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Rehabilitation and Cost Effective house for Sustainable Rural Development - A Case Study of Landslide affected Dasgaon village in Maharashtra

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***Abstract*— Globally rehabilitation of housing in post-disaster situations, especially post landslides, earthquakes, floods, cyclones etc., have been extensively studied in the last few decades. The vital issue which universally is demanding is the kind of construction materials are to be used in such situations and how construction management will play it role. Hence the interest primarily relates to the large amount of economics that is invested in reconstructing large settlements either by the state or by voluntary agencies. More so, the major victims of any natural disaster across the globe are the poor, who lose their capacity to revive their lives.**

On 26th July 2005, out of many villages which suffered a major landslide disaster, a village named Dasgaon in Raigad district of Maharashtra faced heavy landslide which caused the destruction of life and property along with their dwellings. Our research study attempted to understand the cultural, technical, structural and economic complexities that were involved in rebuilding those dwellings and coming up with a cost-effective solution. The dwelling has been designed to withstand severe landslides, earthquakes and floods etc to the best considering all the above-said aspects. Illuminated by natural light during the day and with provisions for proper ventilation, this house is drafted to foster a healthy living. This research also emphasis in cost effective construction materials. We provided a dwelling for the poor villagers where a sense of stability of elementary values of protection exist and gave better livelihood To develop a framework within design where incremental physical development can take place within the settlement. This paper presents and applies a conceptual framework to deal with Nature's vulnerability actions such as landslides, earthquakes, floods, cyclones etc. Drawing upon Construction Materials and Management based approaches, the conceptual agenda provides a unifying lens to examine links between knowledge, implementation and construction along with managerial techniques. The outcome is an integrated approach to provide a dwelling for the poor villagers where a sense of stability of elementary values of protection exist and gave better livelihood and to increase the opportunities for sustainable development.

Index Terms: **Construction management, Construction Materials,Framework, Landslides, Rehabilitation**

I. INTRODUCTION

Human beings have a history of mitigating climate risks and climate changes. Habitation and livelihood choices are shaped by the need to manage climatic risks, especially in rural low-income household areas. Even so, climate events continue to bring devastation. Recent predictions indicate that climate changes are accelerating and will lead to wide-ranging shifts in climate variables. There will be changes in the mean and variance of rainfall and temperature, extreme weather events, food and agriculture production and health.Anne T. Kuriakose et.al , (2012)

Rich in flora and fauna, the Konkan region is considered a slice of paradise in Maharashtra is on the verge of decline. Efforts have been made to conserve the bounty of this beautiful coastline which draws curious tourists to its calming serenity.This abode of splendour was struck by a terrible tragedy in 2005.On 26th July 2005, heavy landslides due to incessant rainfall caused extensive damage to life and property across the hills, with Dasgaon in Mahad alone registering 150 deaths in the Raigad district of Maharashtra. Being a coastal region and prone to calamities, Konkan needs a helping hand to uplift it during and after its recurring mishaps. Funding cannot alone offer solace to the displaced people of this region. A stable shelter is what they really need to restore their lives and pride. Lineament in Konkan plain is shown in **Fig.1**

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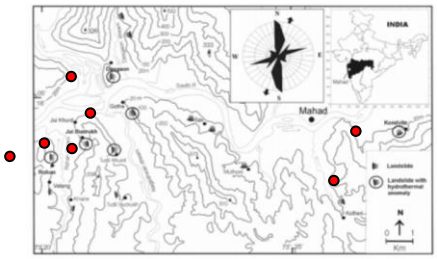

Fig.1: Map showing location and orientation of landslide. (Inset) Azimuth frequency diagram for lineament in Konkan plain (after Widdowson and Mitchel)

The area displaced a number of households and required rehabilitation. It was decided by the state government to rehabilitate the affected area to a site nearby as shown in **Fig.2**and**Fig.3** However, even after ten years of the tragedy, the victims are yet to be rehabilitated forcing them to take shelter in temporary houses made out of Galvanized iron sheets. It is difficult to measure the damage the scars are not just skin deep but lead to life altering and lasting emotional damage.

Fig.2: Source: aaplekonkan.com/Dasgoan Darad 2005

Fig.3:Temporary shelters Dasgoan

II. LITERATUREREVIEW

Many case studies states various paradigms such as Disaster management policies and Materials Technology.

