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Structural Audit Of (G+7) Multistorey Building

Mr. Abhinay Balkrushna Tandel[1], Prof. K. S. Ambhore[2]

[1,2]Department of Civil Engineering, Yadavrao Tasgaonkar Institute of Engineering & Technology, Raigad, (M.S), India-410201

A B S T R A C T

Structural audit is the technical survey of the building in order to check its strength and stability. The life cycle of building can be broadly divided into four phases i.e., architectural planning, structural design, construction, repair and maintenance. In most of building at most care is taken in first three cases but repair and maintenance are forgotten. Ignorance to repair and maintenance causes severe structural distress in building over period of time. Structural audit is the first step in repairing procedure of the building. Structural audit is generally recommended for old buildings.

Keywords: Technical Survey, Strength, Construction, Repair

Introduction

In India there are many old buildings which have reduced strength in due course of time. If further use of such deteriorated structure is continued it may endanger the lives of the occupants and surrounding habitation. Appropriate actions should then be implemented to improve the performance of structures and restore the desired function of structures. Thus, it is utmost important to perform structural audit of existing buildings and to implement maintenance/ repair work timely which will lead to prolonged life of the building and safety of the occupant. To act more responsible and preemptive towards the dilapidated buildings, the municipal corporation must issue notices to the buildings and co-operative societies which are more than 30 years old to carry out mandatory structural audit and submit the audit report. Structural audit should highlight and investigate all critical areas and recommend immediate remedial and preventive measures. It should cover the structural analysis of existing frame and find critical elements for all types of loadings.

Literature review

General

As the world move towards the implementation of Performance Based Engineering philosophies in seismic design of Civil Engineering structures, new seismic design provisions require Structural Engineers to perform both linear and nonlinear analysis for the design of structures. Prefabrication of houses, an innovation that has potential to address environmental and sustainability concerns at a rapid pace, mechanizes the construction process, enabling mass manufacture of affordable houses.

Literature review

1. Patil S.R., Prof. Sayyed G.A" Structural Audit" IOSR Journal of Mechanical and Civil Engineering

Civil Engineering Industry is one of the oldest industries which provide a basic infrastructure to all the human beings. Structures can be any kind it can be Historical, Heritage Structure, Residential building, Commercial building or an Industrial building. Every structure has its own service life, and within this service life it should stand firmly on its position. Ex- A Taj Mahal in Agra in India which is one of the oldest structure and Wonders of the World, and still stand on its position very efficiently. But this not a condition about the today's Structures. A collapsed mechanism has increased and today's Structures are getting collapsed before there service life is completed. Therefore, it is advisable to monitor it periodically by taking a professional opinion. Structural Audit is a preliminary technical survey of a building to assess its general health as a civil engineering structure. It is usually initiated as the first step for repair. In this Project a Root Cause of a faulty mechanism of structure and a preventive measure to overcome a failure of this structures.

2.BHAVAR DADASAHEB "Retrofitting of Existing RCC Buildings by Method of Jacketing"

Many parts of the country have suffered earthquake in last three decades. In costal part of South India faced Tsunami. In first three earthquakes it was found that many of damaged structures were built in non-engineered masonry techniques. Unreinforced masonry structures are the most vulnerable during an earthquake. Normally they are designed for vertical loads and since masonry has adequate compressive strength, the structures behave well as long as the loads are vertical. When such a masonry structure is subjected to lateral inertial loads during an earthquake, the walls develop shear and flexural stresses. The strength of masonry under these conditions often depends on the bond between brick and mortar (or stone and mortar), which is quite poor. This bond is also often very poor when lime mortars or mud mortars are used. A masonry wall can also undergo failure in-plane shear, if the inertial forces are in the plane of the wall. Shear failure in the form of diagonal cracks is observed due to this. However, catastrophic collapses take place when the wall experiences out-of-plane flexure. This can bring down a roof and cause more damage. Masonry buildings with light roofs such as tiled roofs are more vulnerable to out-of-plane vibrations since the top edge can undergo large deformations. It is always useful to investigate the behavior of masonry buildings after an earthquake, so as to identify any inadequacies in earthquake resistant design. Studying types of masonry construction, their performance and failure patterns helps in improving the design and detailing aspects.

