REMEDIES AND EFFECTS OF FLOOD ON BRICKS AND AAC BLOCK WALLS ON RESIDENTIAL BUILDING

A

THESIS

Submitted in partial fulfillment of the requirements for the award of the degree

Of

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IN

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Under the supervision

of

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to

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

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May –2019

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STUDENT DECLARATION

I hereby declare that the work presented in the thesis entitled **“Remedies and effect of flood on bricks and AAC block walls on residential building”** submitted for partial fulfillment of the requirements for the degree of Master of Technology in Civil Engineering at **Jaypee University of Information Technology, Waknaghat** is an authentic record of my work carried out under the supervision of **Mr. Chandra Pal Gautam.** This work has not been submitted elsewhere for the reward of any other degree/diploma. I am fully responsible for the contents of my thesis.

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CERTIFICATE

This is to certify that the work which is being presented in the project report titled "**Remedies and effect of flood on bricks and AAC block walls on residential building"** in partial fulfillment of the requirements for the award of the degree of Master of Technology in Civil Engineering submitted to the Department of Civil Engineering, **Jaypee University of Information Technology, Waknaghat** is an authentic record of work carried out by **Rishav Bansal (172655)** during a period from August, 2018 to May, 2019 under the supervision of **Mr. Chandra Pal Gautam,** Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat. The above statement made is correct to the best of our knowledge.

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ABSTRACT

There are so many effects of flood on the structures which cause a large damage on the materials used in their construction like bricks, concrete, steel, blocks etc. As in case of Kerala flood, the main effect is due to the still water that remains in building for long time as in result structure loses its strength, and as a result depletion of buildings causes very huge loss of human life, property, crops and money. Main objective of this study is to find out different methods which help to reduce the demolition of building materials used in any structure. Application of fiber reinforced polymer sheet, bitumen and waterproofing agents are considered in this project. In these cases with and without FRP, bitumen and waterproofing agent are studied and comparison of their effects to reduce the degradation of building materials is determined. This can be cultivated, to a limited extent, by utilizing materials, hardware, and development procedures that are impervious to flood harm in areas that would be wet during flood. The effects of flooding can be greatly reduced by taking preventative and precautionary measures. This can be done by: - By using bitumen, waterproofing membranes on walls we can save the structure from flood. Bitumen layer can help the structure from water attacks. Increment in the plinth level can also help us from flood. Fiber reinforced composites have a large benefits that have include strength, tensile and various benefits on the structure .To validate the results, a model has been created which is analyzed in two software's which are STAAD PRO and ABAQUS.

Keywords: - Effects, Fiber Reinforced Polymer, Bitumen, ABAQUS, Prevention.

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CHAPTER 1

INTRODUCTION

1.1 Background

Flood is basically an excess flow of water that submerges land which is usually dry. Flooding occur due to extra runoff of water from any source like rivers, oceans, in which the water overtops or breaks embankments results in increment in the flow of water, or flood may occur due to excess of rain. It can also be occurred if flow rate beats the capacity of the river channels. Many of the floods occurs very rapidly such as flash floods ,while others such as slow floods which takes time to develop with visible signs of rain.

1.2 Causes

Heavy rainfall

Overflowing rivers

Broken dams

Storm surges and Tsunamis

Melting snow and Ice

These are the most common causes of floods, both natural and by humans.

1.3 Effects of flood

1.3.1 Primary effects

Vital impacts of floods incorporate death toll harms to structures, including spans, sewerage frameworks, roadways, and trenches. Floods equally regularly harm control transmission and there power age, which at that point has thump on impacts brought about by the loss of intensity due to which loss of drinking water treatment and water source incorporates, which may result in loss of drinking water or extreme water contamination. It might likewise cause the loss of sewage transfer offices. Absence of clean water joined with human sewage in the rising waters raises the danger of waterborne ailments, which can incorporate typhoid, giardia, cryptosporidium, cholera and numerous different illnesses relying on the area of the flood. Harm to streets and transport framework may make it hard to activate help to those influenced or to give crisis wellbeing treatment.

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Rising waters commonly immerse ranch land, making the land unworkable and keeping crops from being planted or reaped, which can prompt deficiencies of sustenance both for people and homestead creatures. Whole reaps for a nation can be lost in extraordinary flood conditions. Some tree species may not endure delayed flooding of their root frameworks.

1.3.2 Long term effects

Reconstructing expenses or nourishment deficiencies prompting cost increments is a typical delayed consequence of extreme flooding. The effect on those influenced may make mental harm those influenced, specifically where passing's, genuine wounds and loss of property happen. Urban flooding can prompt constantly wet houses, which are connected to an expansion in respiratory issues and different diseases.

1.4 Significance of the project

As we are aware flood causes lots of damage to property and buildings. There are so many techniques which can protect the building from damage, also it increases the strength and reduces the degradation of building material like bricks used, concrete blocks.

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CHAPTER 2

LITERATURE REVIEW

2.1 GENERAL

Flood is a natural hazard that may result in unpredicted threat to human life. Sometimes floods can be predictable but many of the time it happens in blink of eye. Floods affects structure in many aspects as nature of hydrostatic load is triangular that effects the structure brutally from downward results in failure and sudden collapse. Millions of works has been done on foundations, beams and studies of structures have been done to make the structure safe from flood. The literature has been studied to get the required data as well to analyze the data in STAAD PRO and ABAQUS.

2.2 LITERATURE SURVEY

Sathiparam et al. [1] assess the dampness impact on manual possessions of block plaster; brick work quality stone work structure basically is affected by various factors like stones that come under the flood. Authors concluded that compressive quality of blocks, concrete mortars just as bond, quality of brick work crystals are explored, in stove waterless, air-dry and rainy situations or by using quality blocks a structure can be saved from flood.

Silvia et al. [2] states that environmental alteration is a worldwide wonder; its harmful effects & all the new seriously felt in reduced nations due to their high belief on common assets and constrained adapting ability to atmosphere fluctuation and boundaries. Author concluded that demonstrate that family units depend vigorously on normal assets for their employment, and that those with low pay experience the ill effects of floods and dry seasons than families with high salary. Then again flood sway is developed on families; hang on vigorously on typical assets for their labor, and having minor salary.

Islam et al. [3] states that Bangladesh is inclined to continue flooding occasions. The proof shows that these occasions are on the ascent and expanding in seriousness. Examination, led by field outings to Bangladesh, used top to bottom meetings with members from normally overwhelmed towns. Author concluded that it is helpful to consider procedures to adapt to a given flooding occasion independently from methodologies to adjust the flooding assets when all is done and that without

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composed and sufficiently resourced adjustment programs, adapting techniques, dependent that can help any structure for being damaged in flood.

Bastawesy et al.[4] assess the hydrology of Channel was explored to assess the quantitative parameters of glimmer flood and its cooperation with the land use utilizing huge number of remote detecting information, advanced height models (DEM), field work and topographic review to assets the flooding condition. Author concluded that the overviewed cross-sectional regions of the dynamic channels and their comparable water driven radii gave a mean pinnacle release for every second. The evaluated net release was 2.1 million cubic meters as determined from the studied geology for the pools and discouragements territories, which caught that streak flood. The aqueduct is overwhelmed by surface spillover as the permeation into the fundamental alluvium is very constrained because of the event of thick Pliocene dirt's few meters beneath the surface.

Hughes et al.[5] assess the general impacts of flooding on structures and basic materials in creating nations are extensively looked into the point of the broadsheet is to animate further ground built study about how & structure upgrades can be presented, given the predominant financial and common supplies of numerous networks, and to look at the suitability of flood sealing measures in creating nations where there are frequently couple of floodplain the board or extensive scale flood anticipation plans. Author concluded that recommendations are proposed with regards to the technique and kind of data which is required for definite examinations before growing new and progressively that makes the structure more powerful and provide more strength and stiffness with structure plan.

Lee et al. [6] states that flood gauging is a preventive auxiliary amount to alleviate immersion. Present flood estimating methods join compound procedures, for example, preparing and streamlining, before the strategy can be connected. Ordinary flood gauging procedures, in light of flood volume, give alarms regardless of whether. Author concluded that another flood estimating procedure has been created dependent on probable flood harm utilizing the dimensional flood harm investigation technique. This flood gaging method conquers difficulties of flood guessing procedures tend to be effectively connected utilizing rainfall information. The contemplated waste zone was separated, and the harm capacities were gotten for each subarea utilizing the flood

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volumes and harm data.

Utilizing these harm capacities, the precipitation power when the flood harm at first happened was determined for every span and subarea. The harm diagram delivered for flood anticipating in each subarea distinguished the precipitation powers and spans that came about because of the underlying event of flood harm. Flood forestalling procedure might be utilized to spare exists, significant resources, & oversee waste territories.

Zischg et al. [7] assess that flood dangers are progressively changing after some period. Hundreds of years, fundamental flood chance is impacted by bothers, moderate modifications in the common habitat or, all the more critically, by financial advancement and human mediations. The investigation principle drivers for flood chance require an unraveling of the separate hazard parts. Author concluded that model setup to break down the fleeting advancement of flood danger, for an ex-post assessment of the key drivers of progress, and for investigating conceivable option flood chance development under various administration locations. This impact isn't as pertinent as the waterway designing measures, yet it will turn out to be progressively applicable later on with proceeded financial development. The displayed methodology could give a methodological system to examining future flood exposure, the definition of stories for adjusting legislative flood chance techniques elements in assembled condition.

Pimental et al. [8] states that to decrease vitality inputs, green unrest and horticulture may utilize such choices as pivots and green excrements to lessen the high vitality request of synthetic composts and pesticides. Horticulture may likewise lessen vitality consumptions by substituting some labor as of now dislodged by motorization. While nobody made, make sure that old-style vitality assets develop rare & costly, the effect on horticulture as commerce and a lifestyle resolve be huge. Author concluded that nevertheless a primer examination of a noteworthy agrarian issue that merits cautious consideration and more noteworthy investigation before the vitality circumstance turns out to be increasingly basic.

Taneka et al. [9] states that user urban communities are situated along downstream reaches of an extensive stream bowl in numerous territories of everywhere extraordinary that are thought influenced task & waterway flood regions.

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Specifically, territories are likewise ensured by stream barrier framework, verifiable release tests can't speak to the effect of upstream waterway flood on downstream extraordinary flood frequencies since it once in a while happens. Author concluded that the application cleared up that upstream waterway flood causes significantly more radical difference in past plan level than barrier activity, demonstrates chance appraisal reflect stream flood of its territories that generally overflow stream zones resolve be overvalued. Moreover, plan additionally created aggregate conveyance capacity of land, which speaks to danger of zones.

Huang et al. [10] assess that amid flood control repository task, vulnerabilities happen in flood determining, hydrograph shape, stream reenactment, supply stockpiling, water level, and release surge. It is in this way imperative to investigate flood control hazard because of these vulnerabilities. Author concluded that proposes a stochastic reproduction strategy, including a copula-based reenactment technique representing flood estimating vulnerability, a copula-based single site day by day stream recreation technique for vulnerability in inspecting strategy for vulnerability away, surge release. Utilizing Crevasses Repository as a contextual investigation, the flood control chance, characterized by customary measurable and entropy strategies, was determined and thought about. The proposed technique palatably saved the factual qualities of the first stream arrangement. Results from contextual analysis demonstrated that the entropy strategy was powerful for evaluating flood hazard because of various vulnerabilities. Therefore, this investigation gives a far reaching assessment of flood chance amid flood control repository activity.

Sungkaew et al. [11] assess that few spaces that experienced they were overviewed amid to distinguish possible cane class that might endure overflowing pressure. Author concluded that incorporated another flood-inclined zone backwoods Stream, Some is in the family moderately notable wicker species, is till now the most flood-tolerant and it gave the idea overwhelmed no less than multi month.

Berlillson et al. [12] assess that environmental change and expanding urbanization present immense difficulties in overseeing urban getting ready for a reasonable future. Exceptional urbanization bringing about the purported user refers to irritates floods by expanding the measure of impermeable surfaces and changing stream courses. Measurements demonstrate that flood catastrophes are a standout

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amongst the hugest as far as harms and misfortunes. Urbanization rates are expanding quickly and it is imperative to Figure out how to live with floods by easing their outcomes, in the present and future Author depicts how flood versatility can be analyzed and spatial zed by a multi-criteria file called Spatial zed Urban Flood Strength Record. This piece (as indicated by the strength definition embraced) consolidates: the risk attributes and the framework introduction and defenselessness, to speak to flood obstruction mapped after some time; the capacity for material recuperation from misfortunes brought about by immersion, thinking about the salary variable; and the useful limit of the waste framework, spoken to by the flood length can be utilized to gauge and imagine the adjustments in flood versatility accomplished by various flood control events, just as in upcoming situations of populace development, wild expansion or environmental modification

Notwithstanding, the flood-influenced populace and flood-initiated mortality increment with decline of per capita Gross domestic product; while the per capita monetary misfortune increments with the expansion of per capita Gross domestic product, demonstrating that the higher the populace thickness and Gross domestic product per unit for a district, the higher affectability of this region to flood risks.

