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COMPARISON OF RESTORATION TECHNIQUES FOR PUBLIC HERITAGE BUILDINGS

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ABSTRACT

Heritage buildings represent past history, culture of country and constitute architectural heritage of the region. Many of the heritage buildings are still in workable condition and they are deteriorating rapidly. Heritage building conservation is a complicated task that follows some strict guidelines and procedures. Hence their conservation and restoration is civil engineer's obligation. This paper reviews about the classification of the common defects occurring in heritage buildings and the methods to repair the defects. The methodologies to handle common problems with respecting the integrity of the structure. It represents the comparison of the methods of repair and restoration on the basis of cost and time. The objective of the paper is to identify the differences in the duration to restore building by repairing the defects theoretically and actually on the field. Also it seeks to highlight the cost increase of the project due to variation between market rates and estimated rates as per DSR. The major defects identified are discussed with the help of case study and a suitable and economical solution for a particular defect is suggested.

Keywords: Heritage Buildings, restoration, conservation, techniques.

I. INTRODUCTION

Heritage structures perform very important role in nation's history, culture and specify the richness of it. To augment life and enhance strength, their restoration, conservation, preservation is very important for the future generations to have knowledge about how mankind lived in past ages. India has a very rich historic background which is evident from various buildings, forts, temples, objects of historic era. Many of these were constructed several hundred years ago when the Indian Civilization was at its peak. Their architecture, design and construction at the time when computers, code of practice, design guidelines, research institutions and modern construction techniques did not exist makes one to realize the wisdom and expertise forefathers.

India is country, with thousands of years history, have a very diverse and rich architectural heritage. Great civilisation was developed grown here. Each region of our subcontinent boasts of monumental buildings and remarkable archaeology. Yet, less than 15,000 monuments and heritage structures are legally protected in India.

Even those structures considered to be of national or local importance in India and protected as such remain under threat from urban pressures, neglect, vandalism and, worse, demolition, only for the value of the land they stand upon. This poor state of preservation of a large part of our national heritage is a result of the inability of those entrusted with their care and management to unlock the economic potential of these worksites and demonstrate that conservation and restoration efforts can lead to meeting development objectives in a more sustainable way.

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II. SYSTEMATIC APPROACH

Restoration and conservation is a fine crucial act, educating to judge just the sufficiency of intervention at the right time. Restoration of architectural heritage requires a multi-disciplinary approach. It is known that heritage structures are specially designed and skilfully built structures. [Kumar P., et.al, 2008].

Physical condition: Behaviour of materials and structural bodies, deterioration causes and mechanisms, possible man made interventions, long-term efficacy of treatments, etc.

Management context: Availability and utilisation of resources, including funds, skilled personnel, and technology; political willpower and legislative mandates and conditions; land use issues, etc. The historic character of a property should be retained as it is and conserved. The replacement of healthy elements or repairable historic materials or intrusion of new method, spaces, and association that recognizes a property should be avoided. Each property should be characterized as a physical record of its place, time and utilisation. Work needed to preserve, conserve and restore existing historic materials and features should be physically, visually and realistically compatible, discoverable and properly recorded for future work. Different materials, structures and construction methods or examples of skilful craftsmanship or great architecture that identifies a property should be conserved. The present condition of historic features should be evaluated to find out the appropriate level of intervention needed. Treatments that cause harm to historic structures should not be used.

Deteriorated old structures should be repaired rather than replaced. Where the acerbity of declination requires replacement of a differential feature, the new feature should match the old in design, colour, texture, and, where possible, materials. Replacement of missing features should be substantiated by documentary and physical evidence. New adaptation and related new construction will be undertaken in such a manner that, if replaced in the future, the vital form and integrity of the historic property and its surrounding would not be impaired. Substitute of missing element from the restoration era should be significant by documentary and physical proofs. A wrong sense of history should not be created by adding doubtful substances, features from other characters, or by adding or merging features that never existed with each other historically. [Sandhbhor S., et.al, 2008].

III. CLASSIFICATION OF ISSUES

There are different issues involved in restoration and conservation of heritage structures.
Environmental issues:-
Environmental problems mention to challenges caused by outer factors such as economy pressure, building condition, building spacial location and business opportunity. Buildings outside central areas are confront with aspects of survival in terms of business efficacy.

The Municipal Heritage Restoration program reported that while poor relative location may comfort the threat of restoration, poor proximity to markets, competitors and pedestrian masses will make it more difficult for customer-oriented businesses to survive. Older sites frequently suffer from limited parking space and difficulties with vehicular accessibility making it difficult for any business in these properties to subsist and the property values reduced. Thus, location of the historic building determines its chances of survival (Kenny, 2006).