3.P. B. Oni "Performance Based Evaluation of Shear Walled RCC Building by Pushover Analysis" International Journal of Modern Engineering Research (IJMER)

As the world move towards the implementation of Performance Based Engineering philosophies in seismic design of Civil Engineering structures, new seismic design provisions require Structural Engineers to perform both linear and nonlinear analysis for the design of structures. In the present work three storey and six storey building models with plus shape Shear wall have been considered. Equivalent static and response spectrum methods are carried out as per IS:1893 (Part 1) -2002 using finite element analysis software ETABS v9.1.1. Seismic performance is assessed by

pushover analysis as per ATC-40 guidelines for earthquake zone V in India. The paper also deals with the effect of the variation of the building height on the structural response of the shear wall. This paper highlights the accuracy of Push over analysis in comparison with the most commonly adopted Response Spectrum Analysis and Equivalent Static Analysis.

4.Krish R. Villaitramani" PREFABRICATED CONSTRUCTION FOR MASS HOUSING IN MUMBAI" International Journal of Innovative Research in Advanced Engineering (IJIRAE)

Urbanization is the rapid influx of people migrating to cities. The UN has predicted that by 2050, 64.1% and 85.9% of the developing and developed world respectively will be urbanized. With limited resources of labour, time and finance, slums around the world continue to grow in size in uninhabitable conditions for humans. Prefabrication of houses, an innovation that has potential to address environmental and sustainability concerns at a rapid pace, mechanizes the construction process, enabling mass manufacture of affordable houses. This paper discusses the case of Mumbai, the city of maximum slum population density in the world, where prefabrication can be a promising solution to housing scarcity.

Methodology

1. **Visual Survey**

• To recognize the types of structural defect.

• To identify any signs of material deterioration.

• To identify any signs of structural distress and deformation.

• To identify any alteration and addition in the structure, misuse which may result in overloading.

Structural System of the building

• Sub structure: Settlement of columns or foundations, Settlement of walls and floors, Deflection and cracks in Retaining wall, Soil bearing capacity through trial pits or from adjacent soil data

• Super structure: Materials used and framing system of structure, identification of the critical structural members like floating columns, transfer beams, slender members, rusting of exposed steel and its extent.

• Mention the status of all building elements like beams, slabs, columns, balconies, canopy, false ceiling, chajja, parapet and railings with respect to parameters deflection, cracks, leakages and spalling of concrete.

• Likewise, verify the status of water tank, staircase, lift and lift machine room.

2. **Addition or Alterations in the building**

• Identification of change of occupancy.

• Alteration or addition of partition walls.

• Alteration or addition in loadings- stacking.

• Alteration or addition of toilets, water tank.

• Alteration or addition of balcony.

3. **Dampness and leakages**

• Detect the dampness in walls.

• Identify the leakages in Terrace, toilets, plumbing lines, drainage lines and overhead tanks.

4. Non-Destructive Testing

In addition to visual inspection, the real strength and quality of a concrete structure need to be checked with non-destructive tests. A number of non-destructive tests (NDT) for concrete members are available to determine present strength and quality of concrete

4.1 Concrete Strength

• Rebound Hammer Test: To measure surface hardness of concrete.

• Ultrasonic Pulse Velocity Test: To assess homogeneity of concrete, to assess strength of concrete qualitatively, to determine structural integrity.

• Core Sampling and Testing: To measure strength, permeability, density of concrete.

4.2 Chemical Attack

• Carbonation Test: To assess depth of carbonation and pH of concrete.

• Chloride Test: To assess total water/acid soluble chloride contents.

• Sulphate Test: To assess total water/water soluble sulphate contents of concrete.

4.3 Corrosion Potential Assessment

• Cover Meter: To measure cover of reinforcement, diameter of reinforcement and spacing of reinforcement.

