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Environmental, economical, technical and operational assessments of common types of separating wall systems in Iran using Analytical Hierarchy Process (AHP)

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ABSTRACT: The construction techniques and types of materials used in construction sites are very important considering mechanical, environmental and economic issues. Separating different parts of a building from each other and protect the interior space from the outside environment requires effective walls. To satisfy the needs of construction projects such as lowering the cost, increasing the speed and minimizing the overall energy consumption of building, construction material industries produce and introduce different types of separating walls for buildings. This research was conducted to assess the environmental, economical, technical and operational impacts of different types of separating walls. Five different types of walls, including solid clay (SC) bricks, hollow clay (HC) blocks, autoclaved aerated concrete (AAC) blocks, three-dimensional (3D) sandwich panels and gypsum boards were investigated in this regard. The goal was to find the most effective type of separating wall among the choices investigated. Each of the fore-mentioned criteria were divided into several sub-criteria, and the Analytical Hierarchy Process (AHP), as one of the best-known multi-criteria decision-making methods, was implemented in the assessments. Evaluations were based on both qualitative and quantitative criteria. Technical data and information were used for quantitative criteria and different types of questionnaires were developed regarding the qualitative criteria. The results of this study, based on all criteria, showed that the gypsum board with the relative priority value of 0.368, is the best choice between the assessed separating walls. The calculated relative priority values of AAC blocks, HC blocks, SC bricks, and 3D panels were 0.177, 0.152, 0.151 and 0.144 respectively.

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1. INTRODUCTION

Separating walls are among the essential parts of any building. Nowadays, there are many separating wall systems in Iran construction industry, which compete against each other. Different parameters such as quality, cost, speed of installation and environmental impact should be compared to make the proper selection.

Several questions need to be answered to enable customers to pick the suitable separating wall system that can meet their needs. The main reason that most of these questions were answered in the Iran market is that no study focused on the assessment criteria of the separating wall systems; and in spite of the importance of this issue, there is no significant and accurate comparative analysis about separating wall systems in the country.

This research compared and assesses different common separating wall systems in Iran concerning environmental, economic, technical, and operational points of view. The Analytical Hierarchy Process (AHP) was used to develop a comparison model. The evaluated separating wall systems are shown in Figure 1.

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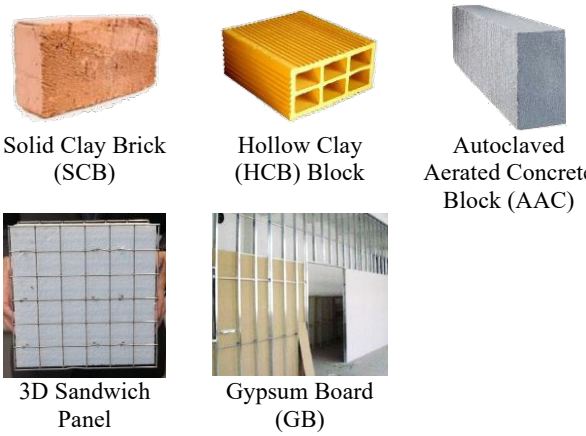

Fig. 1. The evaluated separating wall systems

2. RESEARCH METHODOLOGY

AHP is a powerful Multiple Criteria Decision Making (MCDM) research method. In AHP, after setting up the goals, assessment criteria and sub-criteria develop to compare different choices. By using paired comparison matrices, the

Table 1. Criteria and sub-criteria

Criteria	Sub-criteria	Assessed factors
Environmental	Energy Consumption	* Specific Energy Consumption (SEC) [1]
	Water Consumption	* Water Consumption in the process of producing materials + Water Consumption during the installation phase
	CO_2 Emissions	* CO_2 Emissions resulted from the thermal and electrical energy used in the production phase + Produced CO_2 as a result of Cement Consumption during the installation phase [2]
	Thermal Resistance	* Thermal Resistance of alternatives as an external wall
Economical	Purchase and Transfer Cost	* Based on the National price list of Plan and Budget Organization [3]
	Human Source Cost	
	Machinery and Equipment Cost	
Technical	Weight	* According to the details and the specific weight of the wall
	Thickness	* According to the details and the thickness of the wall components (in both internal and external walls)
Operational	Simplicity of the installation phase	* Using the questionnaire
	Installation phase speed	* Based on the National price list of Plan and Budget Organization [4]