2.3 RESEARCH GAP:-

Learning to live with flood requires learning to manage flood recovery and in most of the cases, research papers does not includes how actually to save the structure. We cannot lower the impact of flood but we can save our structures from steady flow of water as well increase in the strength of building materials, beams we can save the structure from detonation.New techniques like FRP wrapping used now a days for increase the strength of bridge foundation as FRP wrapping kept the water away and increases the life span of the bridge.

2.4 RESEARCH OBJECTIVE:-

The objective of this project is to protect the structural components like walls, beams etc. from degradation by flood water by the application of bitumen, FRP and waterproofing agent, the properties of these construction materials can be improved in large extents. For validations of results physical tests like compressive test, water absorption test is performed on bricks and blocks and then they are analyzed in STAAD PRO and ABAQUS.

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CHAPTER 3

METHODOLOGY

In this project, basically I'm going to provide extra strength to bricks and blocks by using different kind of materials and then model it in software. By wrapping the bricks and blocks with FRP, bitumen and water proofing agent two lab tests will be performed, first is for compressive strength and second is water absorption test. For determining compressive strength bricks and blocks will be used and in both 4 type of cases will be induced i.e. Normal bricks and blocks, bricks and blocks with FRP sheet, bricks and blocks with bitumen layer and bricks and blocks with waterproofing agent. These all types of bricks and blocks will remain in water for at least 3 days. After 3 days, both bricks and blocks will remove from the water and water absorption test will perform. After water absorption test, compressive strength test will be going to perform on Universal Testing Machine. Software work and FEM Modeling, in this part of project, first multi-story building will made in STAAD PRO with bricks and by changing the compressive strength value of bricks which we will get from compressive strength tests for different cases 5 cases will induced, and by compare them final results will be checked. For FEM modeling ABAQUS will be used for results and discussions.

3.1DESIGN WORK ON EXCEL SHEETS

This chapter shows the analysis and design of the beam, column and slab

This design involves three major steps: first one is the evaluation of the stability under the loads, safety factor, and the second one is to design the beam, column and slab.

3.1.1 DESIGN OF BEAM

DESIGN OF BEAM					
Sr. No.	**Data**	**Symbols**	**Quantity**	**Units**	**Remarks**
1	Breath	b	0.25	m	
2	Depth	D	0.60	m	
3	Live load	W_{LL}	10.00	kN	
4	length	l	6.00	m	
5	Concrete grade	F_{ck}	25.00	Mpa	M25 grade
6	Steel grade	F_y	415.00	Fe415	Fe415 grade

Fig3.1 Excel sheet for beam

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7	Depth	d	5.50	mm	
8	Distributed load due to self weight	ΔW_{dl}	0.38	kN/m	
9	Total W_{dl}	W_{dl}	5.38	kN/m	
10	factored load	W_u	23.06	kN/m	(as per code)
11	factored moment	M_u	103.78	knm	(max at mid span)
12	ADOPT D=450MM	d	399.50	mm	(25ϕbars,8ϕstirrups and clear cover 30mm
	fixing up b,d and D				
13	For FE415 steel	$M_{u,lim}$	26.26	Mpa	
14	for m25 concrete	R_{limb}	3.47	Mpa	
15	min value of d	d_{min}	2733.43	mm	
	ADOPT D=450MM				

Fig 3.2 Excel sheet beam dimensions

	ASSUMING 25ϕ BARS,8ϕ STIRRUPS				
16	Depth	d	399.50	mm	
	Determining (Ast)reqd				
17	Pressure	p	1193.13	Mpa	
18	Percentage tension	p_t	1.84	mm^2	
19	Area of steel recq	$(Ast)_{reqd}$	1065.08	mm^2	

Fig 3.3 Excel sheet for Load calculations

DETAILING					
20	Using 3ϕ bars In one lAyer	ϕ_{recq}	21.27	mm	1-25ϕbar nd 2-20ϕ
21	Area of steel	A_{st}	1119.00	mm^2	1119>1062

Fig 3.4 Excel sheet for beam detailing

CHECK					
22	For strength in flexure	d	399.50	mm	
23	Percentage tension	p_t	1.12	%	hence $<pt_{lim}$
25	for deflection control	p_t	1.12		
26	modification factor	k_t	1.01		(code)
27	Precast concrete	P_c	0.00	%	(code) singly reinforced beam
28	Correction factor	K_c	1.00		
29		$l/d_{(max)}$	20.28		
30		$(i/d)_{provided}$	15.02		
	$15.01<(i/d)_{max}$ - HENCE OK				

Fig 3.5 Excel sheet for safety checks

`

3.1.2DESIGN OF COLUMN

Design of column					
Sr. No.	Data	Symbols	Quantity	Units	Remarks
1	Effective length in x direction	lx	3000	mm	
2	Effective length in y direction	ly	3000	mm	
3	Trial depth	Dy	450	mm	
4	Trial width	Dx	600	mm	
5	Concrete grade	Fck	415	Mpa	Fe415 grade
6	Steel grade	fy	20		M25 grade
7	Slenderness ratio (x)	lex*Dx	5kx		
8	Slenderness ratio (y)	ley/Dy	6.67ky		
9	Min eccentricities (x)	ex min	26	mm	>20mm
10	Min eccentricities (y)	ey min	21	mm	>20mm
11	Factored load	pu	3000	kN	

Fig 3.6 Excel sheet preliminary calculation for column design

REINFORCEMENT					
12	Area of longitudanal reinforcement	Asc	3111	mm^2	
		preliminary dimenshions			
13	Length	l	450	mm	
14	Breadth	b	600	mm	
	provide 4-25ϕ at corners		1964	mm^2	
	4-20 dditional		1256	mm^2	
17	Area of longitudanal reinforcement	Asc	3220	>3111	mm^2
18	Pressure	p	1.192593	>0.8	min reinforcment is 0.8
		Hence ok			

Fig 3.7 Excel sheet for reinforcement in column

LATERAL TIES					
20	Tie diameter	ϕt>	6.35	mm	provide 8mm dia
21	Tie spacing	st<	320	mm	provide 300mm
	provide 8mmties @300c/c				

Fig 3.8 Excel sheet lateral ties for column

3.1.3 DESIGN OF SLAB

DESIGN OF SLAB						
Sr. No.	Data	Symbols	Quantity	Units	Remarks	
1	Length	l	14	m		
2	Width	b	8	m		
3	ThickNess of slab	t	230	mm		
4	Live load	W_{ld}	1.5	kN/m		
5	Dead load	W_{dd}	4	kN/m		
6	Steel grade	F_Y	415	Mpa	Fe415 grade	
7	Wide	w	3	m		

Fig 3.9 Excel sheet preliminary calculations for slab

	SOLUTION					
8	Clear spacing		3.4	m		
9	Each slab with clear spacing		27.2	m2	<2 for continous span	
	Determining values for Mu					
10	Thickness of slab	l/d max	30.82		assuming a uniform thickNess for both end	
		dmin	113.56	mm	for an ssumed effective span	
11	Overall depth	D	152.56	mm		
12	Depth	d	125.00	mm		
14	EFFECTIVE (end span)	l	3462.50	mm	as the beam width (300mm) exceeds (code)	
15	distributed load due to self weight	ΔW_{dl}	4.00	kN/m2		
16	Dead load	Wdl	5.50	kN/m2		

Fig 3.10 Excel sheet for moment's calculation of slab

16	Dead load	Wdl	5.50	kN/m2		
17	Factored load (dead load)	Wu,Dl	8.25	kN/m2		
18	Factored load (live load)	Wu,Ll	6.00	kN/m2		

Fig 3.11 Excel sheet for loads acting on a slab

`

FACTORED MOMENTS AT CRITICAL SECTION						
19	Ultimate moment	Mu -ve	-7.118	kNm	at end support	
20	Ultimate moment	Mu ve	15.436	kN/m	at mid span	
21	Ultimate moment	Mu +ve	-17.883	kN/m	at interior support	
FOR INTERIOR SPAN						
23	Ultimate moment	Mu -ve	-17.2436667	kNm/m	at end support	
24	Ultimate moment	Mu ve	11.740625	kNm/m	at mid span	
25	Ultimate moment	Mu +ve	-15.6541667	kNm/m	at interior support	
27	average value	Mu	17.56355924	kNm/m		
REINFORCEMENT						
28	Ultimate moment	Mu	-17.5635592	kNm/m		
30	percentage tenshion	Pt	0.33			
31		pt recquired	412.5	mm2/m		
	ASSUmING 10ϕ BARS (Ab=50.5mm2)					
32	spacing recquired		189.1566265	mm		
ALTERNATIVELY FOR 8ϕ BARS (Ab=50.3)						
33	spacing recquired		121.2048193	mm		
34	Maximum spcing recquired		375	mm	>300mm	
35	AST min.		1.464601168	mm2/m	PROVIDE 8mmϕ@250 C/C	

Fig 3.12 Excel sheet for Moments acting on slab

	LOCATION	END SPAN		INTERIOR SPAN		
36		END SUPPORT	mID SPAN	FIRST INT. SUPPORT	mID SPAN	INT.SUPPORT
38	Mu (kNm/m)	-7.11841	15.4357168	-17.88345	11.740625	-15.65416667
39	Mu/bd2	-0.00046	0.000987886	-0.001145	0.0007514	-0.001001867
40	pt required	0.129	0.287	0.33	0.215	0.292
41	ast (required)mm2/m	161.25	358.75	412.5	268.75	365
42	ast min mm2/m	183.0751				
recquired spacing mm						
44	a 10ϕ	485.5814	218.815331	190.303	292.0930233	215.0684932
45	b 8ϕ	311.938	140.2090592	121.9394	187.1627907	137.8082192
46	max spacing	375				

Fig 3.13 Excel sheet for spacing required

DEFLECTION CONTROL CHECK						
49	(Ast)provided:8ф@110c/c	457.2727	mm2/m			
50	providing cler cover of 30mm,d	126	mm			
51	p1	0.365818				
52	fs	136.8592				
53	kt	1.76			code	
54	(l/d)max	40.48				
55	l/d provided	27.48413			27.5<40.4	
	Hence ok					

Fig 3.14 Excel sheet for safety check of slab

3.2 MATERIAL COLLECTION AND PROPERTIES

As I have to increase the strength parameters of the building, I collected following materials

- AAC blocks
- Bricks
- Bitumen
- Waterproofing agent
- Fiber reinforced polymer sheet.

3.2.1 AAC blocks (Autoclaved Air Crete) blocks generally made up of sand, cement, lime and water. AAC blocks are used for a building construction in much structure as it is easy to assemble. AAC blocks are very light weight as well has very high fire resistive power. As in my project, I used 15 blocks of grade 1 that is purchased from R.S. green infra. Specifications of AAC blocks are: - size in length and breadth is 600*200mm; thickness is 75 mm. Density is 531 kg/m^3, average thermal coefficient is 0.16W/M deg.K.

3.2.2 Bricks, brick are building material that is mainly used for buildings, walls and in all the construction line and are easily available in all the regions. The standard size of bricks is19*9*9cm, density is 680 kg/m^3. As I have taken 15 bricks for my project of grade 1.

3.2.3 Bitumen, grade 40 bitumen has been used in my project as bitumen is having very high binding properties. As bitumen has high resistance to the water, I have taken

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this to increase the strength and to apply bitumen on the bricks.

3.2.4 Waterproofing agent, as its name suggests waterproofing agent is used to resist the impact of water to any structure. In my project I used “Smart care Damp Block ” as it directly can apply on the wall with the help of brush.it is easy to apply as well easy to use with great resisting power to the structure.

3.2.5 FRP (fiber reinforced polymer sheet) is generally very thin and easily can apply over any surface as it is made up of very thin glass fibers or polymer components and provides very high strength to the structure. I have used 0.3 mm thick FRP sheet to wrap bricks and blocks.

