COUNTERBALANCING BENEFITS AND DRAWBACKS OF CONTEMPORARY STABILISED EARTH CONSTRUCTION BY CONSTRUCTION PROFESSIONALS.

Mohammad Sharif Zami

Abstract
It is debatable among the construction professionals whether contemporary stabilised earth construction is beneficial in urban low cost housing. Existing literature recorded a lot of benefits and drawbacks from construction professionals, which is empirically substantiated. But there are drawbacks found in the literature that seemingly are conflicting, and construction professionals are divided in their opinion. This paper seeks to address these conflicts and division by validating the controversial drawbacks of contemporary stabilised earth construction in urban low cost housing.

Keywords
Stabilised earth construction; low cost housing, construction industry.

Introduction
Cities in developing countries have, since the 1950’s, experienced unprecedented growth in terms of spatial development and population increase; urban population increase has particularly been high due to rural-urban migration (Dwyer et al, 1981; Mafico, 1991). Furthermore, there is an urban housing crisis in most developing countries, which is largely attributed to the rapid urbanisation process amongst most of the developing nations. The majority of the urban local authorities and central governments do not have the capacity to provide shelter to a large permanent population; there has been a lag of supply to the demand of urban housing (Mafico, 1991). According to UN Habitat (1996), housing shortage alone in African cities ranges from 33% to 90%. To meet housing needs, many people have resorted to renting backyard shacks and squatting on illegal land, where there are no provisions for social services and utilities. Soil has been, and continues to be, the most widely used building material throughout most developing countries: it is cheap, available in abundance and simple to form into building
elements (Adam and Agib, 2001; Morris and Booyse, 2000). Though literature shows a significant number of successful stabilised earth construction projects solving urban low cost housing crisis particularly in developing countries, some construction professionals still find stabilised earth construction not beneficial. This paper aims to counterbalance the benefits

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<tr>
<th>Benefits (summarised from the literature review)</th>
<th>Author</th>
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<tr>
<td>Suitable for very strong and secured structure.</td>
<td>Lal, 1995, p119; Houben &amp; Guillaud, 1989; Walker et al, 2005;</td>
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<td>Earth construction is regarded as a job creation opportunity.</td>
<td>Adam and Agib, 2001, p11;</td>
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<td>Earth walls (loam) absorb pollutants.</td>
<td>Cassell, 1993; Minke, 2006;</td>
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<tr>
<td>Earth construction promotes local culture, heritage, and material.</td>
<td>Frescura, 1981.</td>
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<td>Earth is available in large quantities in most regions.</td>
<td>Adam and Agib, 2001, p11; Easton, 1998; Lal, 1995; Hadjri et al, 2007; Morris and Booyse, 2000; Adam and Agib, 2001, p11;</td>
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Table 1: Benefits of contemporary earth construction. (Source: compiled by author, 2009).
and drawbacks of contemporary earth construction and address the controversial drawbacks. Furthermore, to achieve the aim, the authors critically review relevant literature and adopt the in-depth interview method to analyse and validate the arguments of this paper. The following two sections review the current state of art on the benefits and drawbacks of contemporary stabilised earth construction to establish a base for the counterbalancing and find the controversial drawbacks to be investigated in this paper.

State of Art Review on Benefits of Earth Construction in Urban Low Cost Housing

The benefits of earth construction are multiple and summarised from the literature and presented in Table 1.