Human Isssues:-
Miscommunication came about by distinctive corporate bodies and systems is a usual problem in preservation works due to the entanglement of number of organizations such as conservator, contractors, material dealer and small scale contractors put together as a team.

Poor communication between engineers, supervisor and general laborer conclude in distinct networks of activities caused by misconceptions of guidance or difference in imitating of scope of work.

Technical Issues:-

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Unavialability of resources to fully developed the monument into a correct innovative use left the structure to remain empty. Another problem is the unavailability of materials and skilled workers to generated composite materials.

Due to scarcity of preservation skills for the restore and maintenance of ancient design, it was identified that about 65% of conservation and restoration, maintenance of historic old monuments are done by unskilled and new workers resulting in 60% of the issues that raised afterward.

Organizational Issues:-

Distinctive organizational systems can lead to many other aspects in preservation ranging from "the strict self-denial of the archaeologists, to the unapologetic self-confidence of the creative architect" (Kamal, 2008).Governing laws pertaining restoration programs for historic structures are not specific and flexible. More than 65 percent respondents agreeing that current laws and guidelines associated to historic government buildings.

Financial Issues:-

Due to the unexpected nature of restoration work, the end expense of conservation and restoration projects is usuallyhard to ascertain. Many assumptions are made in a conservation and restoration program that raisesprovisional costs due to the inappropriate design drawings which is usually the case in any restoration program. Restoration programs require the assurance of substantial costs Unless the correct support is given for restoration program, the financial stakes are often high and hence, not impressive from a business point of view.

IV. METHODOLOGY

Before planning of any restoration of heritage building, it is very much important to first recognise its heritage value and historic significance. Conduct a survey of building, identify the features to be conserved. Start with the building's overall features such as the form, scale and massing. Look at the immediate site, gardens and landscaping that may directly affect the building.

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VeermataJijabai Technological Institute is 7th oldest institutes of education in India. VJTI was founded in 1887. It is more than 100 years old structure.VJTI is a historical monument (declared as heritage site by Govt. of Maharashtra) and even its hostels as well. (ref: archaeological Survey of India and Gazette of Bombay). VJTI building included in Heritage Grade 3 type buildings.

Though building is more than 100 years old, it is still in working condition. Regular maintenance made building to be in working conditions in these years too. But some repairs are necessary.

Dome repair work :-
The dome was first checked by tamping method, the loosened lime plaster layer is been removed. The surface of the dome is cleaned up using wire brushes and blowers. Minor cracks are filled with polymer based cement mortar in the proportion 1:2 (1litre of polymer : 1 Kg of cement). The sealing of cracks is done with this polymer treatment. The layer of lime mortar of 3 to 5 mm thickness applied to the external surface of the dome.

Figure 1:Dome external surface with lime mortar

Inner surface of dome was having plaster of paris sheets rested on wooden battens. Teak wood battens were fixed by long screw nailed in the dome concrete surface. Wooden battens were arranged on the periphery of inner surface of dome. Due to water leakages wooden batten were subjected to fungal growth and plaster of paris sheets rested on them were also starts deteriorated. Again by tamping method is used for checking. The sheets were not ingood condition. Hence POP sheets and battens were removed. Some of the were so tightly fixed that they were removed by cutting. The holes of screws were also poured with cement mortar.

Figure 2:POP sheets and battens removal

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Roof repair work:-
The roof was also having leakages. Some of the battens were subjected to white ants and fungal infection. Old tarfelt was torned on some places. For the roof repair work manglore tiles were and battens were removed. Water based bituminous coating like supreme bituchen was provided. The top marine plywood of 12 mm thickness is provided. Above that self adhesive water proofing membrane is provided. Battens of teak wood(50mm x 25mm)are used to rest the manglore tiles on them. As all battens were not subjected to termites or fungal attack so reused. Timber which is to be reused have to be tested. Moisture content tests and load bearing tests are taken. Manglore tiles are cleaned as much as possible. Fungal growth on them is removed with brushes. Chemical treatment of tiles i.e. anti algaeanti fungal treatment is done.

Figure 3:Roof Repairs

Terrace slab and gutter repair:-
Terrace slab and gutters for eliminating saturation of water on the slab were also repaired. By the tamping method loosened materials were removed. The reinforcement which was exposed is treated by polymer treatment. Surface was cleaned by brushes and blowers. Non dust surface was treated by polymer coatings and cement grout. Vertical and horizontal coats of polymer were applied. Above that brick bat coba was constructed. Ponding tests are conducted with the curing. Once terrace slabs become leakage proof then cement mortar with 1:3 proportion is applied. Gutters are provided water proofing treatment with 3mm thick APP modified bitumen membrane with overlapping with polymer reinforcement.