3.3 EXPERIMENTAL WORK

3.3.1 WATER ABSORPTION TEST FOR BRICKS AND BLOCKS

Water absorption test is basically a test to determine the water absorbed by any material. As water absorption formula is w_1-w_2/w1*100, where w_1 is equals to the weight of dry sample and w_2 is weight of wet sample.

Firstly, 15 bricks and 15 blocks are divided into 5 parts, for every case 3 bricks and 3 blocks were used i.e.

Dry bricks and blocks

Soaked bricks and blocks that are emerged in water directly

Bricks and blocks wrapper with FRP sheet

Bitumen layered blocks and bricks and

Water proofed blocks and bricks.

Water absorption test has been performed so that the absorbed water percentage can be able to determine, for that first 15 bricks and 15 blocks were taken. As 3 dry bricks and blocks is weighed. These all type of blocks and bricks remain emerged in water for 3 days and then the test was performed and from each case three readings will be determined .Average value of each case was used as a w_2 and average value of weight of dry bricks is w_1.

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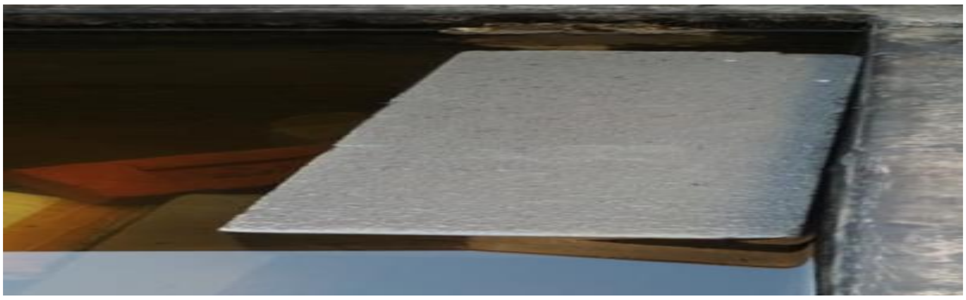

Fig 3.15 Block emerged in water

3.3.2 COMPRESSIVE STRENGTH TEST

After water absorption test, compressive strength of bricks and blocks were checked by the help of UTM (Universal testing Machine)

3.3.2.1 UNIVERSAL TESTING MACHINE

Universal testing machine is used to check the tensile and compressive strength of any material.

Fig 3.16 Universal testing machine

In this testing, the UTM is used for compressive strength as after the water absorption test of all the cases.

`

Fig 3.17 Tests performed for blocks

Fig 3.18 Tests performed for bricks

All cases are performed in UTM and reading was noted down. Three readings were induced from every case. Now, the average value of load is calculated for each case as the value coming out from UTM is in kN/mm^2 I converted all the values in N/mm^2 i.e. compressive strength.

3.4 SOFTWARE WORK

3.4.1 FEM:-FINITE ELEMENT MODELLING in this chapter modeling and stimulation of walls will be done. By creating a brick and using it to make a wall, simulation will be done for 4 cases.

Flood load acting on a normal wall

Wall with FRP sheet and flood load

Wall with bitumen layer and flood load

Wall with waterproofing agent and flood load

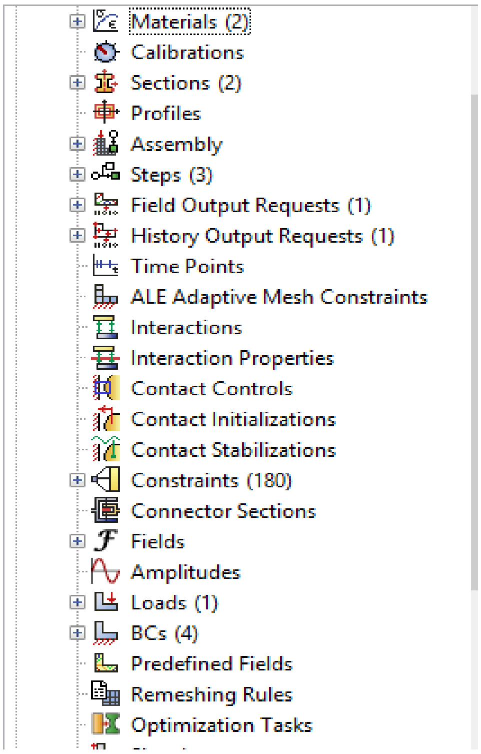

Fig 3.19 Modeling procedure in ABAQUS to design a wall

The modeling is done in following steps:

- Part
- Property
- Interaction
- Assembly
- Loads
- Boundary conditions
- Mesh
- Job

In this section of work, modeling, assembly, assigning property details of different kind of material used is induced. Flood load will remain similar for all types of cases. In boundary conditions wall will be fixed from all joints and hydrostatic load is used for analyses.

3.4.2 MATERIAL PROPERTIES USED:

For analyses and cases following material properties will be used:-

Bricks size (225*112.5*75) mm,

Young's modulus for brick:-3500MPa and Poisson's ratio is 0.15.

Wall size is 2250*750 mm

FRP sheet size 2250*750 mm,

Young’s modulus. :-223000 MPa and Poisson’s ratio. is 0.3

Bitumen layer size 2250*750 mm, Young’s modulus. :-207000 MPa and Poisson’s ratio. is 0.25.

Waterproofing layer 2250*750 mm, Young’s modulus. :-179000MPa and Poisson’s ratio. is 0.19.

3.4.3 Formation of parts and wall

Step 1 (part): - creating a brick

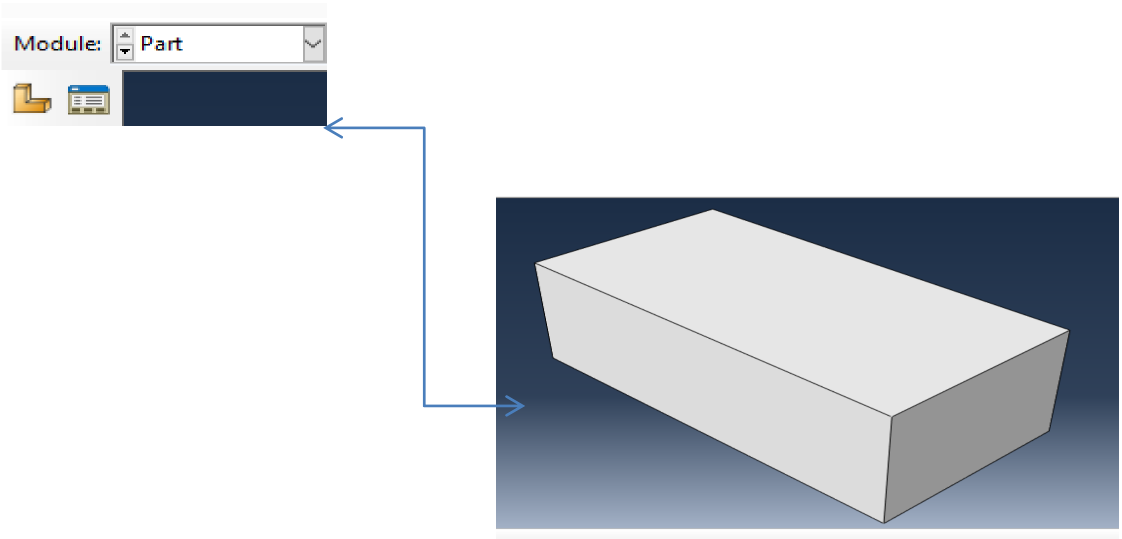

Fig 3.20 Creating a part 1 in ABAQUS

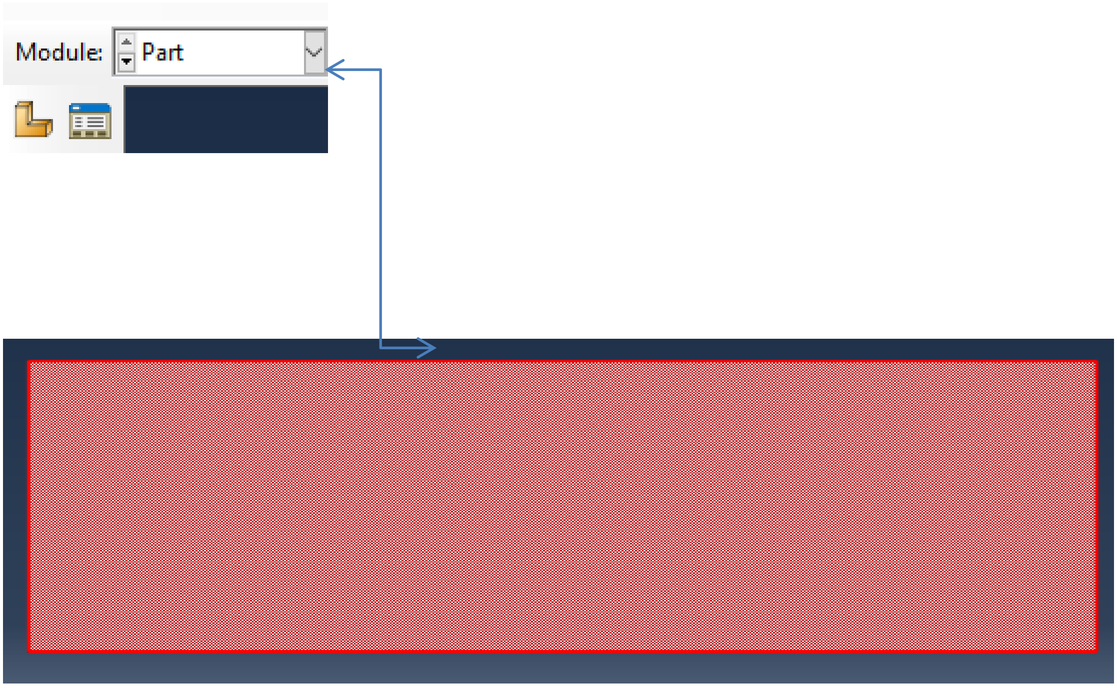

Fig 3.21 Creating part 2 in ABAQUS

These two parts were created as brick and 2nd one is layer sheet by changing the properties it will act as FRP, bitumen and water proofing agent.

Step 2 assigning the material property by providing young's modulus and other basic properties

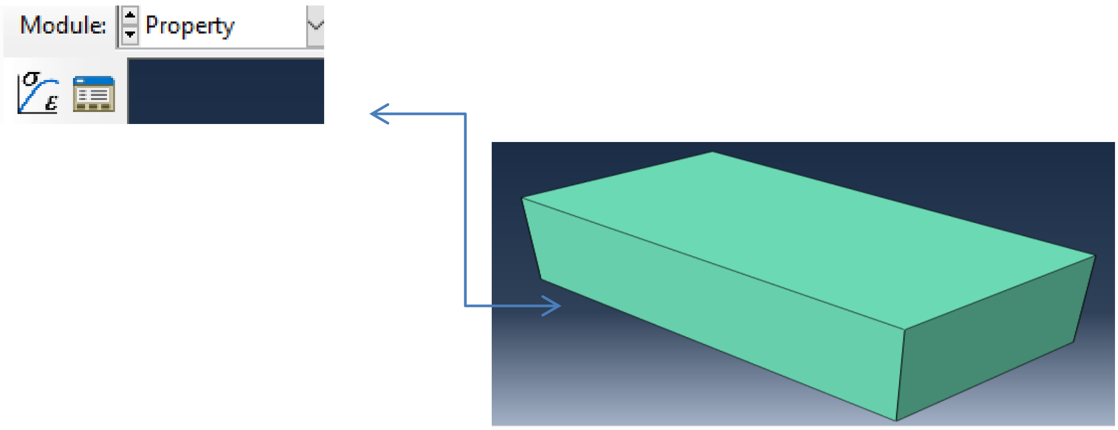

Fig 3.22 Assigning properties to part 1

Fig 3.23 Assigning property to part 2

Step 3 by interacting bricks and assembly a wall has been created

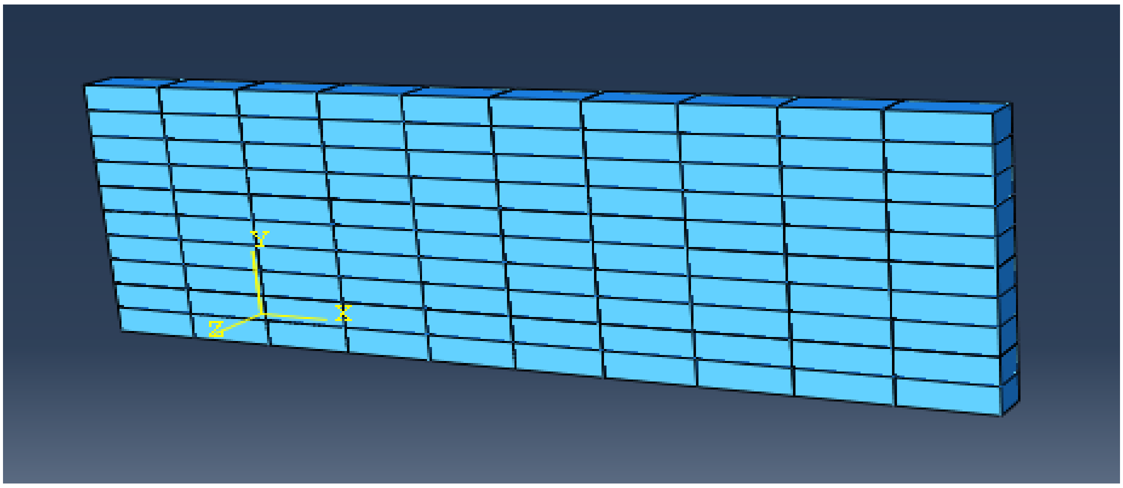

Fig 3.24 Interaction between the bricks and assembly

Step 4:- load: - Boundary conditions that wall is fixed from all ends.

