Identification of Criteria for Plaster Material Selection

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Abstract : Material selection is an essential factor in construction industry which has a large impact on all stake holders as well as the environment. The precise choice of materials for a project requires considerations of aesthetic appeal, initial and maintenance costs, life cycle assessment considerations such as material performance, availability, impact on the environment and the ability to reuse, recycle or dispose of the material at the end of its life. Plastering process uses sand in large quantities which may affect the environment adversely and other alternatives may cause unwanted outcomes and increased costs during the life cycle. The Analytical Hierarchy Process (AHP) is a tool designed to solve Multi Criteria Decision Making (MCDM) problems. AHP enables us to investigate the relative importance of the criteria and alternatives for the identification of the best suited option for application to a particular project.

***Index Terms*— Material Selection, Multi Criteria Decision Making(MCDM), Analytical Hierarchy Process(AHP).**

I. INTRODUCTION

Construction is an area of work wherein making decisions adequately can mean the difference between success and failure. Decision making is a key factor to achieve success in any discipline. As magnitude and scope of problem increases, decision making process gets more and more complicated, because with increase in size and scope, number of alternatives and related factors also increase. An often-overlooked aspect at beginning of a new construction project is the selection of materials that will be used to complete the design. While some project planners only use the finest materials available to avoid cutting corners, this is not always the best route and can even negatively impact the overall plan. The choice of plastering material for a project requires considerations of aesthetic appeal, initial and ongoing costs, life cycle assessment considerations (such as material performance, availability and impact on the environment) and the ability recycle or dispose of the material at the end of its life.

MCDM is a sub-discipline of operations research that explicitly evaluates multiple conflicting criteria in decision making. MCDM is concerned with structuring and solving decision and planning problems involving multiple criteria which leads to more informed and better decisions. Internal Plastering of walls in a residential building requires a large amount of materials and therefore is a considerable portion of the complete budget. Plastering alternatives may use river sand, cement, water in large quantities and thus have a considerable environmental impact.

Alternatives for internal plaster include Tiling, Wall Panels, Wooden Laminates, Glass Finishes, Wall Papers, Upholstered walls, etc. These alternatives are not frequently seen in application for residential buildings. Internal plastering for residential buildings as widely observed in Indian conditions is done using the following three alternatives : Conventional Sand Cement Plaster, Lime Plaster, Gypsum Plaster. The correct choice of alternative much be economically feasible, have low environmental impact, must be easily applicable and also have good aesthetic finish among other qualities. All these limitations and desirable qualities make the selection of internal plastering alternative a Multi Criteria Decision Making problem.

II. OBJECTIVES

A. To identify the various criteria that are to be assessed for selection of a sustainable plaster material.

B. To study use of AHP for plaster material selection.

III. PLASTER MATERIALS AND SELECTION CRITERIA

A. Plaster Alternatives

Internal plaster comes in direct contact to the residents indoor environment and hence it is required to consider all the sustainability criteria's before selecting the final material. The following are some of the basic requirements of a good internal plaster:

- It should be cheap and economical.
- It should be hard and durable.
- It should adhere to the background easily and have a strong bond.
- It should be resistant to changing weather conditions.
- It should possess good workability.
- It should have a smooth and aesthetic finish.

The following three alternatives are most commonly used in Indian conditions are studied and compared in this study.

1) *Sand Cement Plaster* :

The conventional sand cement plaster uses a mix proportion of sand and binding material cement to finish the wall, making moldings and for interior decoration finish purpose. Generally cement plaster is used because cement is considered as good binding material with low cost and easy availability. Also Masons who are familiar with cement plaster are easily available and does not require high level of skill. Plaster is more resistant to knocks and dents in most cases. Cement plaster also changes color slightly as it ages, so new patches are brighter and stand out if you don't paint the entire wall after the repair.