• Half Cell Method: To assess probability of corrosion in the embedded steel.

• Permeability Test: To assess permeability of concrete due to water and air

4.3 Homogeneity and integrity Assessment

•Ultrasonic pulse velocity for determination of cracks and discontinuities.

5. REPAIR & REHABILITATION TECHNIQUES

5.1 Rebound Hammer Test: -

• Schmidt Rebound Hammer Test is a most common nondestructive test (NDT) performed on hardened concrete.

• It works on the principle that the rebound of an elastic mass depends on the hardness of the surface against which the mass impinges. 4. Theoretical relationship between the strength of concrete and the rebound number of the hammer.

• The rebound value indicated by the hammer is related empirically to the compressive strength of concrete.

• It is able to provide a quick estimate of the quality of concrete.

5.2 Ultrasonic Pulse Echo Method

The ultrasonic pulse-echo method, or pulse-echo method, is a non-destructive testing technique using ultrasonic waves to find defects in materials.

The principle of the pulse-echo method is shown in Figure. The transmitter (T) generates an ultrasonic pulsed wave which is reflected by an inhomogeneity like a defect or the back wall of the specimen and obtained by the receiver. An ultrasonic pulsed wave is a synthesis of sinusoidal waves with different frequencies and amplitudes.

The ultrasonic pulse-echo method uses two types of waves, the longitudinal waves and the transverse waves. In longitudinal waves the particle motion is in the same direction as the movement of the wave. If the particle movement is at a right angle to the direction of travel of the wave, it is called a transverse

wave, which is only possible in solid materials. Longitudinal waves are always faster than transverse waves. The velocity of sound of both types of waves can be looked up for different materials.

When an ultrasonic wave reaches a boundary between two media, one part of the energy is transmitted through the boundary and another part is reflected. The percentages of energy transmitted and reflected depend on the acoustic impedance.

5.3 Impact echo Method

Impact-Echo is a method for nondestructive evaluation of concrete and masonry, based on the use of impact-generated stress (sound) waves that propagate through the structure and are reflected by internal flaws and external surfaces. Impact-Echo can be used to make accurate, nondestructive, ASTM approved measurements of thickness in concrete slabs and plates, (ASTM Standard C 1383- 98a). It can also be used to determine the location and extent of flaws such

as cracks,delaminating, voids, honeycombing and deboning in plain, reinforced and post-tensioned concrete structures. It can locate voids in the sub grade directly beneath slabs and pavements. It can be used to determine thickness or locate cracks, voids and other defects in masonry structures where the brick or block units are bonded together with mortar. Impact-echo is not adversely affected by the presence of steel reinforcing bars.

5.4 Ultra-Sonic Pulse Velocity Method

Ultrasonic pulse velocity test consists of measuring travel time, T of ultrasonic pulse of 50 to 54 kHz, produced by an electro-acoustical transducer, held in contact with one surface of the concrete member under test and receiving the same by a similar transducer in contact with the surface at the other end.

With the path length L, (i.e., the distance between the two probes) and time of travel T, the pulse velocity (V=L/T) is calculated.

Higher the elastic modulus, density and integrity of the concrete, higher is the pulse velocity. The ultrasonic pulse velocity depends on the density and elastic properties of the material being tested.

5.5 Probe Penetration Test or Windsor Probe Test

Penetration resistance tests on concrete offers a means of determining relative strengths of concrete in the same structure or relative strength of different structures. Because of nature of equipment's, it cannot and should not be expected to yield absolute values of strength. ASTM C-803 gives this standard test method titled "Penetration Resistance of Hardened Concrete".