Review on Disaster Management

As mentioned above on research article written by **Pande, (2007)** emphasis in his research study about Uttaranchal's disaster management mechanism for reduction of effects of disaster, i.e. damage to property and loss of life and the rapid and effective rescue, relief and rehabilitation of the victims. Uttaranchal has no resettlement and rehabilitation policy. In India only three States, Maharashtra, Madhya Pradesh and Punjab, have state-wide resettlement and rehabilitation (R&R) policies.

Another study by **Murao, (2008)** considered a different approach towards this problem where he did a case study of architecture and urban design on the disaster life cycle in japan which acknowledge the fact that spatial design is an essential component of disaster management, the inter-relationships between these fields have rarely been considered in literature. The purpose describes a scheme for integrating the areas of spatial design and disaster management based on architectural, urban design, and landscape design case studies one of the most disaster-prone countries in the world, Japan. This paper describes the significance of these developments from the viewpoints of the location and social background, and a variety of historical and regional examples related to disaster management are also introduced within this context. The examples are classified into four categories with regards to the purpose for which they were implemented (mitigation, preparedness, response, and recovery) and are defined by the theoretical notion of Disaster Life Cycle for disaster management.

S.S.Thigale et.al, (2007) Considered a field investigation in his research to study the physical framework covering climatic, geologic, geomorphologic and seismologic information on disastrous landslide episode of July 2005 that killed 190 people and gave rise to hydrothermal anomaly. Structured interviews through an appropriately designed questionnaire were also conducted to collect first-hand information from the people who had witnessed the events and those who were involved in rescue operation to throw light on the causative factors responsible for the landslides and generation of hydrothermal anomaly.

Review on Construction Materials

A K Kasthurba1 et.al , (2014) Mentioned in their research work of Materials and Technology use of local material laterite is an important step to save embodied energy, and protect the environment. This paper advocates the use of local laterite a soil type rich in iron and alumina formed under hot and wet tropical conditions due to its cost

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effectiveness and energy efficiency than that of conventional modern materials in developing countries.

S.K. Jain, (2011) This paper summarizes the occurrence and characteristics and properties of laterite as a building material on the basis of testing protocols to facilitate evaluation and extensive use laterite in building applications. Conducted his study to determine the engineering properties viz. compressive strength, toughness index and water absorption capacity of the laterite stone scrap blocks as a building material. Paddy husk ash, saw dust and processed fly ash were used as other constituents and added to the laterite stone scrap in the range of 3 to 9%, 3 to 9%, 20 to 30%, respectively The cement was used as binding material and added in the range of 8 to 16%. The lowest cost of laterite stone scrap block was found to be Rs. 22.94 for the block having 85% laterite stone scrap, 12% cement and 3% paddy husk ash which satisfies BIS standards

K Nagarajan et.al, (2016) Infilled walls concepts with opening of doors and windows were research and the optimistic approach for opening were studied in the paper

III. GAPS IDENTIFIED IN LITERATURE REVIEW

As the Literature view broadly was conducted on disaster management and materials, the following gaps were found out as stated below

• Poorly defined relationships between spatial design and disaster management, that advocates a new interdisciplinary field between architecture and disaster management.

• Pre-design penology that helps in analysing the feasibility report on the basis of applied survey of the affected area.

• Construction Technology using laterite as a building material, building construction techniques of moulding a material into an architectural element.

IV. PROBLEM STATEMENT

Currently over 60 million people **Mid -year trends,(2015)** caught in a whirlwind of displacement, initiating an ever increasing global resettlement crisis. Looking for a decent place to live, while tackling the affordable housing crisis is seemingly getting difficult by the hour. Nevertheless, on the frontlines of the built environment there lingers a hope to improve the quality of life, while working on fringes and under disastrous circumstances.

The master plan was based on the earlier sanctioned government plan, which is designed around a central spine containing provisions for local businesses, rickshaw stands, and a permutation of the four models.

V. AIMS AND OBJECTIVES

The objective was very simple yet economical and eco-friendly, hence the below points elaborate along with site plan maps

(Fig.4and Fig.5)

Fig.4:Master plan for Rehabilitation PlotDasgaon affected area.

- To provide an affordable dwelling module for the villagers.
- Designing a cost efficient dwelling aimed in helping the families affected due to the event.
- Innovating construction techniques for landslides prone areas.
- Identity and Aesthetics: Needs are not Desires. You can answer needs, but people will still have desires. **Aravena** hence the realization that an intervention model that while replicating itself also helps in Identity building of the community at the same time leaves a margin for growth.
- Flexible and Incremental: To yield the key elements of a house at subsidized rates, while encouraging the residents to expand into the adjacent spaces as and when economically viable.
- Intuitive growth and Efficiency: An intuitive approach was taken where the People, the Architects and the Volunteers participated in the building process. This helped in creating confidence and helping the residents gain the lost faith in the system.
- The local knowledge of the abundantly and easily available local materials, as well as salvage goods,

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helped us in further decreasing the cost of the model.