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<tr>
<td>Earth construction is labour intensive.</td>
<td>Lal, 1995, p119; Cassell, 1993;</td>
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<tr>
<td>Mud houses behave poorly in the event of earthquakes.</td>
<td>Blondet and Aguilar, 2007;</td>
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<td>Structural limitations.</td>
<td>Maini, 2005; Hadjri et al, 2007;</td>
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<tr>
<td>Need high maintenance.</td>
<td>Hadjri et al, 2007;</td>
</tr>
<tr>
<td>Professionals earn less money from earth building projects.</td>
<td>Robinson, 1939.</td>
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<tr>
<td>Loam is not a standardised building material.</td>
<td>Minke, 2006; Dunlap, 1993</td>
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<tr>
<td>Need higher wall thickness.</td>
<td>Walker et al, 2005.</td>
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Table 2: Drawbacks of contemporary earth construction (Source: compiled by author, 2009).
rodents making holes in the wall and floor, and poor performance during earthquakes can be solved by stabilising the earth. According to Cassell (1993), the two historical disadvantages to rammed earth have been water damage and labour intensity. The Australians have solved the water damage problem by spraying the wall with a transparent plastic, ideal for wall cleaning with a hose or damp sponge. Labour intensity has been solved by the use of gasoline and pneumatic powered tamping devices (Beyond 2000). Vernacular earthen houses located in seismic areas are at risk because of their inherent structural vulnerability. It is possible to provide reinforcement to earthen buildings in order to improve their structural performance and to prevent their collapse during earthquakes (Blondet and Aguilar, 2007). Furthermore, it is important to take note from the drawbacks of earth construction mentioned in Table 2 that the lack of durability and structural limitations of earth construction is the most frequently mentioned by the authors. Therefore, it is important to review current literature on contemporary stabilised earth construction in terms of a seismic response, durability and structural achievement in brief.

According to Blondet and Aguilar (2007), most present day earthen houses are built without any structural reinforcement, with several storeys, thin walls, large windows and door openings, irregular plan and elevation configurations, these buildings are extremely vulnerable and suffer significant damage or collapse during earthquakes. During the last three decades, researchers at the Catholic University of Peru (PUCP) have attempted to find solutions for improving the seismic performance of earthen buildings. The principal alternative solutions of seismic reinforcement for these vulnerable buildings consist of: - internal cane mesh reinforcement, external wire mesh reinforcement, and external polymer mesh reinforcement (Blondet and Aguilar, 2007). According to Maini (2007), extensive research was carried out to develop vertical and horizontal reinforced concrete members supported the masonry so as to create a box type system which can resist disasters. As a result of the research two types of blocks have been developed: - the square hollow interlocking block suitable for a two storied building and the rectangular hollow interlocking block suitable for a single story building. This technology has been used extensively in Gujarat for the rehabilitation after the 2001 earthquake with a six month technical assistance from Auroville Earth Institute and with this assistance the Catholic Relief Services built 2,698 houses and community centres in 39 villages (Maini, 2007). According to Maini (2005), this technology has been approved by the Government of Gujarat (GSDMA) as a suitable construction method for the rehabilitation of the zones affected by the 2001 earthquake in Kutch district (Figure 1), the Government of Iran (Housing Research Centre) as a suitable construction method for the rehabilitation of the zones affected by the 2003 earthquake of Bam (Figure 2), the Government of Tamil Nadu, India (Relief and Rehabilitation) as a suitable construction method for the rehabilitation of the zones affected by the 2004 tsunami of Indonesia (Maini, 2007).

According to Minke (2006), earth as a building material has lost its credibility chiefly because most modern houses with earth walls cannot withstand earthquakes and because earth is viewed a building material for the poor. In this
context, it is worth mentioning that a census conducted by the Salvadoran government after the earthquake of January 13, 2001 (measuring 7.6 on the Richter scale), states that adobe houses were not worse affected than other types of construction (Minke, 2006). Minke (2006) also explained about earthquake resistant earth construction to address the low cost housing crisis in Guatemala. A bamboo-reinforced panelled rammed earth wall technique was developed in 1978 as part of a research project by the BRL, and successfully implemented jointly with the Francisco Marroquín University (UFM) and the Centre for Appropriate Technology (CEMAT), both in Guatemala. In 1998 the BRL developed another reinforced rammed earth wall system that was utilised for a low-cost housing project built in cooperation with the University of Santiago de Chile in Alhué, Chile, in 2001. The examples of these earthquake resistant earthen houses show that contemporary earth construction is durable enough to replace conventional brick and block construction to address the low cost housing crisis even in the earthquake prone localities.