Windsor Probe is penetration resistance measurement equipment, which consists of a gun powder actuated driver, hardened alloy of probe, loaded cartridges, a depth gauge and other accessories. In this technique a gunpowder actuated driver is used to fire a hardened alloy probe into the concrete. During testing, it is the exposed length of probe which is measured by a calibration depth gauge. But it is preferable to express the coefficient of variation in terms of depth of penetration as the fundamental relation is between concrete strength and penetration depth

The probe a diameter of 6.3mm, length of 73mm and conical point at the tip. The rear of the probe is threaded and screwed into a probe-driving head, which is 12.6mm in diameter and fits snugly along with a rubber washer into the bore of the driver. As the probe penetrates into the concrete, test results are actually not affected by local surface conditions such as texture and moisture content. However, damage in the form of cracking may be cause to slender members. A minimum edge distance and

member thickness of 150mm is required. It is important to leave 50mm distance from the reinforcement present in the member since the presence of reinforcing bars within the zone of influence of penetrating probe affects the penetration depth.

5.6 Ground Penetration Radar Method

Being a low energy device, sensitivity is reduced at higher strengths. Hence it is not recommended for testing concrete having strength above 28 N/sq.mm. in this a spring-loaded device, having energy of about 1.3% of that of Windsor probe, us used to drive 3.56mm diameter, a pointed hardened steel pin into the concrete. The penetration of pin creates a small indentation (or hole) on the surface of concrete. The pin is removed from the hole, the hole is cleaned with an air jet and the hole depth is measured with a suitable depth gauge. Each time a new pin is required as the pin gets blunted after use.

The strength properties of both mortar and stone aggregate influence the penetration depth of the probe in a concrete, which is contrastingly different than cube crushing strength, wherein the mortar strength predominantly governs the strength. Thus the type of stone aggregate has a strong effect on the relation of concrete strength versus depth of penetration.

5.7 Carbonation Test

Concrete chemistry is obviously tough to understand for a small house owner. Spending some amount towards concrete carbonation test is an excellent idea to know the effect of the atmospheric CO_2 on the RCC structure. The concrete carbonation test for in-situ concrete is associated with the corrosion of reinforcement steel. Due to the concrete carbonation, reinforcement corrosion often occurs on the building facades which are exposed to moisture, rainfall and shaded from sunlight. The steel corrosion in concrete also occurs due to the carbonation, when the concrete has a least cover over the steel reinforcement. Carbonation of concrete is associated with the corrosion of steel reinforcement and with shrinkage. However, it also increases both the compressive and tensile strength of concrete, so not all of its effects on concrete are bad. Carbonation is the result of the dissolution of CO_2 in the concrete pore fluid and this react with calcium from calcium hydroxide and calcium silicate hydrate to form calcite ($CaCO_3$). Aragonite may form in hot conditions.

Within a few hours, or a day or two at most, the surface of fresh concrete will have reacted with CO_2 from the air. Gradually, the process penetrates deeper into the concrete at a rate proportional to the square root of time. After a year or so it may typically have reached a depth of perhaps 1 mm for dense concrete of low permeability made with a low water/cement ratio, or up to 5 mm or more for more porous and permeable concrete made using a high water/cement ratio.

5.8 Half Cell Potential Meter Test

The half-cell potential test is the only corrosion monitoring technique standardized by ASTM. It is used to determine the probability of corrosion within the rebar in reinforced concrete structures. This blog dives into the specifics of concrete corrosion, the half-cell potential technique for testing concrete corrosion, and the ways in which the data from the half-cell potential test can be interpreted.

The Basics of Concrete Corrosion In reinforced concrete structures, there is a natural protective film that forms on the surface and prevents the bar from corroding. With time, chlorides (from de- icing salts or marine exposure) and/or CO2 penetrate the concrete and breakdown that protective layer. Chlorides destabilize the passive film leading to its localized breakdown, while CO2 lowers the pH of the concrete below the level of stability of the passive film. In the presence of oxygen and water, an electrochemical reaction initiates the process of corrosion.

Corrosion can be illustrated as shown in Figure 1, where the metal (rebar) reacts in the solution (available in the concrete pores) and gives away electrons from the anode (where oxidization occurs) to the cathode (where reduction occurs). The positive ions formed at the surface of the anode will react and create corrosion by-products. This electrochemical reaction creates a potential difference, and consequently a corrosion current, between the anodic and cathodic areas at the surface of the steel reinforcement. This current, or the potential distribution on the reinforcement surface, is what is of interest when measuring half-cell potential.

