

# CEB as Potential Alternative Sustainable Material in Construction Industry: Survey on the Level of Acceptance in Kuwait

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**Abstract** – Recently, sustainable affordable housing solutions including sustainable construction materials has been at the core of international debates. Constructors and industries seem to have an increasing interest in the compressed earth block as it has many advantages for constructing a durable, comfortable, and low-cost building, it is a promising way of ameliorating the sustainability performance of buildings. The potential barriers to the usage of this technique need to be identified to facilitate and to promote its adoption in local construction. A questionnaire-based survey was conducted in the state of Kuwait to investigate the level of acceptance to this new product and to identify the major potential barriers as perceived by potential private clients. The preliminary results of the survey were very encouraging showing a high level of acceptance and willingness of the respondents toward the CEB's as a construction material and technique. A detailed analysis of the different impact factors shows that the cost reduction associated with the use of CEB's is the most influencing factor driving the respondents to these results.

**Keywords:** Construction industry, CEB, sustainability, questionnaire-based survey.

## 1. Introduction

The need for developing sustainable construction materials is gaining increasing importance around the world due to current climate challenges. Recent research studies show that buildings are responsible for approximately 40% of the total world annual energy consumption [1], 40% of raw material's extraction and 12 % of drinkable water consumption in the industrial countries [2]. In addition, several green building related research studies estimated that the construction industry is responsible for more than 40% of all Greenhouse Gas emissions (GHG) and includes 40 to 50 percent of the entire global economy [3]. A previous research study done in Kuwait highlighted that, the annual allocated budget for housing projects in Kuwait is estimated at KD360 million (= US\$ 1,200 million), and some of the residential projects have an estimated budget of KD15 million (= US\$ 50 million) [4]. Given that the Kuwaiti government takes a major share in the construction industry, the sector has a high impact not only on social life but also on Kuwait's economic growth. All of this contributes in increasing the pressure on local and international contractors and industries to search for a sustainable alternative to traditional construction materials such as fired brick blocks and cementitious masonry blocks.

Transportation, manufacturing, and installation costs can be significant especially when the construction materials are not manufactured at a reasonable distance from the building project. The selection of inappropriate building materials can have a negative impact on environmental and human health[5]. Furthermore, manufacturing waste and used traditional construction materials will affect surrounding environments if not well managed unlike sustainable materials such as earthen materials that have very low impact on the environment.

As a building material and methodology, earth is the ultimate sustainable solution. The earthen construction consists of many different forms of techniques and applications that vary with culture, climate, and resources. The most common ones include: Adobe (sun-dried clay brick), Compressed Earth Blocks (mix of different types of soil such as clay, silt and sand with a stabiliser such as cement), Rammed Earth (compacted layers of moist soil), Cob (mix of earth and straw), Earthbags (soil-filled sacks), Wattle and Daub (woven structure made of reeds, bamboo or branches and covered with mud or daub), and others [6] [7].

Nowadays, Compressed Earth Blocks (CEBs) are being increasingly utilized for construction of modern buildings. The CEB is made from a compressed untreated earth mixed with small amount of cement which does not require firing. It is a simple technology, easily worked with simple tools and can be used by anyone to construct walls, floors and roofs of

advanced architectural design. According to a research study done to evaluate Kuwait soil at different locations, it was found that local soil is suitable to produce CEBs [8]. This allows not only for cost saving, but also for a reduction in GHG emissions compared to traditional clay bricks. In addition, it costs less than traditional cementitious masonry blocks. It offers a perfect solution for affordable and environmental-friendly construction material and technique especially that the raw material is sourced on site saving energy and resources in transportation (based on the results obtained by A. Saad et al. [8]).

The purpose of this study is to determine the current state of the construction industry in the state of Kuwait with a focus on CEB acceptance. A survey of potential clients' level of awareness and acceptance to this material was conducted. This survey was used to obtain a general perspective of the issues associated with the use of this material. Further surveys and simulations could be performed to pinpoint specific areas of improvement and recommend marketing strategies. This survey is used as a qualitative query to obtain opinions and a feel of potential clients (owners, users, residents, etc.) for the state of the practice in the local construction industry. The outcome of this survey can help the project executers and the industries to design their strategies to promote the use of CEB as a sustainable building material in construction.

