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Structural Restoration and Heritage Conservation: A Case Study of Raghunath Palace Surguja Province

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Abstract

A good example of traditional Architecture is Raghunath Palace of Surguja province. Whose studies emphasis the structural challenges that the palace is facing at present era. The paper presents the analysis of structural component, failures and restoration need of the structure. The palace provides a good example of traditional Indian construction technique which is merged with international materials. The research study identifies the structural failure, that include cracks, material degradation due to various environmental factors and then to proposes a restoration strategy that mainly emphasise the use of original material to enhance the compatibility and longevity of structure. The aim of the work is to preserve the historical and architectural integrity of palace while addressing the modern challenges in heritage conservation Buildings are composite materials with the increasing and advancement of technologies and innovations cement are now replaced with traditional materials due to their properties that enhance the building performance. The structure i. e Raghunath palace is indeed an ancient structure but use of traditional material gives it a remarkable key point. Lime Surkhi Mortar with the wood apple Pulp (Limonia acidissima) is the major ingredient that is used in the structure.

The Study of this type of building gives a detail about why wood apple has been used, whether it is beneficial for the building or not, and also what is the vulnerability criteria of building under seismic effect. Due to change of earth crust the seismicity of many areas has been recently changing in India. The fact might be the global disturbance of environment and change of position of drifts plate beneath the earth crust newly constructed structure can withstand such changes as they are designed accordingly. But what about the heritage buildings which were centuries old they might get damaged under this seismicity changes and it is the need of hour to conserve the structure which show about the culture, history of any place.

***Keywords*:** Heritage conservation, Sustainable Restoration, masonry building, lime Surkhi mortar etc.

1. Introduction

All the ancient Structure whether they are palaces Minarets, Bridges etc. represent our culture and history. Yet despite of lack of modern technologies those structure have good durability and also shows the history of our remarkable culture. From ancient Egypt pyramid to the modern Burj Khalifa the construction technologies have evolved but both structures have their own remarkable significance.

Just like we have to maintain our body on regular basis these structures too need maintenance if not done they will deteriorate. Raghunath Place named after Maharaja Raghunath Ramanuj Saran Singh Deo located on Ambikapur Surguja shows the glory of Surguja its remarkable history. The research when conducted on Raghunath palace shows remarkable structure failure which include cracks, settlement, elemental collapse. In order to restore/ rehabilitate the building challenges that can be faced is about its history of material preparation. The entire building is of Lime Surkhi along with wood apple masonry structure which include modern days element imported from foreign land at the time of construction.

The study aims for the development of knowledge of conservation for heritage building which will ensure about sustainability along with preservation of history.

2. Methodology

The whole research is divided into four Broad Category for the identification of problem and its vulnerability effect along with restoration technique.

1. Structural Assessment-The Raghunath palace is about 100-year-old. Structural component like walls, floors, roofs, foundation, girders all have undergone defects due to environmental and maintenance issue. The key point for this is o identify the damages being occurred in the structure.
2. Material Analysis- Raghunath palace as constructed century ago mainly comprises of lime Surkhi wood apple mortar resins as a binder. Our aim is to gets its properties in order to reconstruct the mortar for rehabilitation and to study its importance.
3. Seismic vulnerability study- Since the last decades Surguja province has not been to seismic prone area but recently seismic activity in this area has been increasing which is most important to be considered during the retrofitting of structure.
4. Restoration technique-the structure of historical importance shows in order t restore the building. The main point to kept is to maintain its integrity and sustainability using traditional material and method for restoration and giving structure a more aesthetic look and durability is the objective.

3. Case Study Raghunath palace

3.1. Historical Background

Raghunath palace is an outstanding historical architectural heritage of Surguja region. The construction period as stated by the palace people is between 1922-1925. Palace is a good example of architectural grandeur of that era.it comprises of two-story load bearing structure whose foundation depth is of same height as that of building above the ground level. Its façade is of white colour along with arched shaped opening with lots of windows made of glass that were imported from Belgium, tiles from Italy, roofing system has tradition brick roof that provide natural insulation.

The material being imported from other countries, and skilled artesian from Rajasthan, Haryana intricate the carving on them, local craftsman's ornamental plaster work provide aesthetic appeal.

3.2. Structural Damage Detection and restoration work

To find out the damaged that has occur in the structure first site visit for visual inspection is carried out.

1.Visual inspection- on visiting the palace regularly and interacting with the concern authorities of the Palace following damages are noted

a) Cracks on various portion
b) Marble discoloration
c) Collapse of roofing materials and wall at few places
d) Damage of wooden materials, by termites, fires, fungus etc.
e) Structure shows growth of vegetation over them which cause more cracks.
f) Most important is the lack of maintenance of building

2.Material Testing-As the structure mainly comprise of lime Surkhi and wood apple pulp so it is interesting for any engineer to get the significance of use of wood apple in the structure, durability and strength. In order to find this, test on materials is constructed.

Composition test

Lime ($Ca(OH)_2$)- it act as binder, Surkhi(Crushed brick powder) – improvise strength, Wood Apple (*Limonia Acidissima)* Provide better workability and binding properties, and water.