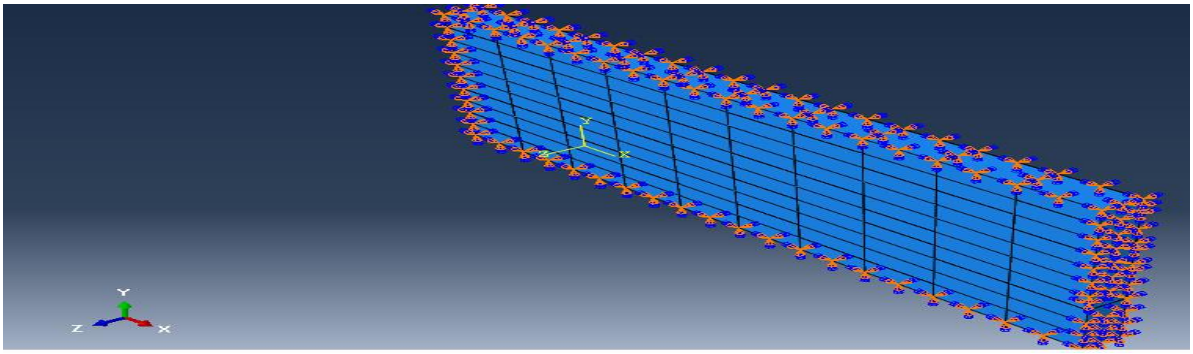

Fig 3.25 applying boundary conditions and hydrostatic load

Step 5 interactions with the layer of different cases with wall

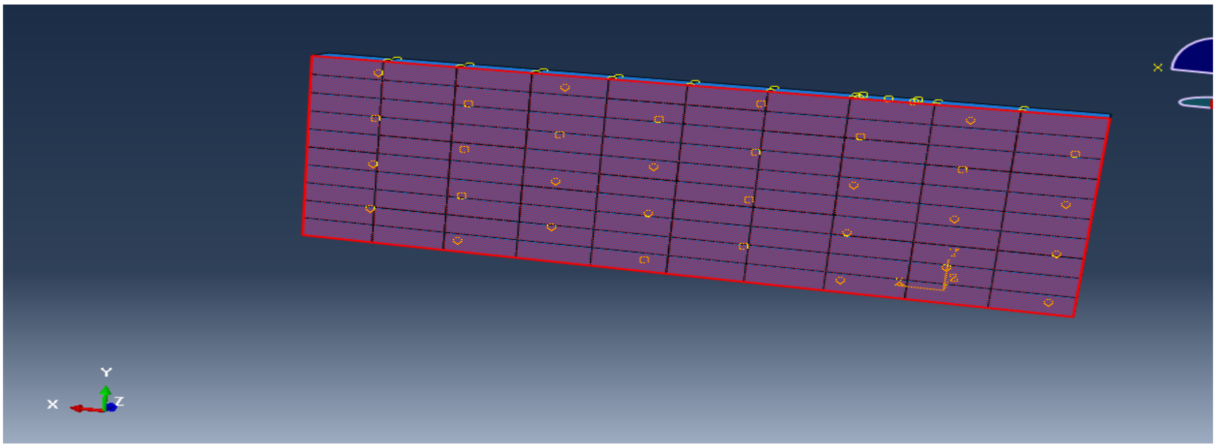

Fig 3.26 Interaction and tie

Step 6 Meshing

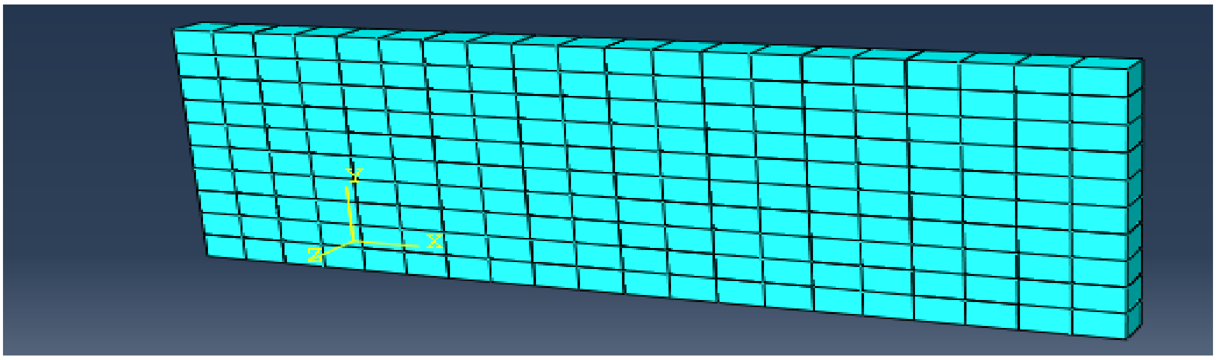

Fig 3.27 Meshing of a brick wall

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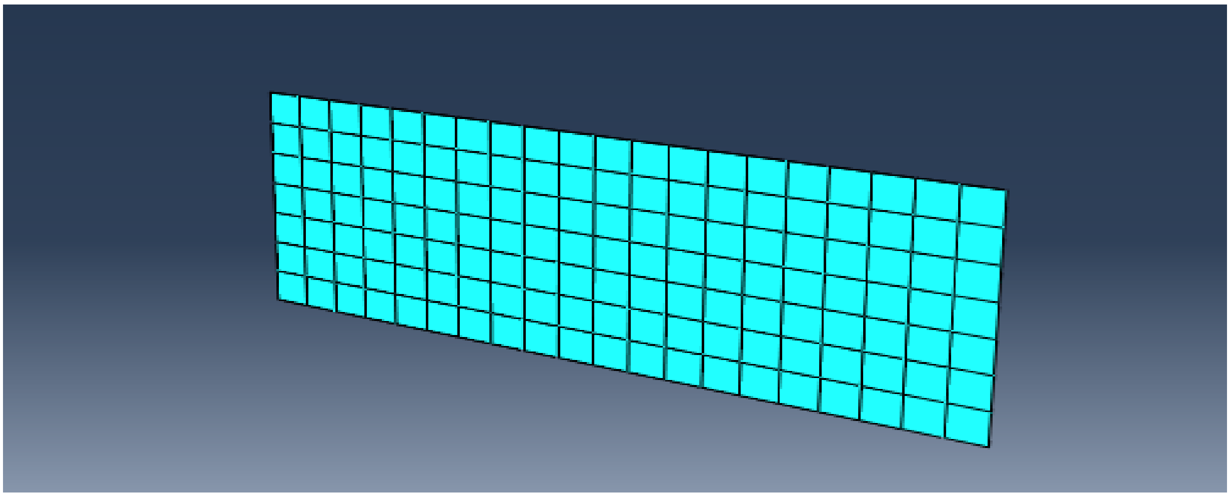

Fig 3.28 Meshing of different layers that are used and part 2

Step 7 Applying hydrostatic loads with impact of 5 kN/m^2

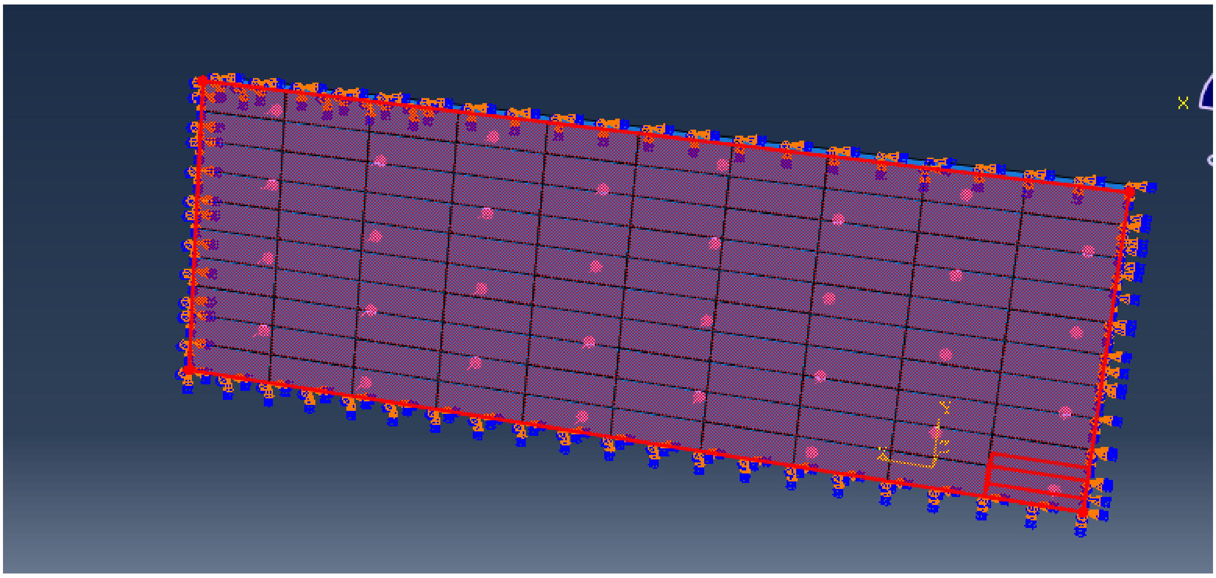

Fig 3.29 Applying hydrostatic load

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Step 8 Submit the job

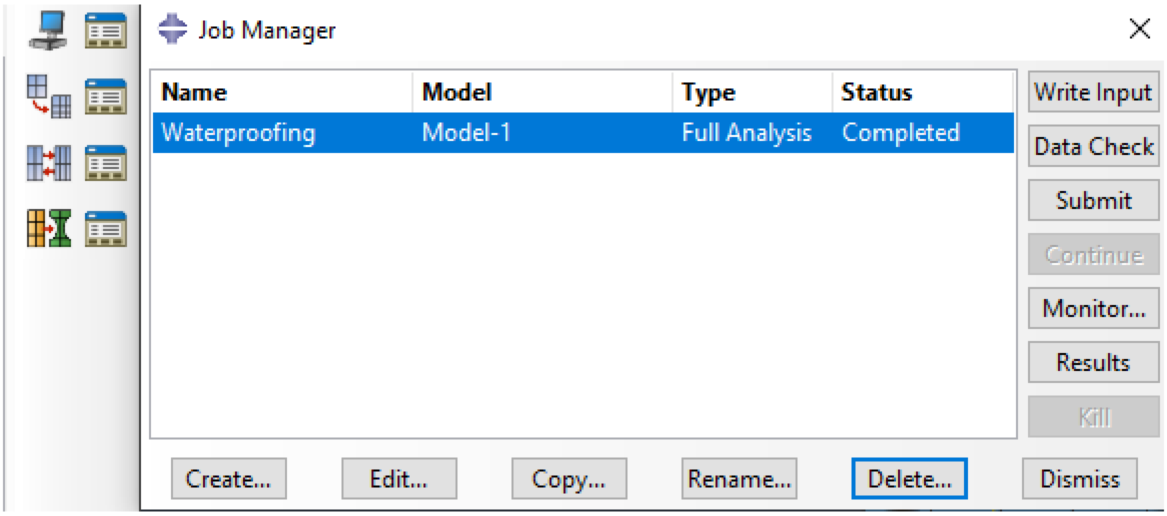

Fig 3.30 Submitting the job

3.5 STAAD PRO ANALYSIS

In STAAD PRO 2 story building is created as to check the influence of flood to the first floor. Firstly, two story building has made with bricks on it and by test results putting the values of compressive strength of bricks modeling has been done. Hydrostatic load of 60kN/m^2 will remain same for the following cases:-

Normal building analysis with flood load

Soaked bricks analysis with flood load

FRP brick analysis with flood load

Bitumen brick and waterproofing agent brick analysis of flood load.

