International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 08, August-2022

Designing of A Landslide Resistant Building

Aysha M K[1], Bisma Shajir[1],Harshad Munna[1],Rania Basheer[2]
[1]Students, Department of Civil Engineering MES Institute of Technology & Management, Chathannoor, Kollam, Kerala, India
[2]Associate professor & Head, Department of Civil Engineering MES Institute of Technology & Management, Chathannoor, Kollam, Kerala, India

***Abstract*—— Landslide is a natural disaster damaging the social life every year. It can be defined as the movement of mass of rock, debris down a slope. It occurs due to natural or manmade activities. Asia was found to be the most affected continent where 75% of landslides occurred. India also faced the loss of humans due to landslides which occurred last year during monsoon in Kerala.Landslides can result in enormous casualties and huge economic losses in mountainous regions. In order to mitigate landslide hazard effectively, new methodologies are required to develop a better understanding of landslide hazard. To reduce future risks, it is important that a lot of attention is paid to the structural design of the buildings.Conventional methods of prevention of landslide includes Sponge City, Green Roof, Flood Warning Mechanism etc. This study was aimed to design a building itself which can resist the ill-effects of landslide. Implementing some mechanical devices on a light weight building can resist the effects of landslide on the building. Accelerometer sensor can detect the vibrations in the soil and check the movement of land. These sensed data is transmitted to the microcontroller board which is already coded with the desired values. By analysing the values the building can be raised to a certain height with the help of a hydraulic system. As the building is made with light weight materials it should be easy to raise.**

Keywords—Galvanized iron frame,Bison panel,Accelerometer sensor,Hydraulic system

I. INTRODUCTION

According to a study by the Geological Society of India, 43 per cent of Kerala's total area is located in landslip or landslide-prone regions. According to Natural Hazard Proneness Assessment by the National Centre for Earth Science Studies 1,848sq.cm in Kerala, extending along steep slopes of Western Ghats (i.e., mostly in Wayanad, Kozhikode, Malappuram, Idukki, Kottayam and Pathanamthitta districts), is highly prone to occurrence of landslide.

In 2019, Kerala witnessed 80 landslides in eight districts over three days and death toll crossed 120.In 2018, about 341 major landslides were reported from ten districts. Idukki district was ravaged by 143 landslides, resulting 140 death. The stable areas had become susceptable to landslide. Primary reason for the expansion of susceptible zones is unsustainable, unscientific construction.

Lanslides are hazards all over the world. Landslide prediction, detection and monitoring have been done by researchers for different case studies all over the world. Landslide detection can be done by using diverse methods like visual inspection using image/video processing, satellite remote sensing, using statistical methods. The main objective to study the landslide detection is to prevent the natural calamity by detecting its early movement. This will reduce or save the human loss caused by the landslide. Also, the objective is to find a certain way in which the sensing elements should respond quickly to rapid changes.

In analytical studies it is noted that, there are a number of technologies have been proposed and used for landslide monitoring but in all these methods we can be only detect the landslide and can not take any necessary methods to protect the existing structures. By implementing these techniques on a building helps to protect the whole structrure including the living things in the structure.

A. Significance of study

On 16th August 2018, severe flood affected the South Indian state Kerala due to heavy rainfall over the region.Over 483 people died and 14 went missing and an estimated propertydamage around 400 billion dollars.Our challenge is to keep our cities and our planet liveable, safe, healthy and attractive throughout this century.Our cities need to become more resilient to be able to tackle thesechallenges, as a lack of resilience will not only lead to a deficiencytechnical infrastructural functioning but will also have consequencesfor a city’s social and economic well-being. So the need of the hour is the implementation of a safe structure related to such extreme conditions.The main advantage of idea is that it is an economical solution for flood mitigation.

II. MATERIALS USED FOR CONSTRUCTION

Materials Used

The building is designed in accompany with various mechanical devices which helps to rise the entire structure, for which the overall weight of the building should be not as much as that of conventional building. Here we are planning a 1400sq.feet single storeyed building. For a conventional building of 1400sq.ft, its average weight should be around 80,000 to 160,000 pound. We cannot lift this much weight, so we have to reduce the entire weight of the building. For this purpose we are using light building materials which can reduce the weight of the building and at the same time it also provide sufficient strength to the building.