2) *Gypsum Plaster* :

Gypsum is a soft sulfate mineral composed of Calcium sulphate di hydrate ($CaSO_4,2H_2O$). Gypsum is a chalk like material and is very light in weight. This material which can be applied over brick, block or concrete surface to form a smooth surface is called gypsum plaster. Gypsum can be directly applied over brick/block work without separate finishing. It is also very easy to apply and level gypsum plaster. Gypsum reaction produces less heat as compared to cement reaction with water. So there are fewer shrinkage cracks. Gypsum sets quickly so painting could be started as early as 72 hours after application of plaster.

3) *Lime Plaster* :

Lime Plaster is a unique product that has been around for centuries. It is perfect for interior plastering as it is highly durable**.** Lime-plastered walls have lasted for thousands of years, are unaffected by water and will not soften or dissolve like gypsum plaster or drywall. Lime plaster is sufficiently durable and resistant to environmental elements, it is less brittle and cracks much less, requiring no expansion joints as a result. Lime based products have a smaller carbon footprint than the cement counterparts. Lime is called a "breathable" material. Breathability refers to a material's ability to allow air-borne vapor or humidity to pass through it. This breathability ensures that moisture will not build up inside the wall system.

B. Selection Criteria for Internal Plastering

Selection of the best plaster finish cannot be done considering only a few aspects and criteria. Materials must be used sustainably, meaning its present use should not compromise the future by running out or harming the environment at any time. Few materials fully meet this criteria. Thus every alternative must be studied carefully and criteria must be chosen a such a way that it offers the balanced best possible solution.

These Assessment Criteria are studied from the various literature reviews of studies done in the past as well as opinion from experienced professionals working in the industry. The following criteria are selected for a balanced Sustainable Assessment of the Plastering Alternatives :

1) Total Cost over entire life cycle
2) Life Span
3) Water Consumption for application and curing
4) Availability of Skilled labour
5) Aesthetics
6) Impact of raw material extraction on environment
7) Resistance to environmental factors.

IV. AHP IN PLASTER ALTERNATIVE SELECTION

Prof. Thomas L. Saaty developed AHP as a solution for MCDM problems in 1980. AHP allows for small inconsistency in judgment because humans are not always consistent. This method derives ratio scales from paired comparisons. The ratio scales are derived from the principal Eigen vectors and the consistency index is derived from the principal Eigen value. The importance of every criteria is distinguished using an Importance Scale. This scaling enables us to assign relative priority or weightage to various criteria or the alternatives in question.

TABLE 4.1 IMPORTANCE SCALE FOR CRITERIA

Scale	Definition
1	Unimportant
2	Little Important
3	Moderately Important
4	Important
5	Extremely Important

Further, pair-wise comparison of alternatives or sub-criteria is made with respect to an element in a higher criteria and consistency of these results are checked using consistency ratio. Implementing the AHP basically depends on the expertise of industry professionals and also takes into account the needs of various stakeholders to determine the best alternative of internal plaster material selection process. The inputs received from various industry experts were analysed and the weightages of criteria were calculated using mean of the various inputs.

TABLE 4.2 WEIGHTAGES OF SAC'S FOR INDOOR PLASTER ALTERNATIVES :

Sr. No.	Criteria	Weightages for criteria (out of 10)
1	Total Cost Over Life Cycle	9
2	Life Span	9.17
3	Water Consumption for application and curing	8.41
4	Availability of Skilled labour	7.67
5	Aesthetics	7.83
6	Impact of raw material extraction on environment	8.75
7	Resistance to environmental factors	8.58

V. CONCLUSION

This paper shows the importance for selection of internal plaster material. For a material to be sustainable it is imperative to choose it wisely keeping in mind all the different Sustainability Assessment criteria. Material selection is a problem in front of stakeholders and decision makers with the ever growing choices of materials and variation on quality and cost. The AHP is presented a solution to this multi criteria decision-making problem in this paper. AHP is proven to be useful in solving the material selection problem. The Sustainability Assessment Criteria presented in this paper will help to accurately choose a balanced alternative of internal plaster material. For future work, decision making software such as Expert Choice™ may also be applied to this problem and its results can be compared to the use of AHP.

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