Material property used

CONCRETE:

Elastic Modulus, $E_{c.} = 5000\sqrt{f_{c.}}$ Ultimate uniaxial compressive strength, f_c = 25.0 MPa., Ultimate tensile compressive strength, $f_{r..} = 0.62.\sqrt{f_{c,}}$ Poisson ratio for concrete = 0.02

BRICKS

Ec.= 0.55 , Poisson ratio for brick is 0.20, density of brick 1900 kg/m^3 , compressive strength will depend as per the case

3.5.1 Floor plan

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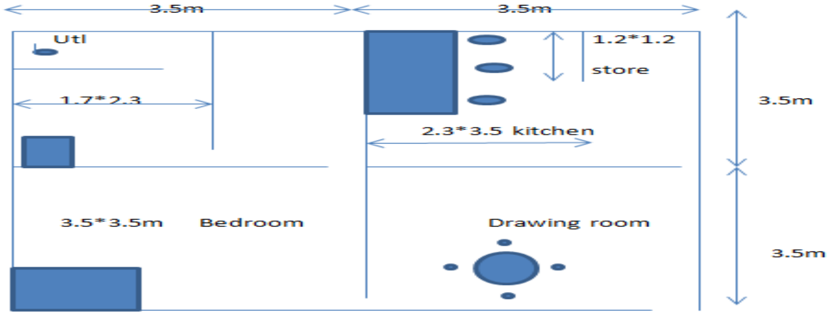

Fig 3.31 Floor plan of structure

3.5.2Geometry of the structure

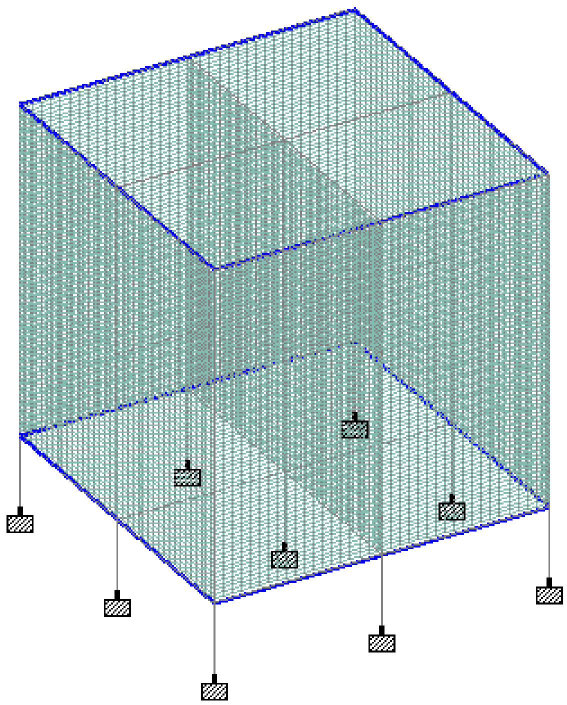

Fig 3.32 Geometry of the structure

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3.5.3 Isometric view

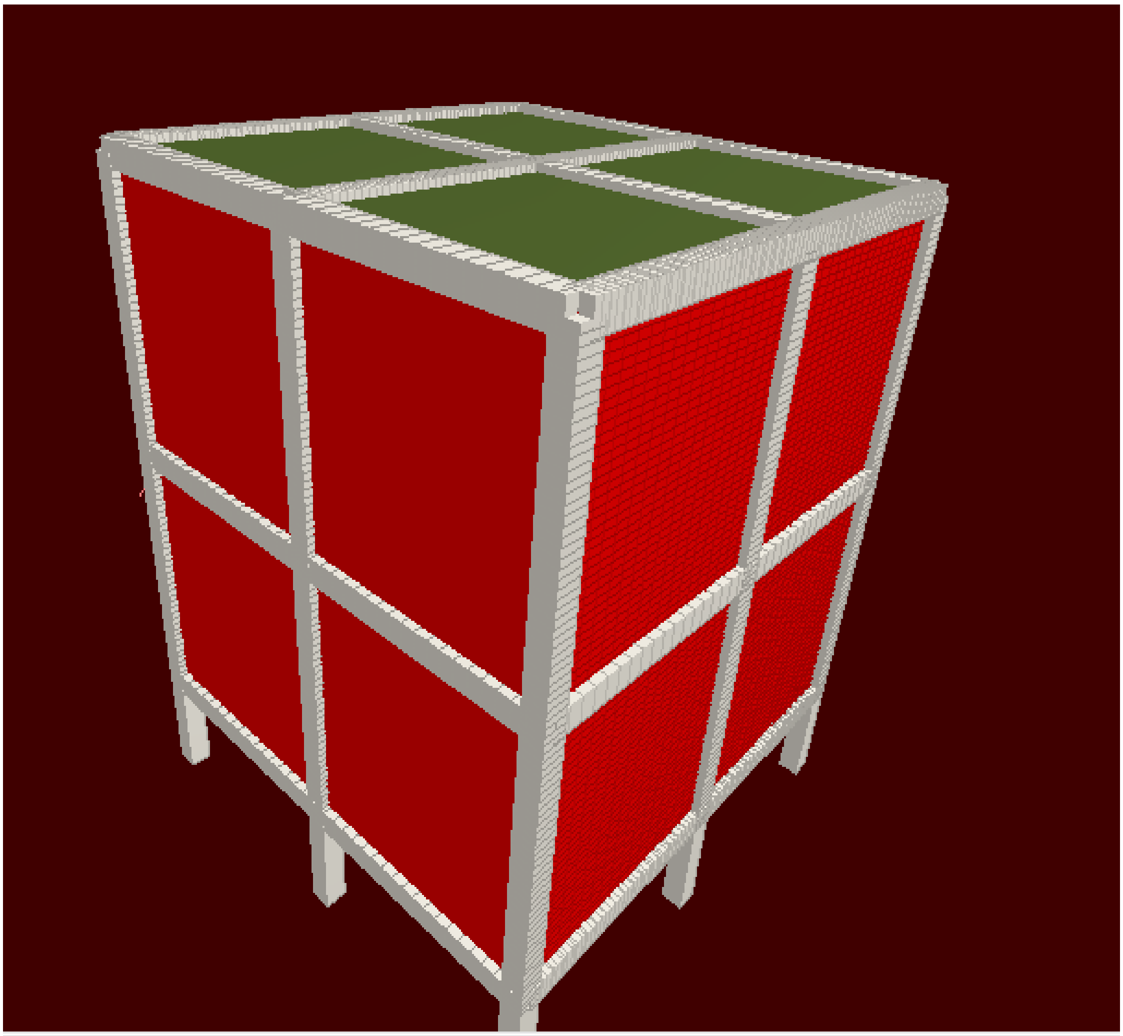
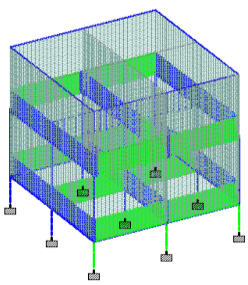


Fig 3.32 Three dimensional view of structure

3.5.4 Loads and boundary conditions

Loading: - the loads that are acting on building i.e. live load, dead load, roof load, self-weight and flood load



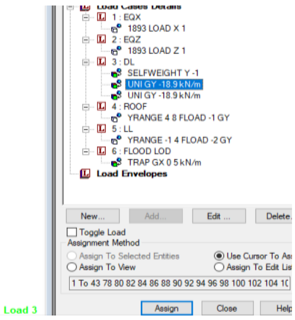


Fig 3.33 loads acting on structure

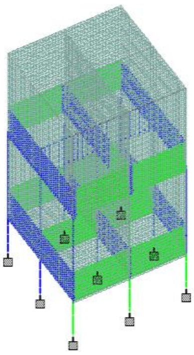


Fig 3.34 Showing dead load acting on a structure

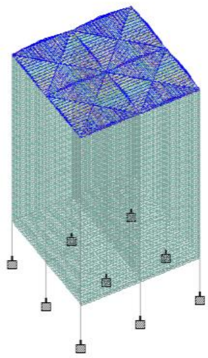


Fig 3.35 Showing roof load

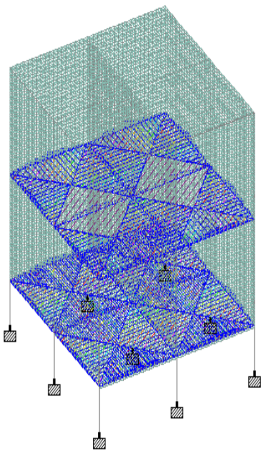


Fig 3.36 Showing live load

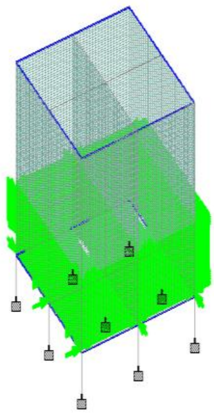


Fig 3.37 Showing flood load

3.5.5 Case 1 Normal bricks used in a structure

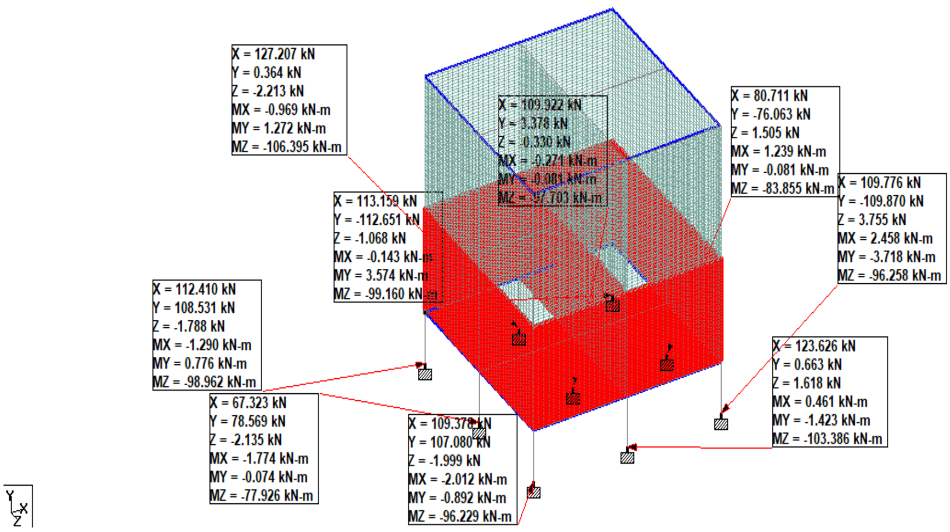


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Fig 3.38 Showing reaction forces acting on foundation