The materials we used here for the construction are:

GI Frame (Galvanized Iron Frame)
Multiwood
Bison Panel

A. GI Frame (Galvanized Iron Frame)

GI (Galvanized Iron) frame is a framing system that utilizes professionally engineeredcold-framed galvanized metal section and prefabricated truss elements that suits theroof,walls designs of homes, commercial & institutional projects. Galvanizing is the process of applying a protective

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 08, August-2022

zinc coating to steel or iron, to prevent rusting. The most common method is hot-dip galvanizing in a bath of hot, molten zinc. In developed countries most larger cities have several galvanizing factories and many items of steel manufacture are galvanized for protection. Typically these include: street furniture, building framework, balconies, verandahs, staircase, ladders, and more. Hot dip galvanized steel is also used for making steel frames as a basic construction material for steel frame building.

Fig 2.1 GI Frame

B. Multiwood

Multiwood refers to a white sheet that is supposed to be made of a "U" Pvc polyester resin. It is completely recyclable that is great to look and environmental friendly as well. It can be used in moisture prone areas without any worry. Resistance to chemical, water proofing features, fire retardant characteristics, bending features etc.makemultiwood a real edge over wood and hence suitable for both. Multiwood can be screwed, drilled, planed, carved, painted and glued also. Owing to its versatility, it has been widely used for interior decoration and for many customized applications. Resistance to chemicals, waterproofing features, fire-retardant characteristics, bending features etc.makesmultiwood a real edge over wood, and hence suitable for speciality applications. Even best quality MDF or PLYWOOD is not terminate or waterproof and hence will perish in few years time. It gives lifetime guarantee for its qualities. It is ideally suitable for both interior and exterior use

Fig 2.2*Multiwood*

C. Bison Panel

Bison panel is an cement bond particle board made out of 62% cement and 28% wood. Due to adoption of special manufacturing process, the panel acquires the strength and durability of cement and the workability of wood. Bison panel are extensively used for several interior and exterior applications such as roof sarking of the modern airports in India. Bison panel are fire, termite and moisture resistant. It is a cement bonded particle boarded that is fire, weather, and termite resistant, a good sound insulating material, dimensionally stable, possesses a smooth surface with wood workability, and is chemically stable. It is a unique all purpose particle board that can be employed for a multitude of application both for interiors and exterior use.

Fig 2.3 Bison Panel

Mechanical Equipments Used

We have used light weight materials for the construction of the superstructure, now for the lifting of building here we are suggesting some mechanical devices which helps in rising the building with in minutes. The devices we are using for lifting up the building are:

Accelerometer Senso
Microcontroller Board
Solenoidal Valve
Hydraulic System

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 08, August-2022

D. Accelerometer Sensor

Accelerometer sensors are the devices which can measures the acceleration of any body or object.it can be used to measure seismic activity, inclination, machine vibration, dynamic distance and speed with or without the influence of gravity.

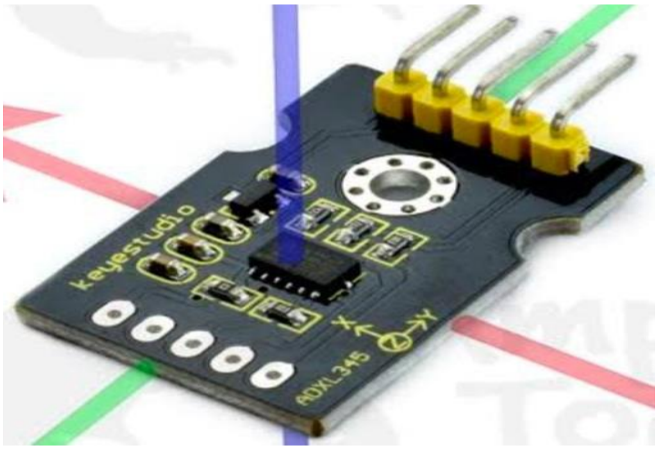

Fig 2.4 Accelerometer Sensor

E. Microcontroller Board

These are used to evaluate programs for embedded devices. Here the vibration detected by sensor are given into the board which is already coded and the board will cross check the input frequency to the coded frequency.