Inspection of Building

1. **Details of Inspection**

1.1 R.C.C. WORK

Framed structures are comprised of number of frames. These frames are formed of columns that are interconnected by mean of beams at floor and roof levels forming a grid. In order to carry various floor loads, the slabs are built monolithically. Within these frames panel, filler or screen walls are constructed. The load of floors, roofs & panel walls are supported by the beams, which transmit these loads to columns, these columns finally carry the whole weight of the structure to the foundation. R.C.C. frames are invariably of monolithic construction by which full continuity throughout columns, beams & slabs (of floor & roofs) can be attained.

- **OBSERVATIONS**

1. Internal as well as external structural members observed damaged at some places. Some external beams and chajjas are found in extremely damaged conditions which needs urgent repair works.

2. Reinforcement corroded badly observed at many places.

3. Spilling of concrete cover is observed at many places.

4. Lintel beams are found cracked at many places.

- **REMEDIAL MEASURES**

Various methods of treating Damaged RCC Members:

i. Polymer built up method.

ii. Micro concrete work.

iii. R.C.C. casting work

1.2 EXTERNAL PLASTER

Plastering is the process in the construction of houses and other civil structures with a plastic material called plaster or mortar of different compositions. It is an intimate mixture of Portland cement and sand with required water to make a plastic mass

- **OBSERVATIONS**

1. External plaster has been cracked & damaged at various places.

2. Fungal growth observed in plaster at many places.

3. Vegetation cracks are also found on external plaster.

4. Separation Cracks are also found on external plaster.

- **REMEDIAL MEASURES**

Formation of the new cracks in the external walls is the ongoing process pf the nature. The process can be delayed by the following ways:

i. Regular repair and maintenance of the external walls.

ii. Avoiding vegetation growth over the wall surface. cut the vegetation growth from its root. Treat the root area by grouting “weedycide” as per the manufacturer’s specification. Remove the dried roots.

iii. Crack filling work at regular intervals.

iv. Avoiding damages of walls by nailing inside the walls for erecting air condition units, Dish antenna, Mobile tower cable, putting advertise holdings, Banners.

1.3 WATER PROOFING SYSTEM

Water proofing describes making an object water proof or water resistant. In a building structure there are several areas which required water proofing systems. The external areas are terrace slab, parapet wall top, lift room top, staircase top, balcony top, chajja top. The internal areas are bathroom areas, water closet areas, kitchen nahani trap area

- **OBSERVATIONS**

i. No leakage are observed in terrace flats as shed is provided on terrace.

ii. Dish antenna fixed on parapet wall, damaging the parapet wall which are the source of leakages.

iii. External leakages through walls and chajjas are observed at many places. Internal toilet leakages and leakage in kitchen sink area are also observed at many flats.

iv. seepage due to capillary action is also observed at many ground floor flats.

- **REMEDIAL MEASURES**

a. Terrace Waterproofing by conventional method.

b. Terrace Waterproofing by Top coat method.

c. Terrace Waterproofing by chemical Coating method.

BILL OF QUANTITY

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL AMOUNT
	A. SUB STRUCTURE				
	1. EARTH WORKS				
1.1	Execute site clearing to an average depth of 20cm to remove top organic soil. Price also includes grabbing roots and tree stamps where such are encountered	m²	765.5	12.38	9476.89
1.2	Execute deep excavation in ordinary soil for septic tank to an average depth of not exceeding 300cm	m³	63	136	8568
1.3	Pit excavation in soft rock to a depth not exceeding 150 cm	m3	-	-	
1.4	footing excavation in soft rock to a depth greater than 150 cm but not exceeding 200cm	m3	810.3	136	1,10,200.80
1.5	Trench excavation in ordinary soil forconstruction of stone masonry under grad beams	m3	53.76	80.51	4328.21
1.6	Fill around foundation with selected granular material imported from outside and compact in layers not exceeding 20 cm thick	m3	521.5	133.58	69661.97
1.7	Cart away and spread surplus excavated material to municipality approved fill site	m³	494.88	45.53	22531.88
1.8	Supply and pack 25cm thick hard core bedding to semi basement slab in basaltic stone	m²	618	108.2	66867.6

	orequivalent, voids and surface filled and blind with hand crushed and chips of same stone				
Total carried to summary					**2,91,635.35**