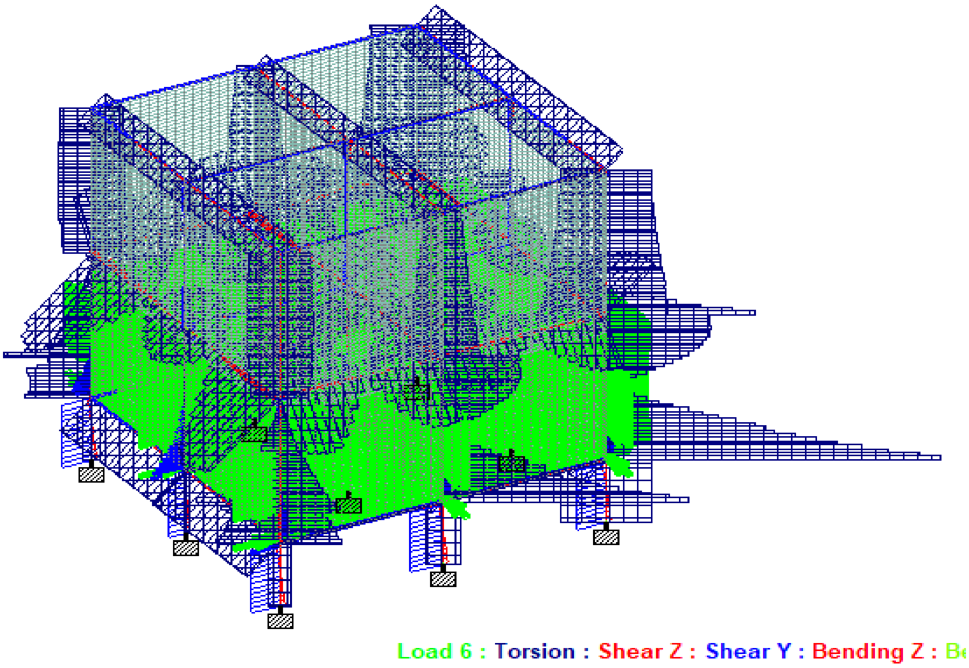

Fig 3.39 Forces acting on a structure

3.5.6 Case 2 soaked bricks used in building

Reactions on a foundation of building with soaked bricks

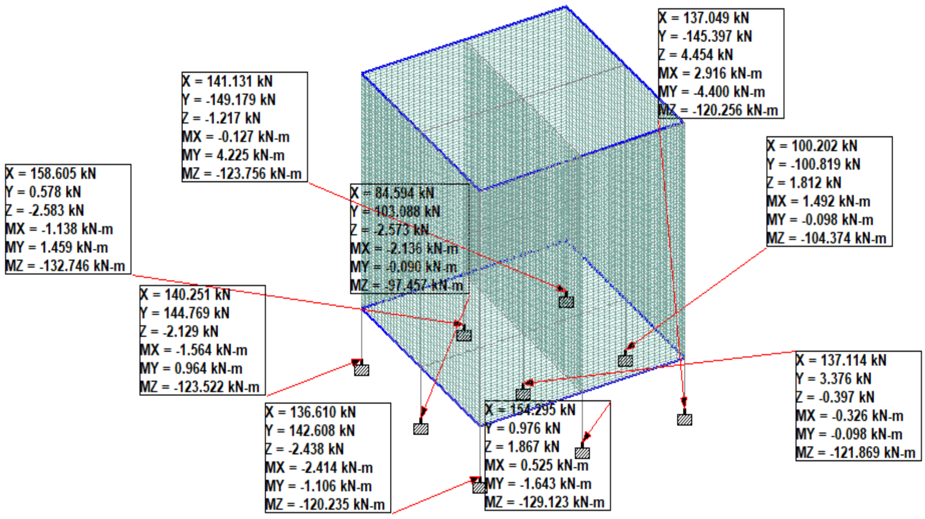

Fig 3.40 Reactions acting on foundation of the structure

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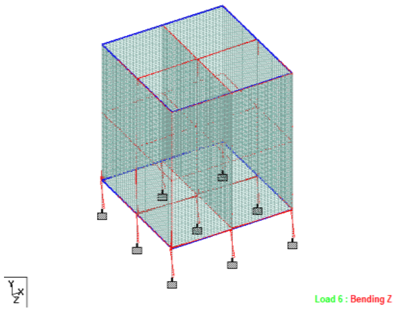

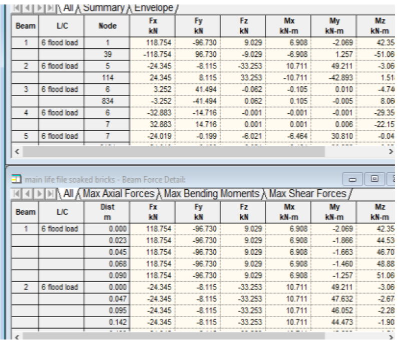

Beam	L/C	Node	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
1	6 flood load	1	118.754	-96.730	9.029	6.908	-2.069	42.35
		39	-118.754	96.730	-9.029	-6.908	1.257	-51.06
2	6 flood load	5	-24.345	-8.115	-33.253	10.711	49.211	-3.06
		114	24.345	8.115	33.253	-10.711	-42.893	1.51
3	6 flood load	6	3.252	41.494	-0.062	-0.105	0.010	-4.74
		834	-3.252	-41.494	0.062	0.105	-0.005	8.06
4	6 flood load	6	-32.883	-14.716	-0.001	-0.001	-0.001	-29.35
		7	32.883	14.716	0.001	0.001	0.006	-22.15
5	6 flood load	7	-24.019	-0.199	-6.021	-6.464	30.810	-0.04

Beam	L/C	Dist m	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
1	6 flood load	0.000	118.754	-96.730	9.029	6.908	-2.069	42.35
		0.023	118.754	-96.730	9.029	6.908	-1.866	44.53
		0.045	118.754	-96.730	9.029	6.908	-1.663	46.70
		0.068	118.754	-96.730	9.029	6.908	-1.460	48.88
		0.090	118.754	-96.730	9.029	6.908	-1.257	51.06
2	6 flood load	0.000	-24.345	-8.115	-33.253	10.711	49.211	-3.06
		0.047	-24.345	-8.115	-33.253	10.711	47.632	-2.67
		0.095	-24.345	-8.115	-33.253	10.711	46.052	-2.28
		0.142	-24.345	-8.115	-33.253	10.711	44.473	-1.90

Fig 3.41 Final forces acting

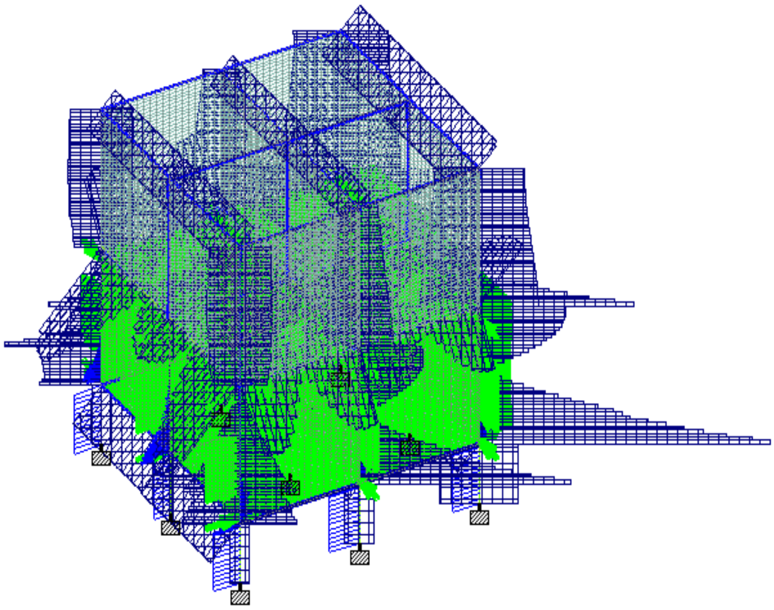

Fig 3.42 Shear, bending and torsion forces acting on a structure

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3.5.7 Case 3 building with having FRP sheet on the bricks

Reactions in a foundation of building with flood and FRP sheet on bricks

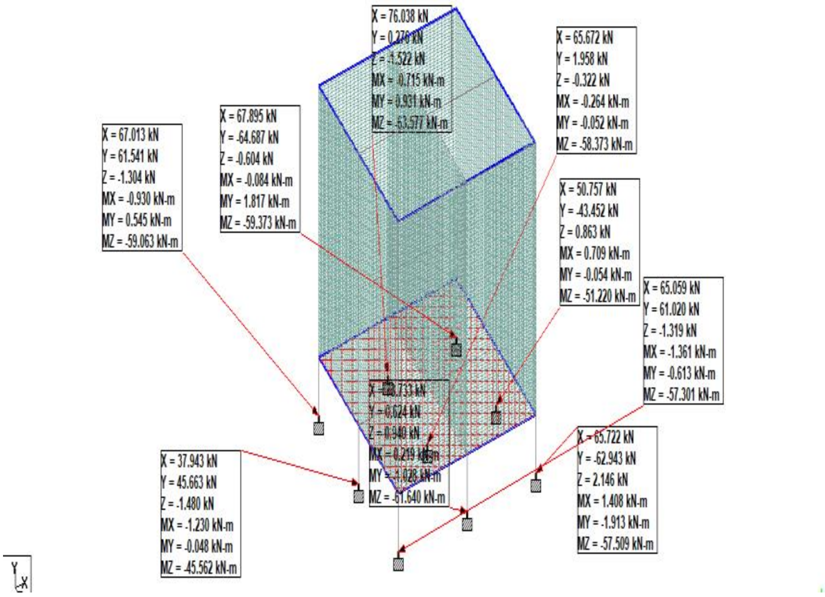
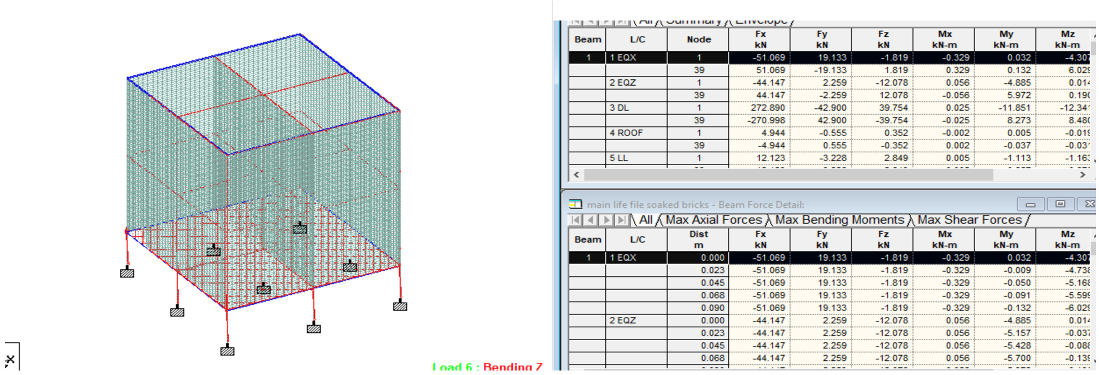


Fig 3.43 Reactions acting on foundations



Beam	L/C	Node	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
1	1 EQX	1	-51.069	19.133	-1.819	-0.329	0.032	-4.307
		39	51.069	-19.133	1.819	0.329	0.132	6.029
	2 EQZ	1	-44.147	2.259	-12.078	0.056	-4.885	0.014
		39	44.147	-2.259	12.078	-0.056	5.972	0.190
	3 DL	1	272.890	-42.900	39.754	0.025	-11.851	-12.341
		39	-270.998	42.900	-39.754	-0.025	8.273	8.480
	4 ROOF	1	4.944	-0.555	0.352	-0.002	0.005	-0.019
		39	-4.944	0.555	-0.352	0.002	-0.037	-0.031
	5 LL	1	12.123	-3.228	2.849	0.005	-1.113	-1.163

Beam	L/C	Dist m	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
1	1 EQX	0.000	-51.069	19.133	-1.819	-0.329	0.032	-4.307
		0.023	-51.069	19.133	-1.819	-0.329	-0.009	-4.738
		0.045	-51.069	19.133	-1.819	-0.329	-0.050	-5.168
		0.068	-51.069	19.133	-1.819	-0.329	-0.091	-5.599
		0.090	-51.069	19.133	-1.819	-0.329	-0.132	-6.029
	2 EQZ	0.000	-44.147	2.259	-12.078	0.056	-4.885	0.014
		0.023	-44.147	2.259	-12.078	0.056	-5.157	-0.037
		0.045	-44.147	2.259	-12.078	0.056	-5.428	-0.088
		0.068	-44.147	2.259	-12.078	0.056	-5.700	-0.139

Fig 3.44 Final forces acting on a structure

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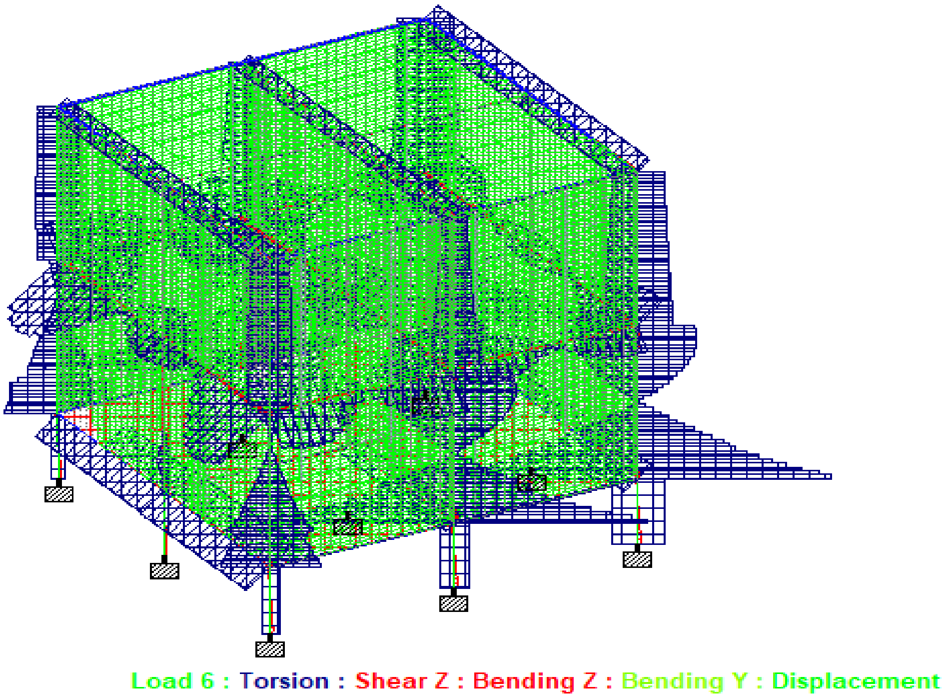