## 2. Questionnaire-Based Survey

The compressed earth block has many advantages for constructing a durable, comfortable, and low-cost building. It is a promising way of enhancing the sustainability performance of buildings. Using the CEB as an alternative method of construction has many challenges in Kuwait. Those challenges need to be identified. A questionnaire-based survey was conducted to investigate the level of acceptance of this new product and to identify the major potential barriers as perceived by potential clients. The survey targeted residential construction in which CEBs can be easily used. The selected people for the survey should be those who are planning to construct their private residence, and who are concerned with the selection of construction materials. The survey aims to identify the barriers to the adoption of the CEBs such as lack of awareness and to help planning proper strategies for promoting the wider adoption of CEBs in buildings development. The survey is based on a questionnaire which consists of four sections. Each section is designed to investigate a certain type of information as explained in Table 1. A pilot study was conducted on 39 respondents to validate and improve the questions in the survey. The questionnaire was updated based on the responses and the comments of the respondents and were converted into "Google Forms" which were used as an internet-based platform.

Table 1 the questionnaire structure and scales.

	Investigated Information	Scale
Section 1	8 questions to identify the respondent profile (Age, gender, educational level) and the type/size of projects that the respondent is interested/involved in.	<ul style="list-style-type: none"> <li>- Nominal scale :</li> <li>Example: category: Owner/Supplier/User.</li> <li>- And Interval scale:</li> <li>Example: size of projects the respondent had been involved in during the last 10 years: KD 50000-100000/100000-300000/300000-700000/open budget</li> </ul>
Section 2	4 questions to investigate the level of knowledge of the respondent about the construction industry.	Five-point ordinal Likert scale (1 to 5): 1 corresponds to "Poor" and 5 corresponds to "Excellent"
Section 3	7 questions to investigate the level of knowledge/awareness of the respondent about environmental issues and sustainability.	Five-point ordinal Likert scale (1 to 5): 1 corresponds to "Extremely not important" and 5 corresponds to "Very important"
Section4	5 questions to investigate the concerns and barriers of the respondent about CEB techniques.	Five-point ordinal Likert scale (1 to 5) 1 corresponds to "Very unlikely" and 5 corresponds to "Very likely"

The questionnaire included redundant questions to investigate and/or measure the same item but with an alternative phrasing of the question. This technique helps to enhance the respondent’s comprehension of the question and leads to more accurate responses [9, 10, 11]. It is also used as a tool to decide whether the response is valid or not. Therefore, an inconsistency of responses to redundant questions are not considered as valid responses and are not included in the results analysis. The survey was conducted during the period from March to May 2021. 214 responses were received in total but only 102 responses were identified as valid responses.

### 3- Results of the survey

The main objective of the survey is to identify the factors that may influence the choice of potential clients or owners on the selection of construction materials and to measure the level of willingness or acceptance to use the CEBs in their private residential projects. The results related to the respondents’ priorities are shown in Fig.1. Fig.2 shows the impact factors that may encourage the potential users to use the CEBs with the associated level of acceptance/willingness.

