sqm	40.00	400.00
	Water proofing materials @ 1 kg per 50 kg of cement used Cement slurry = 44 kg	3.6	kg	32.00	115.20
	Painter	0.2	day	400.00	80.00
	Beldar	1.33	day	300.00	399.00
	Mason 1st class	0.06	day	550.00	33.00
	Sundries	7.28	LS	5.00	36.40
				TOTAL	3,775.31
		Rate for 1 sq.m		**Rs.**	**378.00**

18	Providing and laying integral cement based water proofing treatment including preparation of surface as required for treatment of roofs, balconies, terraces etc consisting of following operations: a) Applying a slurry coat of neat cement using 2.75 kg/ sqm of cement admixed with water proofing compound conforming to IS.2645, over the RCC slab including adjoining walls upto 300 mm height including cleaning the surface before treatment. b) Laying brick bats with mortar using broken bricks/brick bats 25 mm to 115 mm size with 50% of cement mortar 1:5 (1 cement : 5 coarse sand) admixed with water proofing compound conforming to IS : 2645, over 20 mm thick layer of cement mortar of mix 1:5 (1 cement : 5 coarse sand) admixed with water proofing compound conforming to IS : 2645, height including rounding of junctions of walls and slabs c) After two days of proper curing applying a second coat of cement slurry using 2.75 kg/ sqm of cement admixed with water proofing compound conforming to IS : 2645 d) Finishing the surface with 20 mm thick jointless cement mortar of mix 1:4 (1 cement : 4 coarse sand) admixed with water proofing compound conforming to IS: 2645, including laying glass fibre cloth of approved quality in top layer of plaster and finally finishing the surface with trowel with neat cement slurry and making pattern of 300x300 mm square 3 mm deep. e) The whole terrace so finished shall be flooded with water for a minimum period of two weeks for curing and for final test. With average thickness of 120 mm and minimum thickness at khurra as 65 mm.				
	Details of cost for 10 sqm.				
	i) Cement for slurry	0.0275	T	5500.00	151.25
	ii) Cement mortar 1:5 (1 cement: 5 sand)	0.224	cum	3977.00	890.85
	iii) Roof treatment with brick bats and cement mortar				
	Brick Aggregate : 63 mm	0.94	cum	600.00	564.00
	Cement mortar 1:5	0.5	cum	3977.00	1,988.50
	LABOUR:				
	Beldar	1.75	day	300.00	525.00
	Bhisti	0.28	day	350.00	98.00
	Mason 1 st class	0.05	day	550.00	27.50
	Mason 2nd class	0.05	day	500.00	25.00
	Mate	0.04	day	350.00	14.00
	Extra labour for ramming				
	Beldar	0.25	day	300.00	75.00
	Sundries	13.65	LS	2.00	27.30
	iv) Cement for slury	0.0275	T	5500.00	151.25
	Beldar	0.2	day	300.00	60.00
	v) C.M.1:4 - 20 mm thick	10	cum	4531.00	45,310.00
	vi) Water proofing compound	5	kg	32.00	160.00
	Mason 2nd class	0.36	day	500.00	180.00
	Beldar	0.36	day	300.00	108.00
	labour for laying bed mortar	13.65	LS	5.00	68.25
	Mason 2nd class	0.54	day	500.00	270.00
	Beldar	0.54	day	300.00	162.00
	Bhisti	0.45	day	350.00	157.50
				TOTAL	51,013.40
		Rate for 1 sq.m		**Rs.**	**5,101.00**

19	Regrading terracing of mud phaska covered with tiles or brick, in cement by dismantling tiles or bricks, removing mud plaster, preparing the surface of mud phaska to proper in cement mortar 1:3 (1 cement : 3 fine sand), including replacing unserviceable tiles slope, relaying mud plaster gobri leaping and tiles or bricks, grouted or bricks with new ones and disposal of unserviceable material to the dumping ground (the cost of the new tiles or brick excluded) within 50 metres lead.				
	(i) Dismantling tiles/bricks in cement mortar including removing mud plaster and cleaning the tiles/bricks				
	Mason 2nd class	0.54	day	500.00	270.00
	Beldar	0.54	day	300.00	162.00
	(ii) Preparing the surface, for mud phuska to proper slope, relaying mud plaster gobri leeping				
	Mason 2nd class	0.27	day	500.00	135.00
	25mm thick mud plaster including gobri leaping				
	Mud mortar	0.24	cu.m	396.00	95.04
	Bhusa	0.084	quital	400.00	33.60
	Gobri mortar	0.12	cu.m	370.00	44.40
	Beldar	0.25	day	300.00	75.00
	cement Mortars 1:3 for grouting	0.061	cu.m	5561.00	339.22
	Mason 2nd class	1.2	day	500.00	600.00
	Beldar	1.5	day	300.00	450.00
	Bhisti	1	day	350.00	350.00
	Disposal of mulba	5.33	L.S.	5.00	26.65
	Sundries	2.73	L.S.	2.00	5.46
				TOTAL	2,586.37
		Rate for 1 sq.m		**Rs.**	**259.00**

