Exploring the Potential of Modern Rammed Earth Materials in Enhancing the Aesthetics and Sustainability of Rural Community Construction: A Case Study of Duniyapur, Punjab

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Abstract

Earthen materials have been an integral part of the growth of rural dwellings for thousands of years. However, with the homogenization of architectural styles and the lack of cultural atmosphere in the construction of beautiful countryside, the development and application of modern earthen materials have become increasingly important for the future construction of rural communities. This research paper focuses on mud dwelling houses in rural areas of Punjab and constructs a liveability evaluation system to analyse the residents' satisfaction and optimize modern earthen dwelling houses. From the theoretical perspective of "Ternary mutualism", this paper proposes that the relationship between modern earthen materials and rural communities is mutually beneficial. Modern earthen materials serve as the natural foundation, charm display window, and practice platform of rural communities, while rural communities embody the value of modern rammed earth materials, protect their continuation, and promote multiple innovations. Based on this, the paper proposes a construction path of modern earthen materials in rural communities to provide reference for future construction. The research results show that modern earthen materials

a a a a , a c a ba c a a [4].

Results and Analysis

T a a ab a c M a , a c c a a c . U a c , a a x ab a a c c ac a a c . A c c a a a a , x , a , - ca a 28 c - ca c . c ca ba c c c , , ab , a c , a ca [5]. U a a c a c c , a c ac ac x acc 9- ca . a ac ca a aa V10.3 a , a (Tab 1). R ca a c a a a a ca , b a c , c ca a ca , c c a , a c a c . a c a ca a ca . I c c , c c a a c ab ab a a a ba c c c , a a ac ca c a c .

Table 1: Determination of weight value of each indicator.

Index	Weight	Questionnaire
Social economy	0.1219	Q1-Q3
Cultural level	0.0166	Q4-Q5
Per capita income	0.0586	Q6-Q7
Household consumption level	0.0113	Q8-Q9
Industrial development	0.0354	Q10-Q15
Ecological landscape	0.1802	Q16-Q18
Greening level	0.0451	Q19-Q21
Local landscape	0.0451	Q22-Q25
Sustainability	0.0901	Q26-Q27
Housing conditions	0.3389	Q28-Q31
Planning layout	0.0255	Q32-Q33
Living area	0.0077	Q34-Q37
Structural safety	0.0991	Q38-Q41
Material use	0.0368	Q42-Q47
Auxiliary housing	0.0091	Q48-Q50
Livestock breeding	0.0151	Q51-Q52
Room temperature control	0.0087	Q53-Q57
Ventilation and lighting	0.0424	Q58-Q60
Seismic performance	0.0944	Q61-Q63
Infrastructure	0.2356	Q65-Q67
Road facilities	0.1009	Q68-Q71
Water supply facilities	0.0601	Q72-Q75
Drainage facilities	0.0404	Q76-Q78
Power telecommunications	0.0194	Q79-Q82
Sanitation facilities	0.0148	Q83-Q85
Community cultural environment	0.1233	Q86-Q88
Supporting service facilities	0.0117	Q89-Q91
Public security conditions	0.006	Q92-Q95
Neighbourhood relations	0.0415	Q96-Q100
Public space	0.0117	Q101-Q103
Cultural atmosphere	0.0123	Q104-Q106
Mental belonging	0.0171	Q107-Q108
Cultural heritage	0.0229	Q109-Q110

a a a c a a ab a a c M a , a c c , a c , c ca a ca , c c a , a c a c [6].

Analysis of resident satisfaction evaluation

I a c c D a a , ba a a ca a c ab [7]. a a a ac a a ca a c a , a , ba ca a , a , a a . A a 120 a a a c c a a a a a ac a ab . I a D a , a 50% a a c , ca c - c c c [8]. ac a a c a , a a a a c c . H , a 70% a a a a a ca , c ca b a a . A a , a ab a ca a a c ca c . A , x c c ab c a a , c a c , a , a a a [9]. a a b a b c a , a a , c a c , a c b . W ab 40% c a a a a , a x a 20% a a a , b a a b c [10]. R a a c , x a ac a , a , a a a ac , ca a ac ba c c c a a a . H , a a a c c c ca a a a ac . A c c a , a ac b a a b c c , ca a a a (F 1). H , a 50% x a ac b c ac , ca c a b c ac ac a c a xc a . O a , a a c - c c, , a c , a c c a D a a . A c c c a a [11].

Development of a habitable earthen community evaluation system

Ra a a b a a a a a c a a a . T a , a a a a ca a a a a [12]. H , a a c c c b c , c c a c aba a a c a a c a c c a a c a ac . a c c " a a ," a a c a b a ac : a a c , a c ac , a c ca a . Na a c c ca c , c a , , a c ca , a . H a c ac c c a a a , c a a , c a ac , a a c c c . T c ca a a a , c c ca ab , a c . a a c a ac c c a c a a a a , c a ab a a a c c [13].