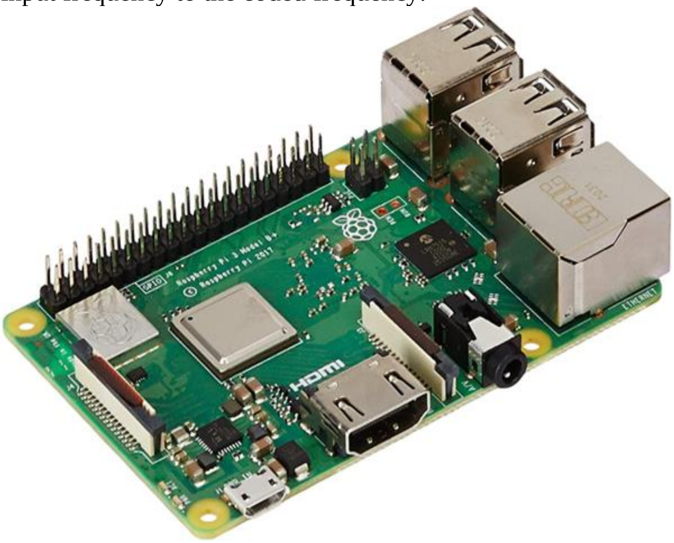

Fig 2.5 Microcontroller Board

F. Solenoidal Valve

It is an electromechanically operated valve. They are most frequently usedcontrol elements in fluidics. There task is to shut off, release, dose, distribute or mixfluids.

Fig 2.6 Solenoidal Valve

G. Hydraulic System

Hydraulic control system includes a pressure regulating part for regulating hydraulic pressure generated from a hydraulic pump to constant line pressure, a manual valve selectively supplying hydraulic pressure to a drive pressure passage.

Fig 2.7 Hydraulic System

III. CONSTRUCTION AND WORKING DETAILS

This chapter deals with various construction details and working details of the landslide resistant building.

A. Construction Details

As we are using less weight building materials, conventional type construction is not possible here.So here we are suggesting a new methodology for the construction of the building.

1. *Foundation*

GI frame incorporated reinforcements are provided as the foundations for the building. Well arranged reinforcements acts as the load bearing structure and from there the loads are transmitted to the ground through the four pillers provided on the four corners of the foundation. These pillers acts as the support to the entire system and also the hydraulic lifting system are contained in these pillers.

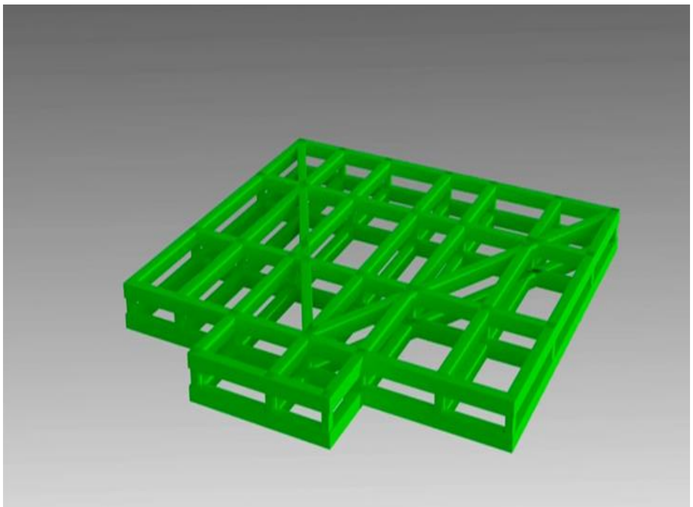

Fig 3.1*Steel Reinforcement*

2. Super Structure

GI Frames which are sandwiched in between multi wood panels are used as the exterior and interior walls of the building. It can acts as the load bearing part of the building. Around 3mm sized each multi wood panels are used here.GI Frames of dimension 8'' are provided on the main wall and of 6'' are on the interior wall. Roofing and flooring of the building is made with this frame and bison panel. Bison Panel with the reinforcement can withstand the load acting on the structure.