Figure 4: Brick bat coba

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V. ANALYSIS

The analysis of construction techniques is done on the basis of time and cost. The different items and activities were identified. The method of data collection is field visit. Also for comparing the basic rates were taken from District Schedule Rate.(DSR) and with these rates and market rates, rate analysis is been performed. Consider this example of one item in repairs, To provide and applying lime plaster with required mixing component of 12 mm thickness. The rate analysis is done by considering CPWD DSR rates.

Table 1:-Rate analysis by DSR

Providing and applying Lime Plaster with required mixing component in 1: 3 (lime: sand) with 12mm thickness with approved material and specification including scaffolding etc. complete.				
Description	Unit	Quantity	Rate	Amount
Details of cost for 1 cum.				
MATERIAL:				
(0.475 cum. of lime putty = 3.01 q of unslaked lime)				
Un Slaked Lime	Quintal	3.01	700	2,107.00
Fine Sand zone	cum	2.14	650	1,391.00
Carriage of lime	cum	0.39	106.64	41.59
Carriage of fine sand	cum	2.14	106.64	228.21
LABOUR:				
Beldar	day	3.4	297	1009.8
Bhisti	day	2.8	328	918.4
Running cost for upkeep of mortar mixer	day	1	800	800
Fuel cost for running the mixer	Lit	8	60	480
Sundries	L.S	52	1.7	88.4
Cost of 1 cum say				7,064.40
contractors profit 15%				1059.6599
Total				8,124.06
for 12mm thick				853.0262

Second table shows the analysis of the same item with prevailing market rates.

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Table 2:- Rate analysis by market rates

Providing and applying Lime Plaster with required mixing component in 1: 3 (lime: sand) with 12mm thickness with approved material and specification including scaffolding etc. complete.				
Description	Unit	Quantity	Rate	Amount
Details of cost for 1 cum.				
MATERIAL:				
(0.475 cum. of lime putty = 3.01 q of unslaked lime)				
Un Slaked Lime	Quintal	3.01	700	2,107.00
Fine Sand zone	cum	2.14	650	1,391.00
Carriage of lime	cum	0.39	106.64	41.59
Carriage of fine sand	cum	2.14	106.64	228.21
LABOUR:				
Beldar	day	3.4	400	1360
Bhisti	day	2.8	350	980
Running cost for upkeep of mortar mixer	day	1	800	800
Fuel cost for running the mixer	Lit	8	60	480
Sundries	L.S	52	1.7	88.4
Cost of 1 cum say				7,579.70
contractors profit 15%				1136.955
Total				8,716.65
for 12mm thick				915

Each item's analysis is done with both DSR and market rates. The actual cost of project (cost calculated by market rates) is 2.43% greater than the estimated cost.

Table 3:- Cost comparison of different techniques

Technique	Cost	Duration
Cement plaster 1:3	235	3
Lime plaster 1:3 for walls	209	4
Lime plaster 1:3 for cornices	514	9
Lime Plaster 1:3 for spherical surfaces	286	6

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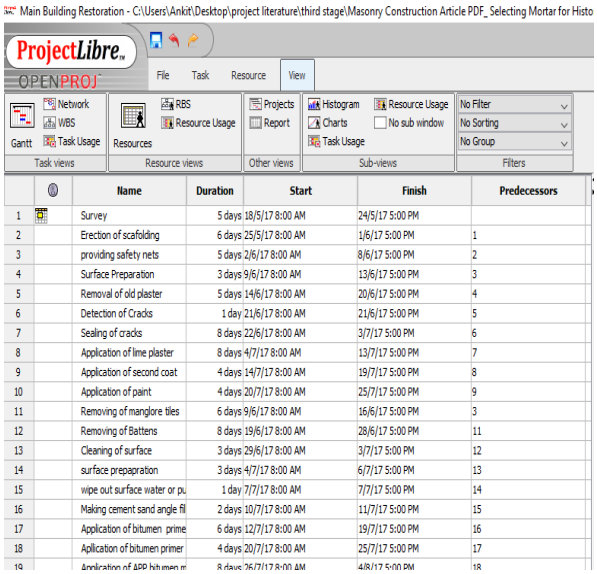
For different lime mortar application techniques lime plastering for plastering to walls, cornices and spherical surfaces are compared with their cost for unit square meter application. Where as for modular surfaces like cornices plastering cost is highest among all and it takes more time than the other techniques, skilled labours are required for restoration and conservation of heritage building.