Fig 3.45 shear, bending and torsion forces

3.5.8 Case 4 building having bitumen layer on the bricks

Reaction on the foundation of building with flood and bitumen on bricks

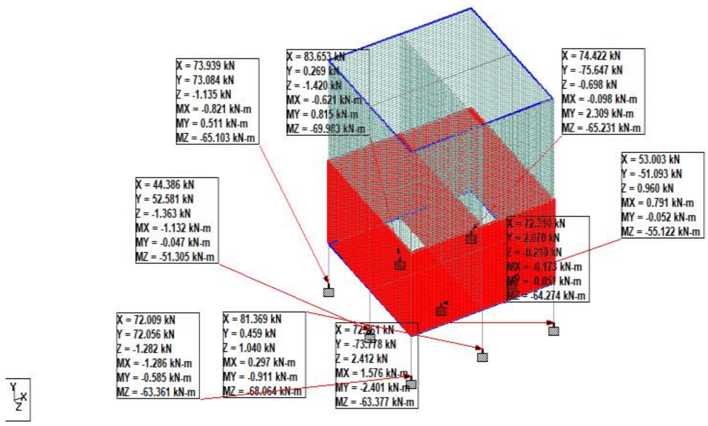

Fig 3.46 Reactions forces acting on the foundation

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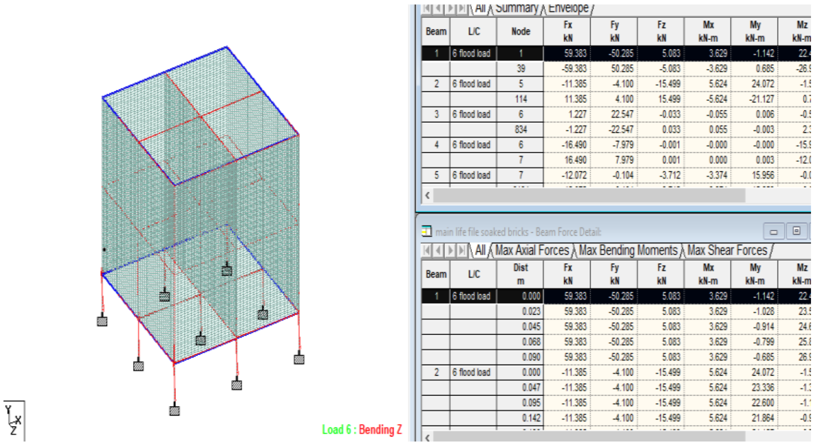


Fig 3.47 Final forces acting on structure

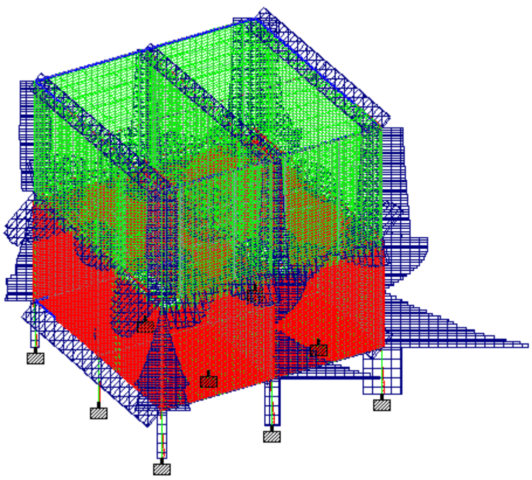


Fig 3.48 Shear, bending and torsion forces acting on the structure

3.5.9 Case 5 building having waterproofed bricks

Reactions on foundation of the building with flood and waterproofing agent on bricks

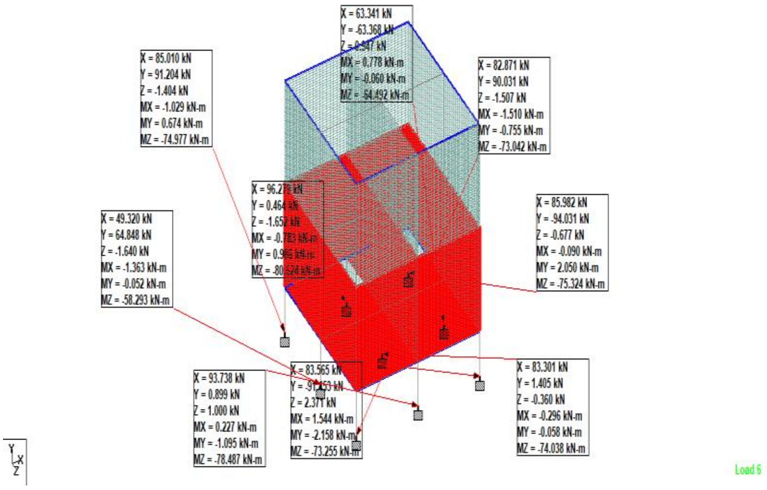
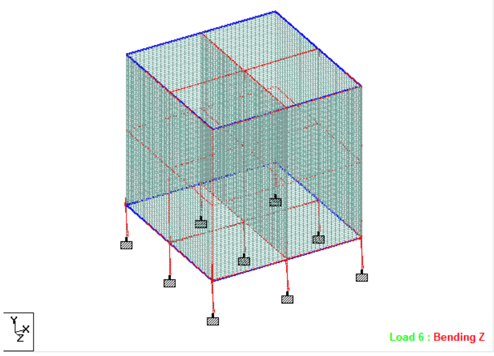
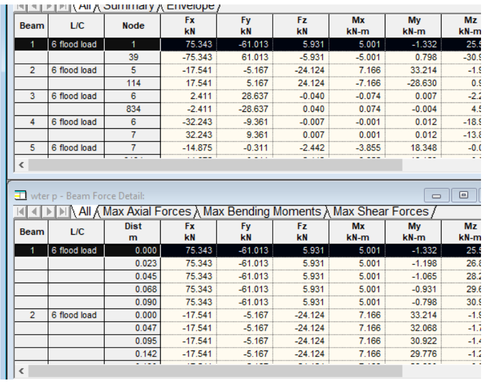


Fig 3.49 Reactions acting on the foundation of the structure





All / Summary / Envelope

Beam	L/C	Node	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
1	6 flood load	1	75.343	-61.013	5.931	5.001	-1.332	25.5
		39	-75.343	61.013	-5.931	-5.001	0.798	-30.9
2	6 flood load	5	-17.541	-5.167	-24.124	7.166	33.214	-1.9
		114	17.541	5.167	24.124	-7.166	-28.630	0.9
3	6 flood load	6	2.411	28.637	-0.040	-0.074	0.007	-2.2
		834	-2.411	-28.637	0.040	0.074	-0.004	4.5
4	6 flood load	6	-32.243	-9.361	-0.007	-0.001	0.012	-18.9
		7	32.243	9.361	0.007	0.001	0.012	-13.8
5	6 flood load	7	-14.875	-0.311	-2.442	-3.855	18.348	-0.0

wter p - Beam Force Detail:

All / Max Axial Forces / Max Bending Moments / Max Shear Forces

Beam	L/C	Dist m	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
1	6 flood load	0.000	75.343	-61.013	5.931	5.001	-1.332	25.5
		0.023	75.343	-61.013	5.931	5.001	-1.198	26.8
		0.045	75.343	-61.013	5.931	5.001	-1.065	28.2
		0.068	75.343	-61.013	5.931	5.001	-0.931	29.6
		0.090	75.343	-61.013	5.931	5.001	-0.798	30.9
2	6 flood load	0.000	-17.541	-5.167	-24.124	7.166	33.214	-1.9
		0.047	-17.541	-5.167	-24.124	7.166	32.068	-1.7
		0.095	-17.541	-5.167	-24.124	7.166	30.922	-1.4
		0.142	-17.541	-5.167	-24.124	7.166	29.776	-1.2

Fig 3.50 Final forces acting on a structure

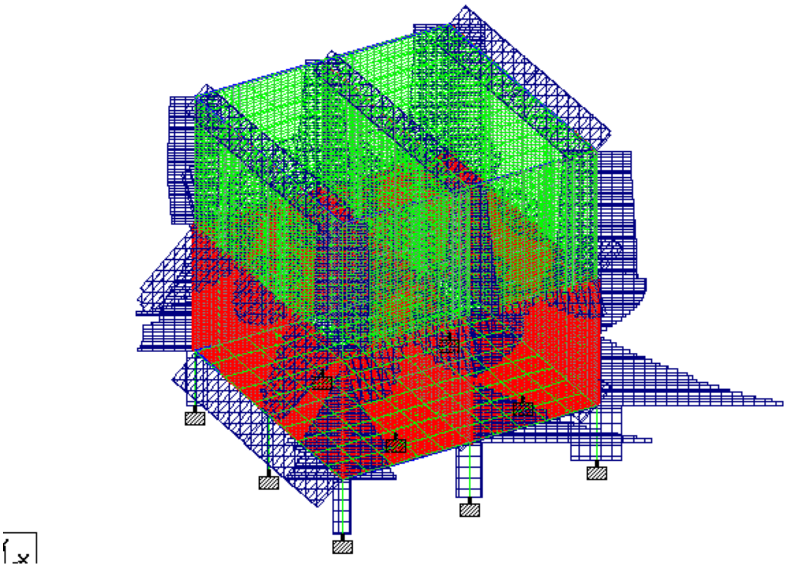


Fig 3.51 Shear, bending moment and torsion acting on a structure

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CHAPTER 4

RESULTS AND DISCUSSION

4.1 Water absorption test

Table 4.1 Comparison and the water absorbed by bricks

Samples	Weight in kg	Water absorbed (%)
Dry Bricks		
SAMPLE 1	2.602	-
SAMPLE 2	2.713	
SAMPLE 3	2.777	
Soaked Bricks		
SAMPLE 1	3.518	28.9
SAMPLE 2	3.389	
SAMPLE 3	3.524	
Bricks with water proofing agent		
SAMPLE 1	3.181	11.9
SAMPLE 2	3.888	
SAMPLE 3	3.315	
Bricks with FRP sheet		
SAMPLE 1	3.021	11.4
SAMPLE 2	3.111	
SAMPLE 3	3.097	
Bricks with bitumen		
SAMPLE 1	3.017	11.4
SAMPLE 2	3.121	
SAMPLE 3	3.097	

`

Table 4.2 Percentage water absorbed

Material	Water absorbed (%)
Soaked bricks	28.9
Bricks with FRP sheet	11.4
Bricks with waterproofing agent	11.9
Bricks with bitumen layer	11.4