3. Flooring

Bison panel with GI Frame can be placed as the flooring of the building. 6mm thickened bison panels can be used. Above which tiles or any other flooring materials can be used, which would be as same as conventional building. These bison panels with the reinforcement can provide adequate support to the structure.

4. Roofing

Bison panels embedded with the reinforcement are also provided as the roofing of the structure. Either sloping or flat roof can be provided but sloping roof should be more convenient, as it would be more resistant to the wind loads and provides proper aeration to the building.

B. Working Details

To protect the building from landslide we have to implement specific equipments in it. These equipments helps the building to rise during landslide. During the time of landslide there should be vibrations within the underground soil strata. These vibrations are detected by accelerometer sensor and it identifies the frequency and intensity of the landslide. Then these datas are transmitted towards the microcontroller board. The board is already coded with the frequencies and the height to which the building have to be raised according to the intensity of landslide. The board crosscheck the data from the sensor and operates according to it. The datas that obtained from the board are then passed to the solenoidal valve which acts as a connecting link between board and the hydraulics lifting system. According to the input data the hydraulics lifting system uplifts the building to desired height with respect to the intensity of landslide. As the weight of the building is already reduced without any difficult we can raise the building and the debrises will flow underneath the raised building. All these processes will be within a minute.

Accelerometer sensor are put into the ground at about 10m depth from the foundation. The output from the sensor are transmitted in the form of voltages through electric wires to the micro controller board which is placed under the ground near the sensor. Microcontroller board and solenoidal valve are placed inside a box which we named as controlling box. Connections from these devices are provided to the hydraulic system which is in the four corner pillars.

Fig 3.2 shows connection of sensors and controlling box.

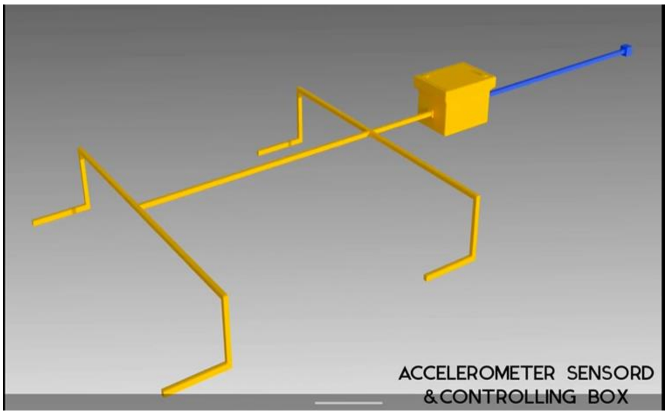

Fig 3.2 Accelerometer sensor & Controlling box

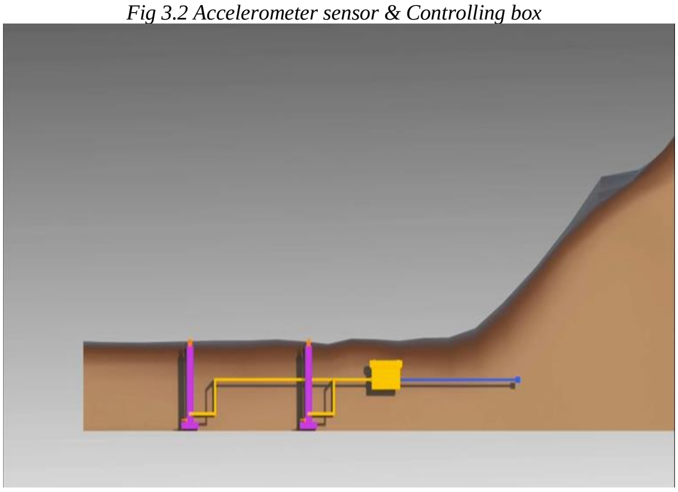

Fig 3.3 Connections to the pillars

Then these system is connected to the pillar in which the hydraulic system is inbuilted, Fig 3.3 shows the connection of the controlling box and the sensor to the pillar. On the top of the pillars, the foundation which is made with the reinforcements are laid and above which the superstructure have to be constructed. Up to here the building should acts as a normal building. During the time of landslide or in early, the sensor detects the unfrequent vibrations on the ground. Fig 5.4 shows the sensor detecting vibrations. These frequencies are transmitted to the controlling box.