Structural limitation is one of the major drawbacks of earth construction highlighted in Table 2. Related to this, Maini (2005) shows enough examples of buildings with large spans constructed of compressed stabilised earth blocks (CSEB) and the research and development seeks to optimize the structures by increasing the span of the roof, decreasing its thickness, and creating new shapes. Note that all vaults and domes are built with compressed stabilised earth blocks, which are laid in “free spanning” mode (without formwork), which has been developed by the Auroville Earth Institute and this technique is a development of the Nubian technique (Maini, 2005). Figure 3 shows a dome measuring 22.16 diameter of a temple constructed out of CSEB and Figure 4 shows a vault measuring a span of 10.35 meter constructed out of CSEB. Therefore, these
examples support that contemporary stabilised earth construction is able to overcome the drawback of structural limitation.

This section critically analysed the drawbacks (1, 3, 4, 5, 8, 9, and 10 in Table 2) of earth construction which can be addressed and solved by different solutions in contemporary stabilised earth construction research and innovation. On the basis of the evidence found in the literature review that the drawbacks of earth construction can be solved and therefore, the drawbacks identified in the Table 2 are reconsidered, revised and presented in Table 3.

Three of the drawbacks (2, 6, and 7 in Table 3) of earth construction need to be investigated whether they are real or mere speculation as construction professionals are divided in their opinion regarding these three drawbacks. An appropriate research method should be applied to investigate and substantiate the facts of the drawbacks 2, 6 and 7. The fifteen (15) benefits of earth construction identified in Section 2 and the ten (10) drawbacks in Section 3 together counterbalance and are illustrated in Figure 5. This graphical presentation of the counterbalance between the benefits and drawbacks of earth construction help to understand how stabilisation of earth can help overcome the drawbacks of earth construction become beneficial to urban low cost housing.

Figure 5 counterbalanced the benefits and drawbacks, in which it is shown that Seven (07) of the drawbacks can be addressed by the innovation of contemporary stabilised earth construction (empirical evidence found in the literature) and the facts behind the three (03) drawbacks still needs to be investigated in this paper. Moreover from the Figure 5, it is notable that the benefits are significantly more than the drawbacks and logically one can argue that stabilised earth construction is beneficial in urban low cost housing.
After a critical review of the existing literatures, it appears that there is a lack of structured research, to date, carried out counterbalancing potential benefits and drawbacks of contemporary stabilised earth construction in urban low cost housing. The critical review of the literature permit the researcher to recognise and identify the existing up-to-date benefits and drawbacks mentioned by different researcher, in which it appeared that three of the drawbacks are controversial amongst the contemporary earth construction professionals. The benefits and drawbacks of stabilised earth construction found in the literature are recorded in the light of the researchers (professionals) experience and perception. Therefore, the research technique adopted in this paper is in-depth-interviews which effectively collect data from construction professionals and validates the facts behind the three drawbacks (2, 6, and 7 in Table 3).

An interview is a purposeful discussion between two or more people (Kahn and Cannell, 1957, p149 cited in Marshall and Rossman, 1995, p80). An in-depth interview is an open-ended, discovery-oriented method and its goal is to deeply explore the respondent’s point of view, feelings and perspectives (Guion, 2006). In this sense, in-depth interviews yield information. According to Boyce and Neale (2006), in-depth interviewing is a qualitative research technique that involves conducting intensive individual interviews with a small number of respondents to
explore their perspectives on a particular idea, programme or situation. Therefore, the in-depth interview is a technique designed to elicit a vivid picture of the participant’s perspective on the research topic. The in-depth interview technique is chosen as the mode of data collection due to its ability to explore the three (2, 6, and 7 in Table 3) drawbacks of stabilised earth construction in urban low cost housing. Therefore, for this research, the in-depth interview is chosen as a suitable research technique because the results will offer an informed look at the current and potential status of those three drawbacks. A substantial literature review in Section 3 found that the identified drawbacks (2, 6, and 7 in Table 3) suffer from lack of evidence. Due to these glaring discrepancies in the prescriptions made by different researchers in this area, the results of this in-depth interview will be relevant, provide clarification facts behind the drawbacks identified in the literature review.