- Fundamental: Built solution to sustain a requited lifestyle meeting the community's socio-economic objectives.

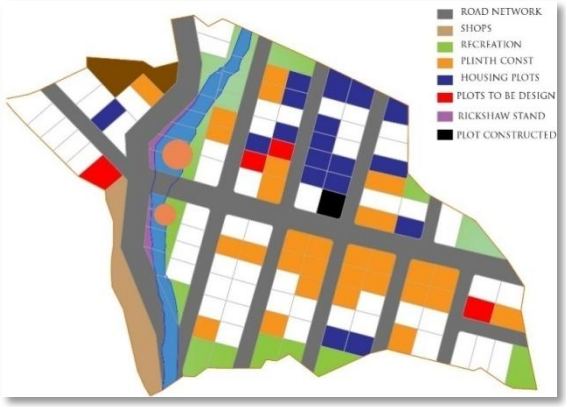

Fig.5: Planning proposal for Rehabilitation Dasgaon affected area.

VI.METHODOLOGY

The methodology consists of various essential values for better living environment with keen research and documentation as shown in **Fig.6**.As per the study both conventional and cost effective building materials are readily available. Among these the most relevant option has to be selected on the basis of ease of transportation, cost effectiveness and ease of use. While the design is flexible to the creative freedom of the user to use any material available and affordable such as brick, rubble or laterite, we built the first module in laterite masonry. It is a locally available building material, cheaper than bricks. The ideation of the first module was approached at multiple levels owing to the constrain that the module was to be built on the already constructed plinths. This posed as a challenge because the footings for these plinths went only a mere 600 mm deep. A reinforced concrete belt had to be built around it to strengthen the structure. The same built is repeated at three more levels in the super structure, at the sill level, lintel level and at the pitching level of the roof truss.

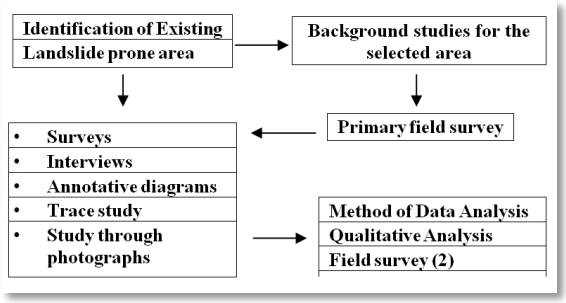

Fig.6: : Flow chart showing the breakdown of methodology for the Research.

Upon taking an approximate estimate of the 3 cases as shown in **Fig.7** we came to a conclusion that the case 3 works best in terms of affordability and ecological responses. Laterite is a locally available materials with few of the largest laterite producers situated in the area. Mangalore roofing tiles are native to the Western Ghats region which experiences a heavy rainfall and hence making thatch or acrylic roofing not suitable.

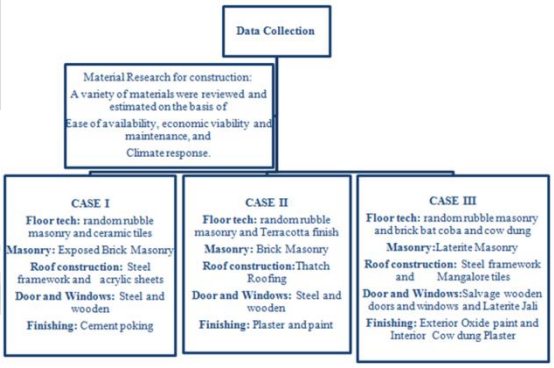

Fig.7: Flow chart showing various cases for construction

Fig.8a and Fig.8b shows 3D representation of the module and Plan of the module (showing the design proposal of a module for Dasgaon affected area out of laterite as a building material.)