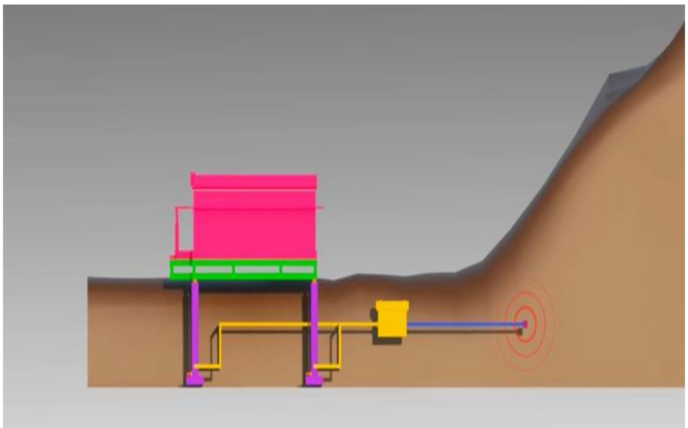

Fig 3.4 Sensor detecting vibrations on earth

The frequencies detected by the sensor are cross checked by the micro-controller board and sends the signals to solenoidal valve, it initiates the hydraulic system. All these processes are happening within seconds

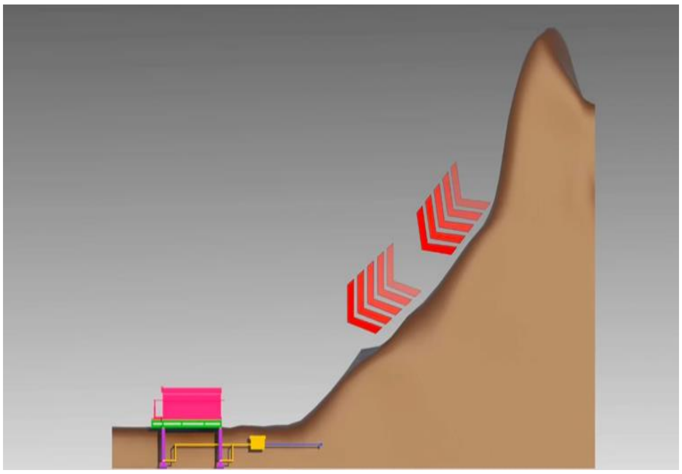

Fig 3.5 Landslide approaching

Within the time period that the debrises reaches the structure, the entire structure rises upto the desired value of height in accordance with the intensity of the landslide and the landside matters will flow through under the building. Thereby properties and peoples could not get any damages or injuries

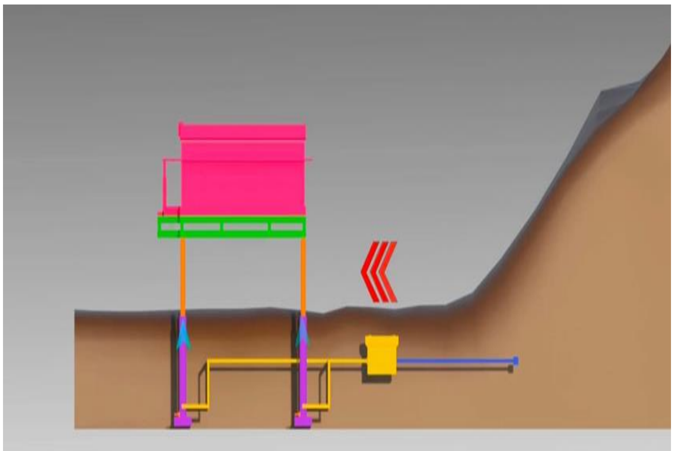

Fig 3.6 Uplifted Building

As this mechanism is fully automated, there should not get any destruction even if the landslide is happening on night time or no residents are in the house. Complete protection will get to the inhabitants in the building and no property damage occurs. By using flexible pipes for water pumping and electricity, there should not occurs any hinderences in water and power supply.