According to the Wallace Foundation (2009), analysing in-depth interviews involves reviewing the records of the interviews and taking notes to keep track of the findings that are emerging and the two most common strategies for organising notes are: - organising by question and theme. The researcher of this study used the strategy of organising by question to analyse the data. According to Boyce and Neale (2006), in-depth interviews are flexible in that they can be presented in many ways; there is no specific format to follow. However, like all evaluation results, justification and methodology of the study should be provided, as well as any supporting information (that is copies of instruments and guides used in the study). Boyce and Neale (2006) also stated that care should be taken in presenting the in-depth interview data, such as, using qualitative descriptors rather than trying to ‘quantify’ the information. One might consider using qualifiers such as ‘the prevalent feeling was that . . .,’ or ‘several participants strongly felt that . . .,’ or even ‘most participants agreed that’. Providing quotes from respondents throughout the report adds credibility to the information. The researcher should be careful that the respondent is not identified or provide quotes that are easily traced back to an individual, especially if confidentiality is promised (Boyce and Neale, 2006).

As there are a limited number of contemporary earth construction experts in the world, the most notable of these were contacted as expert panelists for this in-depth interview. A list of twenty (20) participants (experts) was contacted from both the private and public sector that would appear to have the required knowledge and/or experience of the subject. Telephone calls were made to follow up the invitation of the experts to take part in the interview. A total of eight (08) individuals responded and agreed to participate. Three (03) of the experts were academician researchers with an average of over thirty years work experience. The remaining five (05) experts were practitioners with an average of ten years practical experience (Table 4). In essence, data was collected through face to face interviews with four experts and telephone conversations with four more experts.
Analysis and Discussion of Findings from the In-Depth Interviews

Each interview session lasted between thirty (30) and forty (40) minutes. The interviews were audio and/or video recorded to facilitate verbatim transcription. Each expert was asked the following two questions:

1. From your experience do you think that the stabilised earth construction in urban low cost housing requires extra cost, extra skilled labour compared to the conventional brick and block construction? If Yes, how? If no, is it then a misconception?

2. Are the professionals (Architects, civil engineers, etc.) make more/less/same amount of money from their customary fees of a stabilised earth construction project compare to a conventional (brick, block) project?

A mixed response was recorded from the interviewees when they were asked if stabilised earth construction required extra labour and cost. One of the experts thought that stabilised earth construction is not cost effective as he mentioned, “No, if it is un-stabilised. Definitely not, in the case of un-stabilised earth construction. As the situation develops and you get competition between contractors, you get scales of economy. You would find that actually un-stabilised earth building would become extremely affordable and very fast.” He further explained how un-stabilised earth construction become cost and labour effective. He suggested breaking the un-stabilised construction scenario into couple of different areas, “We are comparing laying concrete blocks with earth blocks. What is the difference? There is no difference. You are comparing laying
concrete blocks with rammed earth. What is the difference there? The difference is a block layer will probably employ two others, for mixing his mortar, and supplying him and to himself. That’s a team of three. Whereas rammed earth uses a carpenter who will fix the formwork together and then a team of eight or nine unskilled labours. So, there is a different ratio of skilled and unskilled labour. It is labour intensive but the costs are then put into local community and not sent to the cement factory.” It is notable from the expert’s statement that skilled labour is not essential in contemporary earth construction.

Seven (07) of the experts thought that it did not require extra cost, because they argued that although the method of this construction in many developing countries can be highly labour intensive, the unemployment rate is very high and therefore the countries have an immediate large pool of cheap labour. Whereas in the UK the labour cost is very expensive. Cost of construction in the UK is governed by labour cost; in most developing countries it is governed by the material cost, particularly the cost of cement in relation to stabilised earth. The economic benefits will depend on how much cement is used and the technology used in its construction. For CSEB, presses are required; rammed earth requires formwork. In summary, these technologies can be cheaper in most of the developing countries, if the cheap labour cost is considered. Whereas the reverse is true in USA and North America, Australia, and in Europe where labour costs are much higher.

However one of the experts (though he thought that stabilised earth construction is cost effective) said that, to access the cost effectiveness one really needs the thorough analysis of the system of building of this type of construction start to finish. People always say earth construction should be cheaper, and the good reason is that the earth material is plentiful. To determine whether it is cheap to construct with stabilised earth, it depend on the circumstances. For example if one want to build urban housing in any particular country, first it need to see the source of suitable soil, whether it is available onsite or needs to be brought from a long distance. If it has to be transported from distances, it may not be cheaper. Brick may be cheaper in this case. Therefore, we can say this technology may be or may not be cheaper depends on the situation and this needs research to find out. Therefore, if the suitable soil, skilled labour is locally available then this type of construction might be cheaper. Self help type of project might be cheaper as well. The expert further elaborate that, more analysis needed before one start this type technology, situation become very complicated in urban housing if building by laws specifically mentions certain standard of earth block, for example crushing strength of the block, etc. In this type of situation supervisor, skilled labour and specialised professionals required on site if one making the blocks onsite. In this situation this type of construction might not be cheaper. Whereas brick and cement one can straight buy from the designated manufacturer with stipulated standards.