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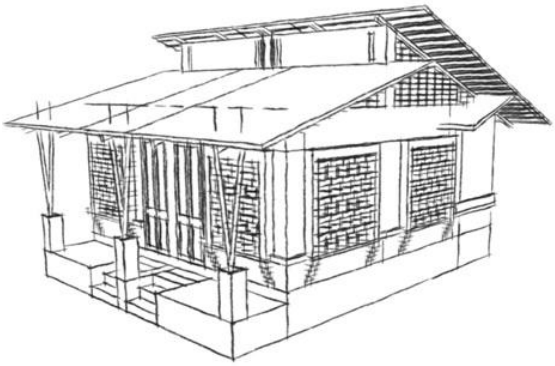

Fig.8a 3D representation of the Module

The cost for foundation and plinth was relatively suppressed as the plinth for the house was already made by the previous organizing committee. K.V, (2001) Even then the approximate cost for making the plinth and foundation with rubble dry pack masonry would cost a total of Rs. 12,000/-

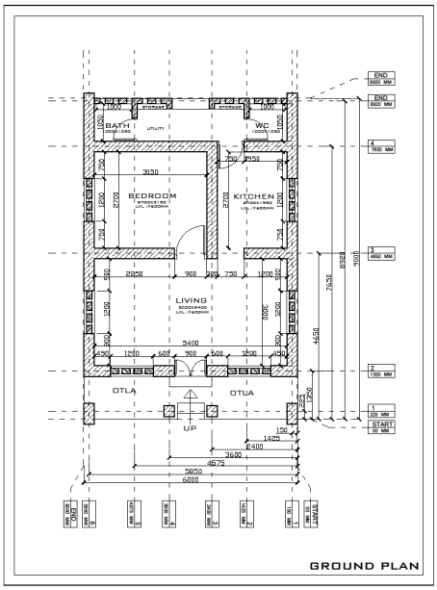

Fig.8b Plan of the module

The flooring is made up of Brickbat Coba and coated with the cow dung mixture with lime as a stabilizer. In the temporary shelters provided by the authorities we see a major shortcoming in the basic sanitation facilities.Construction process is shown in **Fig.9**We tackled it by providing toilets with a leach pit/dry toilets, which require very little water compared to a normal latrine. The bathrooms and toilets were provided with cement oxide flooring.

Fig.9: Image showing the construction process (a,b,c,d)showing Construction of plinth beam,

Laterite masonry work,Mangalore tiles used as roofing material, Cow dung and lime has been used for Flooring and internal plaster upto sill level respectively Windows, frames and Mangalore roofing tiles were salvaged from nearby houses that were undergoing demolition due to a road widening initiative. The other openings were designed in brick Jaalis, and so was the flag. The roof had glass Mangalore tiles to allow light from the roof. New Mangalore tiles which would have otherwise cost us Rs.6/ tile, now cost us only Rs. 2.5/ tile. The doors and windows were cleaned and polished before use. Mangalore tiles was our ideal choice as a roofing material, given that it is easily available and responds well to the local climate.

VII.RESULTS

We made a comparison between the following conditions to draw a conclusion between Exposed bricks, Bricks and Cement plaster and Laterite stone.The module measures 20' X 24' cost Rs.1,40,000/- in total.Construction cost Rs.320/sqft

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Fig.10 (a,b,c) Completed Dwelling unit at Dasgoan.

Expose Brickwork , Plastered Walls and Laterite Masonary costs Rs. 108000/- , Rs. 100000/- and Rs. 45,200 /- respectively. See **Fig.11**

Fig 10shows Completed Dwelling unit at Dasgoan.The exterior of the module was exposed laterite, painted with a coat of red oxide and cement lime mortar in the ratio of 1:1:8. Red oxide has excellent adhesion and rust inhibiting properties. The interior plaster was done with a mixture of cow dung and husk, while using lime as a stabilizer.

IX. CONCLUSION

Moreover, in Raigad district people at large are dependent on the slicing, sizing, collecting and transporting of laterite blocks. Therefore, it only made sense to use a material that was a product of the region as it encouraged the local laterite industry to flourish.

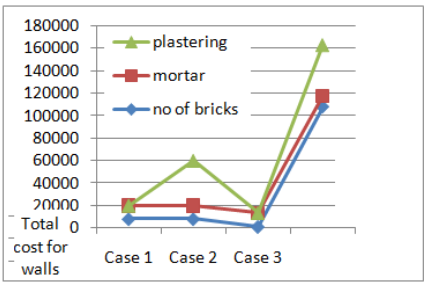

Fig.11: Results

The restrains jointly imposed by the natural calamities, the volatile conditions of the land and cost restrictions serve to curb the scope of design to a degree. But it cannot be wrongly interpreted as delivering disposable solutions. Hence this initiative is to raise awareness of building cost affordable housing and at the same time fostering independence as well as communal and mutual interdependence.

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