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL AMOUNT
	2. STONE MASONRY				
2.1	Supply and construct stone masonry foundation wall bedded and joined in 1:4 cement mortar below natural ground level	m^3	35.85	995.6	35,692.28
2.2	Ditto as item 2.1 above natural ground level	m^3	10	1200	12,000.00
Total carried to summary					**47,692.28**

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL AMOUNT
	3. CONCRETE WORKS				
3.1	Supply and cast 5cm thick lean concrete in C-5 concrete quality with minimum cement content of 150Kg/ m3 under:				
a)	Isolated footing	m2	344.96	70	24,147.20
b)	Stone masonry	m^2	35.85	70	2,509.50
c)	Ground floor grade beams.	m^2	35.85	70	2,509.50
3.2	Supply and cast according to design reinforced concrete class C-25, prepared following mix design based on laboratory test, into form work and vibrated around steel reinforcement bars (Steel reinforcement bars and form work measured separately) for:				
a)	footing pad	m3	275.97	2799.8	7,72,660.80
b)	Foundation column	m3	8.45	2799.8	23,658.31
c)	Ground floor grade beams.	m3	33.1	2799.8	92,673.38
d)	Ground floor slab (10cm thick) with C-15	m^2	430.92	330	1,42,203.60
3.3	Provide and fix in position steel panel form work for:				
a)	Isolated footing	m^2	394.24	140	55,193.60
b)	Foundation column	m^2	84.48	140	11827.2
c)	Ground floor grade beams	m^2	226	140	31,640.00
3.4	Provide and put in place steel reinforcements of the following type and diameter according to structural drawings. Price includes tying wire and brushing bars off elements compromising essential bondage with concrete				
a)	Dia. 6 mm deformed bar	kg	342.89	29.93	10,262.70
b)	Dia. 8 mm deformed bar	kg	1230	29.93	36,813.90
c)	Dia. 10 mm deformed bar	kg	3250	29.93	97,272.50
d)	Dia. 12 mm deformed bar	kg	3840	29.93	1,14,934.20
e)	Dia. 14 mm deformed bar	kg	4578.67	29.93	1,37,039.60
g)	Dia. 24 mm deformed bar	kg	5900	29.93	1,76,587.00
Total carried to summary					**17,31,930.60**

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL AMOUNT
	B. SUPERSTRUCTURE				
	1. CONCRETE WORKS				
1.1	Supply and cast according to design reinforced concrete class C-25, prepared following mix design based on laboratory test, into form work and vibrated around steel reinforcement bars (Steel reinforcement bars and form work measured separately) for:				
a)	Elevation columns.	m^3	128.13	2799.8	3,58,738.30
b)	Intermediate beam	m^3	356.01	2799.8	9,96,765.20
c)	15cm suspended floor slab	m^2	159.2	2799.8	4,45,728.20
d)	Top tie beam	m^3	25.43	2799.8	71,198.90
e)	Stair case and landing	m^3	40.1	2799.8	1,12,271.98
f)	Ribbed slab toppings	m^3	25.76	2799.8	72,122.85
g)	Shear walls	m^3	18.9	2799.8	52,916.22
1.2	Provide and fix in position steel panel or wooden form work whichever is appropriate for:				
a)	Elevation columns	m^2	133.1	140	18634
b)	Intermediate beam	m^2	847.5	140	1,18,650
c)	15cm suspended floor slab	m^2	120	140	16800
d)	Top tie beam	m^2	226	140	31,640
e)	Stair case and landing	m^2	95.7	140	13,398
f)	for shear walls	m^2	235.2	140	32,928
1.3	Provide and put in place steel reinforcements of the following diameter and type according to structural drawings. Price includes tying wire and brushing bars off elements compromising essential bondage with concrete				
a)	Dia. 6 mm deformed bar	Kg	4890.98	29.93	1,46,387.03
b)	Dia. 8 mm deformed bar	Kg	8890	29.93	2,66,077.70
c)	Dia. 10 mm deformed bar	Kg	12976	29.93	388371.68
d)	Dia. 12 mm deformed bar	Kg	16790	29.93	502524.7
e)	Dia. 14mm deformed bar	Kg	34980	29.93	1046951.1
f)	Dia. 16 mm deformed bar	Kg	22459	29.93	672197.87
g)	Dia. 20 mm deformed bar	Kg	13438	29.93	402199.34
h)	Dia. 24 mm deformed bar	Kg	9809	29.93	293583.37
Total Carried to Summary					**33,41,791.65**