For finding this composition and the properties various test should be carried out.

a) Acid Dissolution test-A known value of mortar sample is taken and dissolved in dilute HCL in which lime get reacted and converted to CO_2wherea s Surkhi is non-reactive on filtering provide amount of Surkhi content and lime content.

b) Loss of Ignition Test-for the presence of Wood apple the mortar sample is heated up to 900-1000℃ and loss of eeight indicate the amount of wood apple as it is organic content.

c) Water absorption test-to find that wood apple is good water resistance, cube of lime Surkhi mortar with and without wood apple is prepared and oven dried for 24 hours then immerged in water for 24 hours. The amount of water absorbed in both cases show that wood apple provides better water insulation

d) Sorptivity Test-the cubes of lime Surkhi mortar with and without wood apple is exposed to water at one side. the capillary action on this at 10 min, 20 min, 30 min…60 min shows the moisture uptake. This shows that wood apple cube is better than normal lime Surkhi mortar.

e) Dry wet cycle durability test- mortar cubes are consequently soaked in water for 8 hour and then dry at 60℃ for 16 hours. Repeating this for 20-25 cycle and then checking crack, weight loss etc. show that wood apple mortar cube sample retain strength and has less cracks

3. Seismic Study-Seismic zone of Surguja has been changed from III to II due to recent earthquake activities. The areas surrounding the district ahs also many mining zones which can trigger the effect of seismicity. The structure should be restored by keeping in mind this important factor so that in future if any other shock wave strikes the area it do not have any damaging effect on palace building. As structure is already in vulnerable condition any higher shock wave will leads to grater damage. So, maintenance delay is not acceptable at such point.

4. Restoration Project-after such feasibility analysis on palace now the restoration work has been started so that our rich historical background should not be lost.

The owner of palace along with engineer's team has decide to restore this Marvelous historical structure and converting it into renewed one. So that the palace is opened up all the time and maintenance could be done in regular basis. For restoration structural integrity and sustainability is given due importance. the project is divided into phases of restoration

a) The seven courtyard and 7 wells which were the part of inner beauty are repaired and plantation is to be done
b) Each section that is separated by the courtyard is restored simultaneously which include

I) Scrapping of damage element
II) Construction and placement of girder and beams which are damaged of wood and steel
III) Wall repair work
IV) Removal of vegetation that has grown on the palace like algal bloom
V) Reconstruction of roofs as many of the rooms roof has been collapse when fire has been broke out in the palace which is the main cause of place closure.
VI) Foundation stabilization using grouting method
VII) Masonry strengthening by lime Surkhi grouting and if completely damage new construction keeping the integrity of structure.
VIII) Wood preservation
IX) New glasses placement in windows
X) Architectural design preservation

These works are ongoing along with soil and under drainage testing after the test and its report future repair technique according to sub soil condition will be adopted for soils stabilization. Since work is in progress and is at its preliminary stages modern tools and techniques are used for the restoration work. If in future it is needed to adopt any ancient technique for a particular portion team of engineers are ready to ask for help from various researchers, and also archaeological department of India at any special condition.

4. Experimental Result

The Material test result for its composition, water absorption , Sorptivity, loss of ignition and dry and wet test conducted on mortar sample for getting the significance use of wood apple in mortar are below

Table 1: Water absorption test

Sample Detail	Dry weight	Wet Weight	Water Absoprtion
A- Lime Surkhi	180	205	13.88%
B-Lime Surkhi wood apple (5%)	186	201	8.06%
B- Lime Surkhi wood apple (10%)	191	202	5.75

Table 2: Sorptivity Test

Sample Detail	Change in weight at 60 min ΔW in g	Sorptivity=ΔW/a√t mm/min$^{0.5}$
A- Lime Surkhi	14.6	0.754
B-Lime Surkhi wood apple (5%)	11.85	0.612
B- Lime Surkhi wood apple (10%)	9.3	0.48

Table 3: Dry wet cycle durability Test

Sample Detail	Weight loss %	Crack Development	Compressive strength retention %
A- Lime Surkhi	11%	Minor hair line cracks	76.2%
B-Lime Surkhi wood apple (5%)	6.75%	No cracks	87.8%
B- Lime Surkhi wood apple (10%)	4.1%	No cracks	93.1%

From the test conducted it is proved that on adding wood apple pulp in the lime Surkhi mortar water absorption capacity gets reduced due to organic properties of pulp and help in moisture retention as well as the durability of of structure significantly enhanced.

5. Conclusion

The Structural damage detection of Raghunath Palace with well known facts along with the visual inspection and material testing it has been seen that use of lime Surkhi mortar with wood apple as a additive at that era help in reducing the water absorption capacity as well as seepage problem even though at that era problem pertaining to water seepage from underground as well as from outskirt of any building were not well known. The technologies were not developed but huge structure with aesthetic component along with highly durability were constructed. The study helps in gaining knowledge about the same so that proper restoration work can be carried out. The Restoration work of palace is ongoing and all the various defects, collapse and elemental damage to structure are accordingly repaired and at few places new construction is being done as few portions are completely collapsed. The test conducted on lime Surkhi wood apple mortar help in preparation of mix design of the mortar so that cement mortar should not be used and integrity of structure is maintained.

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7. References

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