Time Analysis:-
The analysis of repairs and restoration is also done on the basis of time. The work break down structure of whole activities is prepared ideally and it is compared with the actual time taken by the work to be completed. For this project libre an open software is used.



		Name	Duration	Start	Finish	Predecessors
1		Survey	5 days	18/5/17 8:00 AM	24/5/17 5:00 PM	
2		Erection of scafolding	6 days	25/5/17 8:00 AM	1/6/17 5:00 PM	1
3		providing safety nets	5 days	2/6/17 8:00 AM	8/6/17 5:00 PM	2
4		Surface Preparation	3 days	9/6/17 8:00 AM	13/6/17 5:00 PM	3
5		Removal of old plaster	5 days	14/6/17 8:00 AM	20/6/17 5:00 PM	4
6		Detection of Cracks	1 day	21/6/17 8:00 AM	21/6/17 5:00 PM	5
7		Sealing of cracks	8 days	22/6/17 8:00 AM	3/7/17 5:00 PM	6
8		Application of lime plaster	8 days	4/7/17 8:00 AM	13/7/17 5:00 PM	7
9		Application of second coat	4 days	14/7/17 8:00 AM	19/7/17 5:00 PM	8
10		Application of paint	4 days	20/7/17 8:00 AM	25/7/17 5:00 PM	9
11		Removing of manglore tiles	6 days	9/6/17 8:00 AM	16/6/17 5:00 PM	3
12		Removing of Battens	8 days	19/6/17 8:00 AM	28/6/17 5:00 PM	11
13		Cleaning of surface	3 days	29/6/17 8:00 AM	3/7/17 5:00 PM	12
14		surface prepapration	3 days	4/7/17 8:00 AM	6/7/17 5:00 PM	13
15		wipe out surface water or pu	1 day	7/7/17 8:00 AM	7/7/17 5:00 PM	14
16		Making cement sand angle fil	2 days	10/7/17 8:00 AM	11/7/17 5:00 PM	15
17		Application of bitumen prime	6 days	12/7/17 8:00 AM	19/7/17 5:00 PM	16
18		Aplication of bitumen primer	4 days	20/7/17 8:00 AM	25/7/17 5:00 PM	17

Figure 5:-Activities and start and end time

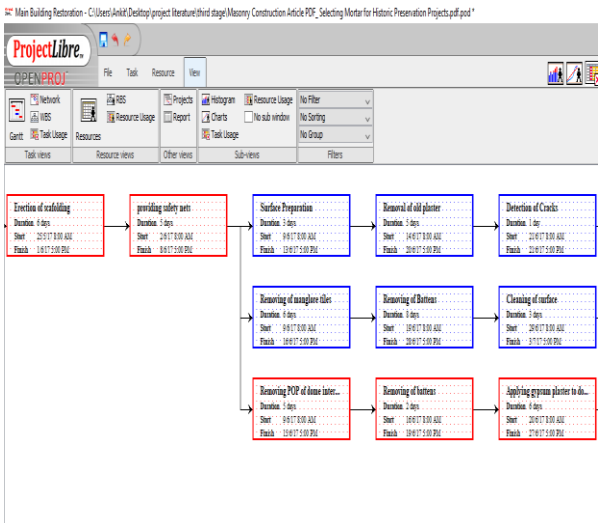


Figure 6:-Network diagram of WBS

All the activities their time duration with the requirement of sequence is the input for software.

The work breakdown structure so form by the software are compared on the basis of time. Ideally the work of repairs and restoration should require time of 5 months . the project started on 18th May, 2017 and the end date was 6th October,2017.

But the actual duration of the project was 7 months The project actually completed 29th December, 2017.
Note:-labour worked for 8 hours a day and work for 5 days in week is considered.

VI. CONCLUSION

For considering any heritage structure for repair and restoration there must be a systematic approach. Heritage value of the building, protection by laws, defects in the structure must be well known. In the repairs and restoration of VJTI structure, by cost comparison it is observed that the comparison of items by DSR rates and by market rates has difference of nearly 2.43%.For the largescale work difference in the estimated cost and actual cost may increase. Hence it is necessary to strictly monitor the specifications and market conditions while restoration of heritage structure.

Similarly the estimated durationfor restoration and the actual duration also differs by two and half month. Due to environmental conditions like raining in Mumbai, human error like skilled labourshortage work was delayed. All this issues must be considered while planning restoration of heritage structure. In heritage structure repairs alike materials should be used. Lime plastering, use of old mangalore tiles and battens is appropriate method for repairs and restoration.

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