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL AMOUNT
	2. BLOCK WORKS AND PARTITION WALL				
2.1	20cm thick class C HCB wall both sides left for plastering; bedded in cement mortar (1:3).Price shall include mortar bed	m^2	737.81	301.14	2,22,184.10

2.2	10cm thick class C HCB wall both sides left for plastering; bedded in cement mortar (1:3).Price shall include mortar bed	m²	599.52	252	1,51,079.04
Total Carried to Summary					**3,73,263.14**

ITEM	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL AMOUNT
	3. ROOFING WORKS				
3.1	Supply and fix G-30 EGA sheet roof cover. Price also includes fixing accessories. Horizontal projection is taken and trusses and purloin measured separately	m2	721.67	147.15	1,06,193.70
3.2	Supply and fix G-30 galvanized flat metal sheet gutter dev. length 50cm. Price includes two coats of anti-rest paint and three coats of synthetic enamel paint	ml	85	82.86	7043.1
3.3	Supply and fix G-28 galvanized flat metal sheet copping dev. Length 50cm. Price includes two coats of anti-rest paint and three coats of synthetic enamel paint	ml	35	64.59	2260.65
3.4	Supply and fix PVC down pipe with its Dia. 80 mm	ml	25	36.18	904.5
Total Carried to Summary					**1,16,401.95**

SUMMARY SHEET		
Sr.No.	**DESCRIPTION**	**AMOUNT (BIRR)**
A Sub-Structure		
1	Earth Work	2,91,635.35
2	Stone Masonry	47,692.28
3	Concrete Work	17,31,930.60
Sub-Total A		**20,71,258.23**

B Super-Structure		
1	Concrete Work	33,41,791.65
2	Block Work	3,73,263.14
3	Roofing Work	1,16,401.95
4	Carpentry & Joinery Works	3,40,189.56
5	Metal Works	18,20,270.50
6	Finishing Works	29,63,217.20
7	Glazing Work	2,16,000.00
8	Painting Work	2,94,756.00
9	Sanitary Installation Work (15%)	17,30,572.20
10	Electrical Installation Work (15%)	17,30,572.20
Sub-Total B		**1,49,98,290.58**
Total Summary A + B		**1,70,69,548.58**

CONCLUSIONS AND RECOMMENDATIONS

- The following are the observations pertaining to the structure: -
- Internal as well as external structural members observed damaged at some places. Some external beams and chajjas are found in extremely damaged conditions which needs urgent repair works.
- Leakages/ seepages are observed eternally in toilet and kitchen sink area. Eternal leakages through walls and chajjas are also observed.
- Dish antenna fixed and parapet wall, external wall and entrance loft are also observed.
- Lintels beams found damaged at some places.
- The G.I. and PVC down take pipe line appeared to be in working condition. Plumbing leakage was observed.
- Several cracks and fungal growth were observed over the external façade of the building.
- Vegetation growth is also observed.
- The structure shows several types of damages and distress. However, looking at the nature and extend thereof, it can be concluded that the structure is in repairable condition. Hence necessary repair is suggested in recommendation are required so as to restore it to structurally sound condition.
- Leakages / seepages commonly observed in the building, along with their distresses noted in the building require urgent attention for corrective measure.

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