IV. PLAN AND ESTIMATION

This chapter deals with the plan and estimation of the building. We are designing a normal single storeyed residential building of 1400sq ft. Providing with all facilities of a residential building which include a sitout, living room, 3 bed room, 2 bathrooms, a dining area and a kitchen.
Fig 4.1 shows the plan of the building.

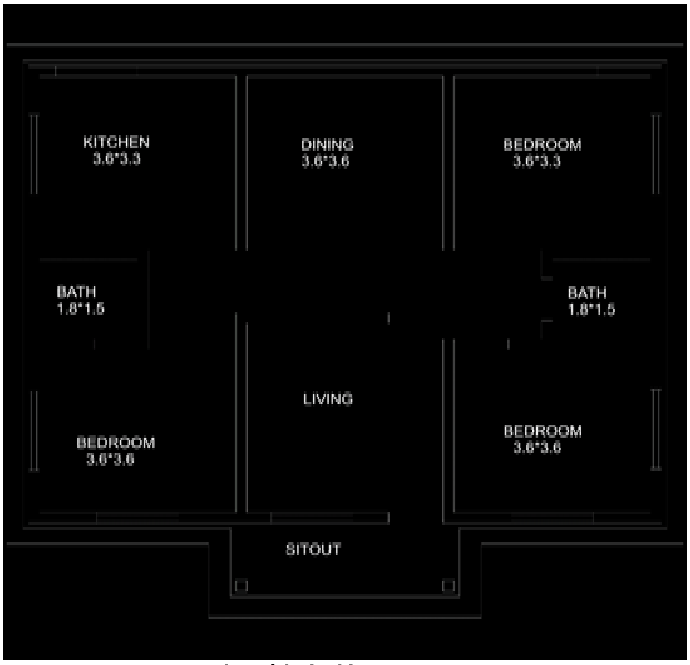

Fig 4.1 Plan of the building

Sl No	Discription	Unit rate	Length	Breadth	Height	Number	Quantity	Total
1	Earthwork excavation by mechanical means (hydraulic excavator) including dressing of sides and ramming of bottoms,including getting out of the excavated soil and disposal of surplus excavated soil	300/m3	12	11	2		264	79200
2	Centering and shuttering including strutting, propping etc and removal of shuttering for PCC	247/m2	44		0.1		4.4	1086.8
3	Providing and laying in position cement concrete (PCC) of specified grade excluding cost of centering and shuttering in 1:1.5:3 (1 cement : 1.5 : fine aggregate : 3 graded stone aggregate 20 mm nominal size)	6259/m3	11.2	10.5	0.1		11.76	73605.84
4	Centering and shuttering including strutting, propping etc and removal of shuttering for RCC	247/m2	44		0.12		5.28	1304.16

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 08, August-2022

	5	Providing and laying in position grade of reinforced cement concrete (RCC) of specified grade excluding cost of centering and shuttering in 1:1.5:3 (1 cement : 1.5 : fine aggregate : 3 graded stone aggregate 20 mm nominal size) for Mat foundation		6700/m3	11.2	10.5	0.12		14.112	94550	
	6	Providing and laying in position grade of reinforced cement concrete (RCC) of specified grade excluding cost of centering and shuttering in 1:1.5:3 (1 cement : 1.5 : fine aggregate : 3 graded stone aggregate 20 mm nominal size) for **column footing**		6700/m3	0.6	0.45	0.6	4	0.648	4331.6	
	7	Installation and fixing of hydraulic system , collection of sensors for predicting landslides, protective casing and manhole for future inspections								150000	
	3	Welding works including Corner Pillars Footing Base plate ,GI Round Pipe 8",GI Round Pipe 7",120x120 Square pipe work for floor								404420	
	4	Bison pannel work 8 x 4 (40mm) feet for floor including materials , scaffoldings and supports		581/m2	11.2	10.5			117.6	68325.6	
	5	GI Framework for walls with GI tube (80 X 40) mm including cost of materials and labour		1291.2/m2	95		3		285	367992	
	6	MDF Sheet work for walls including materials and labour along with scaffoldings and supports		1892.2/m2	95		3		285	539277	
	7	GI Framework for Roof including cost of materials , scaffolding charges and labour		1183.6/m2	11.2	10.5			117.6	139191.36	
	8	Bison pannel work for roof with material and labour		581/m2	11.2	10.5			117.6	68325.6	
	9	Providing and laying vitrified floor tiles of approved make, laid on tile gum , including epoxy work on joints with matching pigments (size of tile 60 x 60 mm) and suitable wall tiles		1302/m2	11.2	10.5			117.6	153115.2	
	10	Painting including labour and materials (inside and outside , 1 coat primer + 2 coats emulsion)		202/m2	95		3		285	57570	
	11	Plumbing (including fittings and sanitary)								70000	
	12	Electrificaation (including switch boards , lights)								196000	
	13	Doors and Windows (FRP / WPVC)		200/m2					27.41	58986.32	
	14	Waterproofing roof		753.2/m2	11.2	10.5			117.6	88576.22	
										2615857.7	TOTAL