6.6.6 FLOORING

20	Providing and laying Vitrified tiles in floor with different sizes (thickness to be specified by the manufacturer), with water absorption less than 0.08% and conforming to IS:15622 , of approved brand & manufacturer, in all colours and shade, laid with cement based high polymer modified quick set tile adhesive (water based) conforming to IS : 15477, in average 6 mm thickness, including grouting of joints (Payment for grouting of joints to be made separately).				
	Details of cost for 1 sqm.				
	Vitrified floor tile 50x50 cm	1.03	Sq.m	745.00	763.63
	High polymer modified quickset tile adhesive	10.00	kg	17.00	170.00
	Mason 1st class	0.20	day	550.00	110.00
	Coolie	0.40	day	300.00	120.00
	Sundries	26.91	LS	5.00	134.55
				TOTAL	1,298.18
		Rate for 1 sq.m		**Rs.**	**1,298.00**

21	52 mm thick cement concrete flooring with concrete hardener topping, under layer 40 mm thick cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 20 mm nominal size) and top layer 12 mm thick cement hardener consisting of mix 1:2 (1 cement hardener mix : 2 graded stone aggregate 6mm nominal size) by volume, hardening compound mixed @ 2 litre per 50 kg of cement or as per manufacturer's specifications. This includes cost of cement slurry, but excluding the cost of nosing of steps etc. complete.				
	Details of cost for 10 sqm.				
	MATERIAL:				
	Stone Aggregate : 20 mm nominal size	0.27	cu.m	1200.00	320.40
	Stone Aggregate : 10 mm nominal size	0.09	cu.m	1300.00	115.70
	sand	0.18	cu.m	1000.00	178.00
	Portland Cement	0.23	Tonne	5500.00	1,265.00
	Hardening compound	2.44	Litre	40.00	97.60
	LABOUR:				
	Mason 2nd class	2.15	day	500.00	1,075.00
	Beldar	1.60	day	300.00	480.00
	Coolie	1.88	day	300.00	564.00
	Bhisti	0.27	day	350.00	94.50
	Sundries	53.82	LS	5.00	269.10
				TOTAL	4,459.30
		Rate for 1 sq.m		**Rs.**	**446.00**

6.7 RATE PER CATEGORY

Sl.N0.	Name of parts	Category	Unit	Item Nos.	Rate
1	PAINTS	MINOR	Int.	2,	33.00
			Ext.	3,	52.00
		MEDIUM	Int.	1,2	44.00
			Ext.	1,3	63.00
		MAJOR	Int.	2,4	277.00
			Ext.	3,4	296.00
2	PLASTERING	MINOR	sq.m	5,3	296.00
		MEDIUM	sq.m	6,3	278.00
		MAJOR	sq.m	3,4,6	522.00
3	DAMPNESS	MINOR	sq.m	3,17	378.00
		MEDIUM	sq.m	18,	5,101.00
		MAJOR	sq.m	18,19	5,360.00
4	MASONRY	MINOR	sq.m	3,5,6	338.00
		MEDIUM	sq.m	6,4,3	522.00
		MAJOR	sq.m	8,4,3	768.00
5	FLOORING	MINOR	sq.m	20	446.00
		MEDIUM	sq.m	21	1,298.00
		MAJOR	sq.m	20,21	1,744.00
6	RCC COLUMN	MINOR	sq.m	15,3,6,13,14	752.00
		MEDIUM	cu.m	16,14,15,13,3	1,764.00
		MAJOR	cu.m	3,12,13,14,16	5,093.00
7	RCC BEAM	MINOR	sq.m	3,13,14,15	526.00
		MEDIUM	cu.m	3,6,13,14,15,16	1,990.00
		MAJOR	cu.m	3,12,13,14,15,16	5,310.00
8	RCC SLAB	MINOR	sq.m	3,4,6	522.00
		MEDIUM	sq.m	3,4,6,13,14,15	996.00
		MAJOR	sq.m	3,4,6,13,14,15,16	2,234.00

C O N C L U S I O N

The following conclusion can be drawn for the study and the project work.

- The Rapid Visual Screening (RVS) method is important for Condition Assessment of buildings. It is important to provide technological inputs such as use of Excel program in line with RVS procedures.

- There may be different causes of degradation in buildings. These causes may be classified into various categories.

- The deterioration in buildings is reflected in the form of effect of various types.

- Percentage of cost of repair in buildings is connected to grade points provided to different structural components.

- Percentage of repairs increases for increasing percentage of deterioration.

- Percentage cost of repair with respect to different components such as paints, plastering, dampness, etc,. is different in each case, This is dependent on the grade points provided to different parameters such as minor, medium and minor.

- Comparison of analysis of rates with RVS procedure may work as an efficient tool for repair of buildings.

SCOPE OF FUTURE STUDIES

The scope of further study may include some of the following aspects.

1. Further modification of the tool to take up new parameters

2. Modification for different types of events such as earthquake, floods, Tsunami etc.

3. Inclusion of financial aspects including insurance consideration.

4. Use of aspects such as Fuzzy logic and artificial neural networking etc.

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