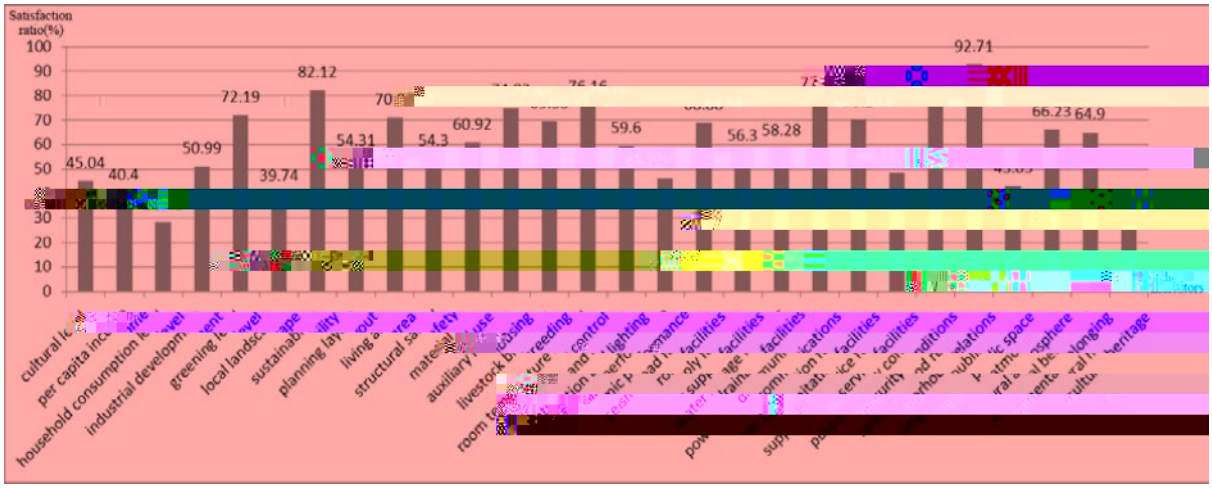

Figure 1: Residents satisfaction with relationships and public security.

Table 2: Summary table of improvement methods for structures in the earthen houses.

Component	Instructions
Foundation	Set 300-500mm brick, stone, or concrete foundation. Set moisture barrier between foundation and rammed earth wall.
Wall structure	Set wood structure column at the junction of the four corners of the rammed earth house and the inner and outer walls. Set wood ring beam horizontally in the top of the rammed earth wall to enhance the integrity of the rammed earth house. Connect the wooden ring beams by lap joints or picks. Arrange long horizontally pulled bamboo strips inside the rammed earth wall, and make lashings at the junction between the vertical and horizontal walls. Set up vertical pins such as short wooden sticks and bamboo strips with a spacing of not more than 1 meter in the upper and lower seams of the rammed earth wall.
Building and roof structure	Place lamellar wooden beams on the cross walls and gables for the sandwich foor structure. Fix them seamlessly to each other and connect them with horizontal wooden beams. Place a wooden pallet under the wooden purlins to reduce the local compressive stress of the wooden truss for the roof purlin structure. Set the wood wall to resist earthquake. For the wooden slope roof structure, lay the wooden rafters under the wood purlin with bamboo mat, grass mud, and green tiles.

Ra a a a a a c ca a , a c c c a c ca c c a a ab . M a a a a a c a a c a c , c , , a c a c . a a a a c c c a c a ca c , a a c c a a c a -b . c a a c c a c a c , b a a b a c a c a a ac , a - c c b [14]. M a a a a ac ca a c a ac c c a c , a b a a a c ca . I c c , a a b a a c , a c ac , a c ca a ca c a a b a c c a ac c c a c a a a a a [15]. a a ca c a a c a a -b a ac ca a a ab a a c .

Creating a beautiful rural cultural community: e path to success

I c c a a c , a ac a a a a a a . ca b ac b a b c ac , b c c ac , a a a . a a c a a ab a c a c , a , , a b c a c a b c ac a a c a a a c . M a a b c a a a c a a a ac . a ac ca b b c a a ac [16]. a a ac , a ac , a , a c ac , a c a a ac a a ac a a ca ba c a c ca . A a ac b a c a c a a a , c a a b a c a c a a [17]. M c a a b c c a a a , x c a a a ca , a ac , a a x . C a c , a , a x ca a a a a a a a a a a a a a [18]. c a a b c ba c ca c a ca a . Tab 2 S a c a . x ca a c x a c aca c . C a ca a b c a c a a . T x a ca c a x a a a a ac ca a c x c , b ab a a ac a a [19]. a c a a a a ca b ac b , ba b , , a b c ac b a ca . a ca a b c a c c a a ab a . C c c a a c c . I a a a c a c x a c a a a a a a a a b , b , a c b . T a a c c c a a a

b a c ca , a c , , a c a c c a a . c a x a c a c c c a a b a b c a a . c a c a c c , c a c a a ca , c , a c a ac , a c a c a c x c x a a b [20].

Conclusion

P a a c c , a c c a c , a a c ca c a a a c a a , a a a a a . a a a x c a c c a ca b a a a a , a a c a a a a c a a ca . H , a a a , b a a a a a c a a a b a a ab a a b b a c c a c a a a a c .

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