Fig 4.2 Estimation of the building

Fig 4.2 shows the estimation of the building which includes the total cost needed to construct the entire structure including material cost, labour charge, plumbing, and wiring charges etc.

The final cost estimated, including the cost of hydraulic system, plumbing works, electrical works and wood works of the landslide resistant building of 1400sq.ft can be completed at a cost of approximately 27 lakhs.

V. CONCLUSION

The present study was aimed to design a landslide resistant building. In recent years we are witnessing tremendous landslides in Kerala and thus huge disasters are causing to human life and properties, out of which a huge lose is to the construction field.

This project is on the assumption that we can provide a successful way to alleviate the ill-effects of landslide causing on residential buildings. With the help of some mechanical devices on a light weight residential building we can eliminate the destruction of the building on a landslide.

The design of building is in such a way that during a landslide it can rises up itself by the action of the mechanical devices which includes a sensor and hydraulic lifting mechanism. For a structure to rises up by itself, the self-weight of the building should be a minimum, to obtain that condition the super structure of the building is designed with light weight non conventional building materials which poses adequate strength to the building and can withstand wind load, live load etc.

Even so it has its own limitations, with further increase in the advancement of technology we can make it as our future residential building in landslide prone areas. The most successful way to mitigate loses of life, property and function is to construct buildings that are strong and disaster resistant.

Scope For Future

With each passing year, effects of landlsides are increasing in hilly areas. We cannot predict or prevent landslide. What we can do is to protect ourselves from the effects of landslides. This project have an extensive range of development, if executed properly. Adopting broad variety of modest new artificial light weight materials which acquires sufficient strength for construction of super structure is a good approach in all fields. This innovative modular design of housing is affordable for even an average middle class family which the building posses the living conditions as same as in a conventional building and the major advantage is the protection from the damages caused by landslide. With the help of advanced technologies we can make this building resilient from earthquake and flood. If necessary steps are taken by the government in adopting these types of building as a solution tolandslide, the economic wellbeing of the state could be uplifted. With upcoming facilities we can build even advanced buildingusing the concept.

REFERENCES

[1] Elise Elsacker, Simson Vandelook , Joost Brancart, Eveline Peeters, Lasrs De Laet [2019] "*Risk analysis of building damage induced by landslide disaster 2019*"

[2] Elvin Karana, Davine Blauwhoff, Erik –Jan Hultink And Serena Camere, [2018] "Building resilience to chronic landslide hazard through citizen science"

[3] Magdum Rutuja R, Palkar Omkar V, Patil Devyani U, Varkat Priya S, Waingade Saloni V, Mane Sunil S, [2020] "*Replacement of material & testing of bricks using demolition & agricultural waste 2020".*

[4] Mitchell Jones, Andreas Mautner, Stefano Luenco, Alexander Bismarck, Sabu John*"Engineered composite construction :A critical review 2019*".[2019]

[5] Noam Attias, Ofer Danai, Nirit Ezov, Ezri Tarazi, Yasha J. Grobman[2017] "Weather Related Flood and Landslide Damage: A Risk Index in Areas".

[6] Yangang Xing, Matthew Brewer, Hoda EI- Gharabaway, Gareth Griffith And

[7] Phil Jones[2017] "Thriving with water: Developments in Amphibious architecture in North America".