Table 2. The relative values of the criteria and sub-criteria of the first and second levels

Criteria	RV**	Sub-criteria	RV**
Environmental	0.13	Energy Consumption	0.252
		Water Consumption	0.288
		CO_2 Emissions	0.217
		Thermal Resistance	0.243
Economical	0.42	Purchase/Transfer Cost	0.617
		Human Source Cost	0.263
		Equipment Cost	0.120
Technical	0.22	Weight	0.834
		Thickness:	0.166
		As an internal wall	0.865
		As an external wall	0.135
Operational	0.23	Simplicity of installation	0.478
		Installation phase speed:	0.522
		As an internal wall	0.192
		As an external wall	0.808
** Relative Value			

relative values of each factor are estimated. Finally, the overall composite value of each factor is estimated based on obtained relative values. Table 1 illustrates the criteria and sub-criteria of this research.

Since some of the criteria and sub-criteria are qualitative, a few online questionnaires were developed and distributed using the Google Docs' program. These questionnaires were sent to more than 80 civil engineering faculty members, practicing engineers and top executives all over Iran.

3. RESULTS AND DISCUSSION

After collecting the experts' responses to the qualitative parameter questionnaires, the relative values of the environmental, economical, technical and operational criteria and sub-criteria were obtained. These attainments are presented in Table 2

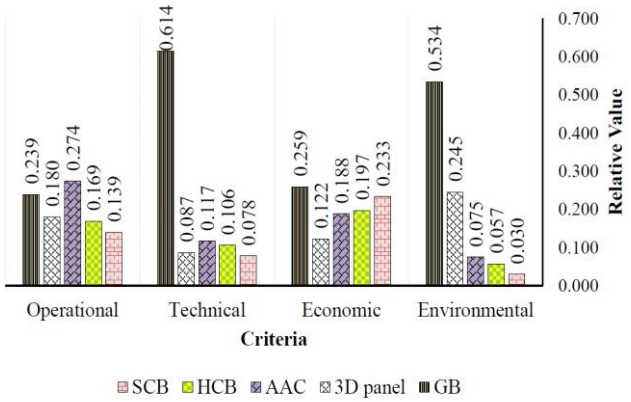

Fig. 2. Relative values of different alternatives

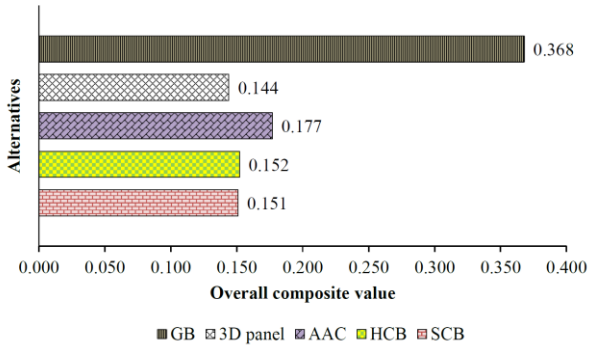

Fig. 3. The final ranking of various separating wall systems

A close look at this table reveals that from the experts' point of view, water consumption, purchase and transfer cost, weight, and installation phase speed of wall systems were the most important sub-criteria of environmental, economic, technical and operational aspects, respectively.

4. DATA ANALYSIS

Based on quantitative and qualitative parameters and considering the relative value of the alternatives in the sub-criteria and its relation to the criteria, alternatives were ranked, as shown in Figure 2.

According to Figure 3, to determine the optimum alternative, the overall composite values of each alternative choice should be obtained. These values were calculated based on the relative value of alternatives in each sub-criterion regarding their relation to the priorities and goals.

5. CONCLUSION

The low rank of SCB & HCB showed that traditional separating wall systems are not favorable in the market anymore. On the other hand, the slight difference between the values of these two alternatives suggested that, despite general beliefs, the supply and production of HCB did not make any significant effect in selecting these separating wall systems.

One of the most interesting outcomes of this study was that 3D Panel systems were the least favorite systems among all alternatives. Even lower than the SCB and the HCB. This system ranked second in both environmental and technical views. However, due to Maintaining the lowest rank in the economic factor, its overall rank dropped to the lowest. This could be an alarming factor that showed, not all innovative solutions could become attractive in the market if they did not consider economic issues and overall operating costs.

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