Five (05) of the experts responded that professionals make less money if it is an earth construction project. In regards to professional’s fees, one of the experts stated that, “Architects fees are charged on the total cost of the building. Therefore, if the cost of the earth building is lower than the conventional brick and block..."
building architects will get less money. That’s why professionals tend to increase the cost of the building by suggesting costly material to the clients.” Therefore, if the fees are based on the final cost of the building, their commission will be less, what most architects do on projects which deal with these low cost technologies, they would agree with the client that for the sake of the fees, they would use estimated cost based on conventional materials. It is notable that all these five experts are practitioners. One of these five experts thought professionals get paid less unless it is a prestigious project, as he states, “Professionals make less money, unless it is a prestige project, there would be a small number of prestige projects built in earth, pise or adobe. Clients would be prepared to pay reasonable architects fees for a product which is well designed but expensive to build. So the architect would get a reasonable fee. But many architects believe the community needs this type of projects because it is more economical, it’s a way of providing people housing which they can afford. And they don’t get that type of fees from these building projects.”

Three (03) of the experts see no difference in professional’s fees. It is important to note that all these experts experience working with contemporary earth based on United Kingdom as one of them states, “I have no idea outside UK. Certainly in the UK I would suspect that, because of the associated risk of using a novel material the fees charged by the professionals to do an earth building would be higher than that would be in conventional building. Both the design team and the contractors if they are dealing with novel, unfamiliar technology, they will charge higher fees to cover their risk.” Supporting this statement another expert states, “In terms of delivery of rammed earth buildings, delivery of cob building as they are more expensive to build than conventional buildings.” The expert explains the reason of the extra cost of earth building. According to the expert, professionals dealing with unfamiliar material would charge more not only because of risk but also they might be spending more time themselves on the project. Having to learn thing from first principal they have to do their own research, so they will spend more time even if it is a conventional solution made of brick and block or steel, concrete work where they are familiar. Because of this inevitably the professional fees will be higher.

In the light of the findings of the in-depth interviews in this section the following lessons are learnt:

- Stabilised earth construction is cost effective and not labour intensive in the developing countries where labour is cheap and a lot of unskilled labour is available due to the high unemployment rate. Therefore, stabilised earth construction in low cost urban housing is beneficial dependent on the labour cost and the availability of the suitable soil on site.

- Stabilised earth construction is not cost effective and labour intensive in the developed countries where labour is expensive and skilled labour is unavailable.

- Professionals in the developing countries make less money from earth construction projects compared to the conventional brick, concrete construction projects because of the prejudices and wrong perception about the earth building.

- Professionals in the developed countries make more money from earth construction projects
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compared to the conventional brick, concrete construction projects because of the labour intensiveness, novelty of earth as a building material, and unavailability of the skilled labour in contemporary earth construction.

Conclusions

This paper has investigated and analysed literature and argued that contemporary stabilised earth as an alternative material in the construction of urban low cost housing. The counterbalancing of benefits and drawbacks of contemporary earth construction was analysed from the literature review and it was found that the majority drawbacks of earth construction can be addressed by up to date research and innovation of contemporary stabilised earth construction. Three of the drawbacks were investigated in this paper through a series of in-depth interviews as these were not addressed in the existing literature. It is found that stabilised earth is affordable and would be an appropriate alternative to conventional building materials in the case of urban low cost house construction in developing countries. In addition, the benefit of contemporary stabilised earth construction is greatly dependent on the labour cost and the availability of the suitable soil on site. Stabilised earth construction does not require extra cost, time, and skilled labour constructing low cost urban housing in the developing countries. But construction professionals make less money out of earth construction projects compared to the conventional construction projects.

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