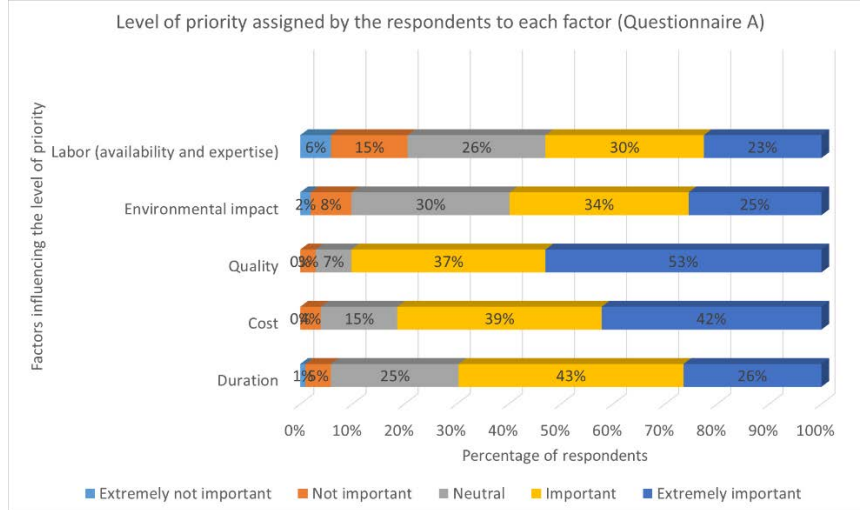


Fig.1: Results of the survey related to the respondents’ priorities

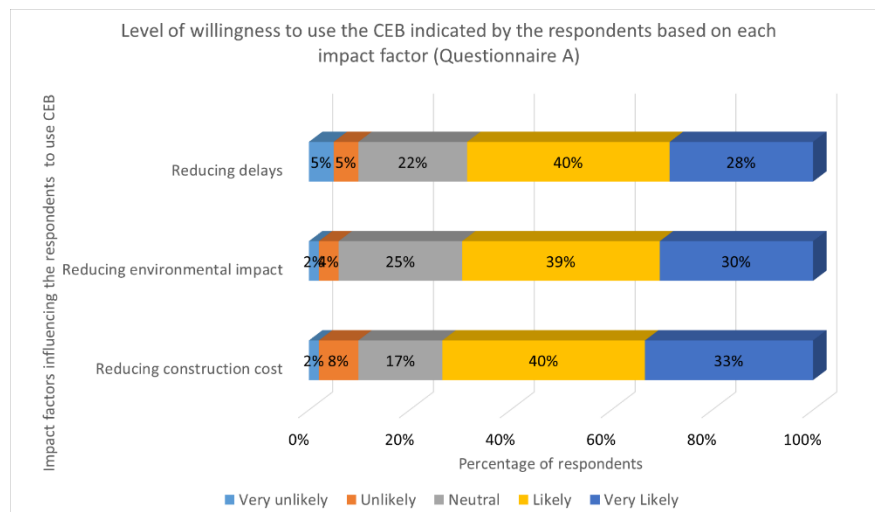


Fig.2: Level of willingness/acceptance based on the impact factors

In a very general way, the results show a high level of acceptance for the CEBs. On average, 70% of the respondents are likely or very likely to use the CEBs in their construction projects. As preliminary results, this is very encouraging

According to the results shown in Fig.1, the cost and the quality were top priorities for all of the respondents when choosing a construction material. However, the availability of skilled labor and the environmental impact seem to be important for the respondents: 40% of the respondents answered being “extremely not interested” to “neutral” regarding environmental impact of the construction material choice. 47% of the respondents answered being “extremely not to “neutral” by the availability of skilled labor.

Fig.2 shows the level of willingness of the respondents to use the CEB based on other impact factors including project duration, environmental impact, and cost. The influence of these factors (reducing delays, reducing environmental impact, reducing the cost) seem to have a similar impact on the respondents’ level of acceptance to use CEBs with a slightly higher influence for the cost factor.

#### 4. Conclusions

A survey of potential clients on the level and factors of acceptance of CEBs as construction alternative and technique in Kuwait was carried out. A questionnaire was sent out as “Google Forms” to collect the responses and analyse them. The most important factors influencing the decision of the client were categorized as duration, cost, quality, environment impact and availability of skilled labor. The results of the survey showed that the most important factors are the quality of materials followed by the cost. The environmental impact and the level of expertise of labor ranked the lowest. Based on the questionnaire results, it was concluded that the 70 % of the respondents are likely or very likely to use the CEBs with a higher score for the cost factor, followed by the environmental impact and the construction delays.

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