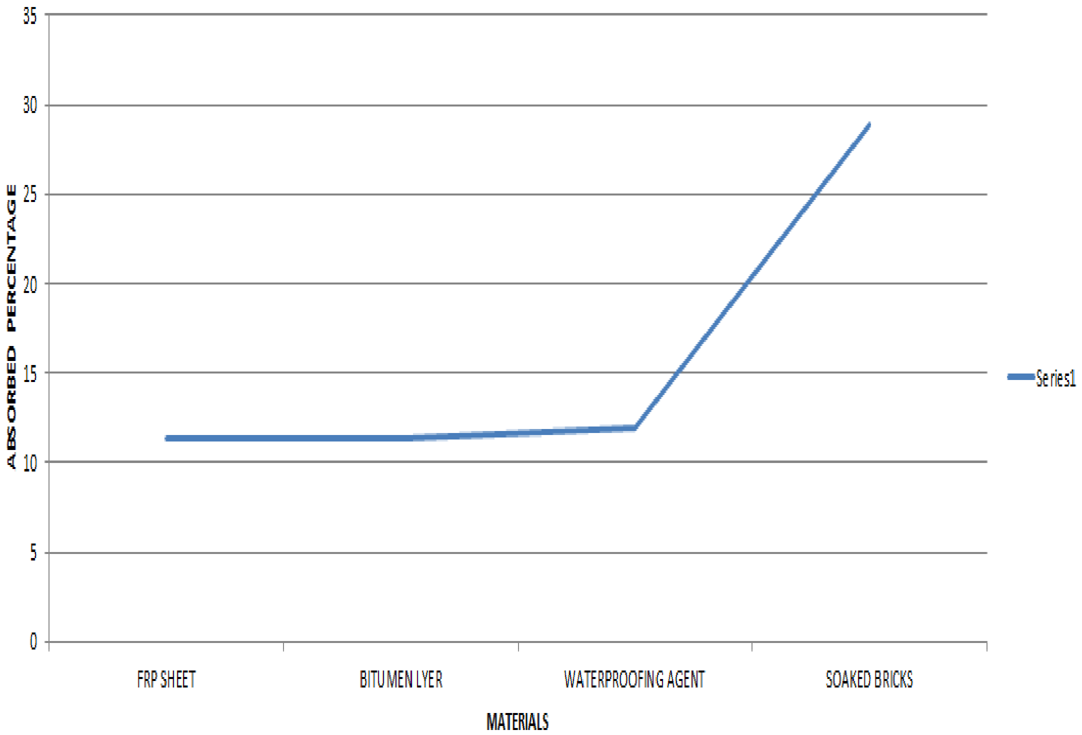

Fig 4.1 Graph showing absorbed percentage vs. materials

As per the Graph the water absorbed by the bricks is 28.9% which is much more than any another case. As the water absorbed by bitumen coated bricks and FRP sheeted bricks are similar of 11.4% and by some fraction the water absorbed by waterproofed bricks is 11.9%. Hence it implies that by use of these materials the life span of bricks can be able to increase

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4.2 Compressive strength tests for bricks

Table 4.3 Results and comparison between the compressive strengths of bricks

Samples	Load in kN/mm^2	Compressive strength N/mm^2	Avg. Compressive strength
Dry Bricks			
SAMPLE 1	187.7	10.97	10.4
SAMPLE 2	163.2	9.54	
SAMPLE 3	180.2	10.53	
Soaked Bricks			
SAMPLE 1	173.4	10.14	9.58
SAMPLE 2	167.7	9.80	
SAMPLE 3	150.9	8.82	
Bricks with water proofing agent			
SAMPLE 1	209.7	12.26	12.26
SAMPLE 2	214.07	12.51	
SAMPLE 3	205.8	12.03	
Bricks with FRP sheet			
SAMPLE 1	211.5	12.36	13.3
SAMPLE 2	234.8	13.73	
SAMPLE 3	222.7	13.02	
Bricks with bitumen			
SAMPLE 1	2.15.9	12.62	12.51
SAMPLE 2	217.5	12.71	
SAMPLE 3	209.00	12.22	

`

Table 4.4 Variations of results

Material	Compressive strength	Difference (%)
Dry bricks	10.4N/mm^2	
Soaked bricks	9.58N/mm^2	-7.88
Bricks with FRP sheet	13.03N/mm^2	27.88
Bricks with waterproofing agent	12.26N/mm^2	17.88
Bricks with bitumen layer	12.51N/mm^2	20.19

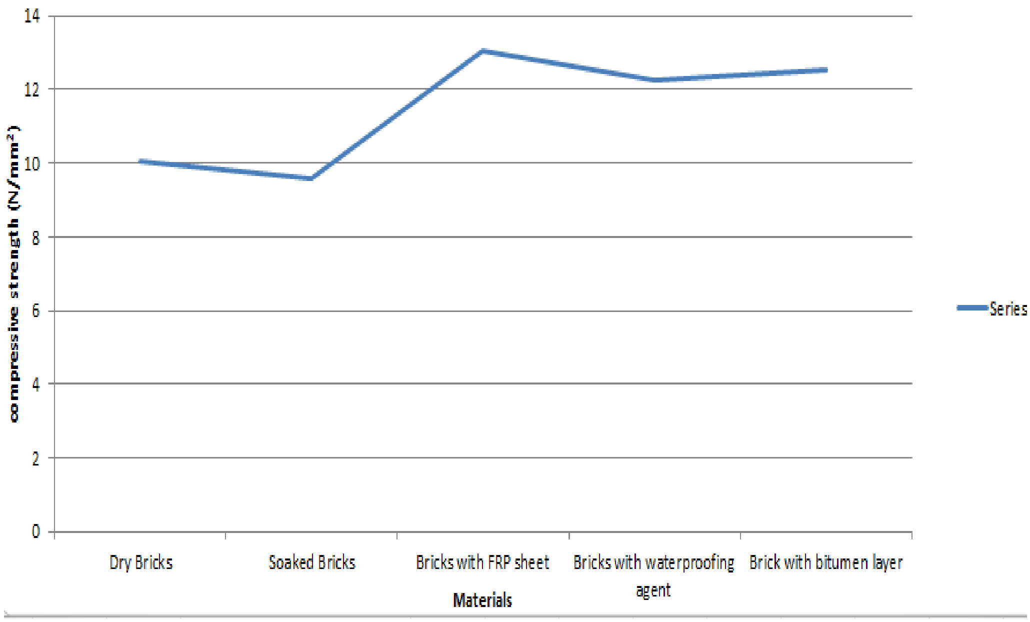

Fig 4.2 Graph showing difference compressive strength wary w.r.t. materials

Compressive strength or FRP sheeted bricks is coming out to be maximum as FRP sheeted bricks provide almost 28% more strength from normal bricks. Normal bricks when emerged in water and by compressive strength test it losses about 7.88 of its strength while bitumen layering and waterproofed bricks gin strength of 17.88 and 20.19 % respectively.

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4.3 Compressive strength test readings for blocks

Table 4.5 showing compressive strength for blocks and calculations

Samples	**Load in kN/mm²**	**Compressive strength N/mm²**	**Avg. Compressive strength**
Dry Blocks			
SAMPLE 1	148.7	2.20	2.09
SAMPLE 2	111.2	1.64	
SAMPLE 3	164.9	2.44	
Soaked Blocks			
SAMPLE 1	107.4	1.59	1.50
SAMPLE 2	090.4	1.33	
SAMPLE 3	106.9	1.58	
Blocks with water proofing agent			
SAMPLE 1	162.89	2.41	2.39
SAMPLE 2	159.08	2.35	
SAMPLE 3	164.28	2.43	
Blocks with FRP sheet			
SAMPLE 1	180.7	2.66	2.7
SAMPLE 2	174.9	2.59	
SAMPLE 3	192.8	2.85	
Blocks with bitumen			
SAMPLE 1	152.7	2.26	2.56
SAMPLE 2	198.8	2.94	
SAMPLE 3	167.5	2.48	

`

4.4 Water absorption results for blocks

Table 4.6 Variation of results for blocks

Material	Compressive strength	Difference (%)
Dry Blocks	2.09N/mm^2	
Soaked blocks	1.50N/mm^2	-28.22
Blocks with FRP sheet	2.70N/mm^2	29.18
Blocks with waterproofing agent	2.39N/mm^2	14.35
blocks with bitumen layer	2.56N/mm^2	22.48

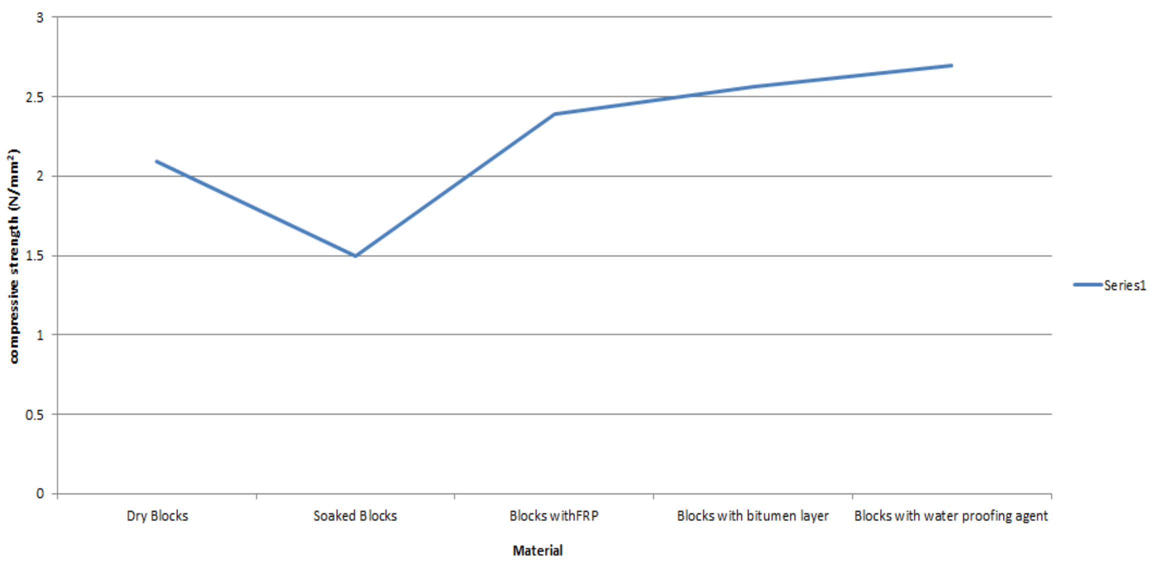

Fig 4.3 Graph showing compressive strength variation with different blocks

Compressive strength of normal blocks cut down by almost 28.22 percentages while others gain strength by using extra materials and it will help the blocks to provide strength while in flood sections or area.

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Table4.7 Water absorption test readings

Samples	Weight in kg	Water absorbed (%)
Dry Blocks		
SAMPLE 1	8.803	-
SAMPLE 2	8.943	
SAMPLE 3	9.012	
Soaked Blocks		
SAMPLE 1	16.417	86.6
SAMPLE 2	17.012	
SAMPLE 3	16.58	
Blocks with water proofing agent		
SAMPLE 1	12.289	25.7
SAMPLE 2	12.985	
SAMPLE 3	12.432	
Blocks with FRP sheet		
SAMPLE 1	11.289	40.9
SAMPLE 2	11.123	
SAMPLE 3	11.22	
Blocks with bitumen		
SAMPLE 1	12.085	35.4
SAMPLE 2	12.023	
SAMPLE 3	12.121	

`

Table 4.8 Variations and water absorbed by blocks

Material	Water absorbed (%)
Soaked blocks	86.6
Blocks with FRP sheet	25.7
Blocks with waterproofing agent	40.9
Blocks with bitumen layer	35.4

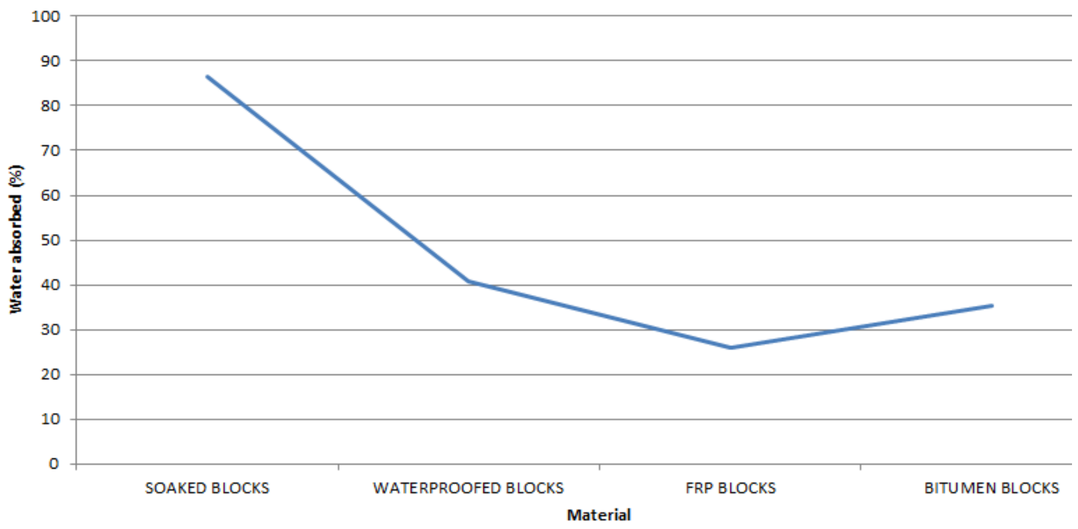

Fig 4.4 Graph showing difference between water absorbed by different materials

Water absorbed by normal block is about 86.6 % as weight of block is gained too much and others have much less value of absorption.

4.5 STAAD PRO RESULTS

Case 1 for normal bricks used in building

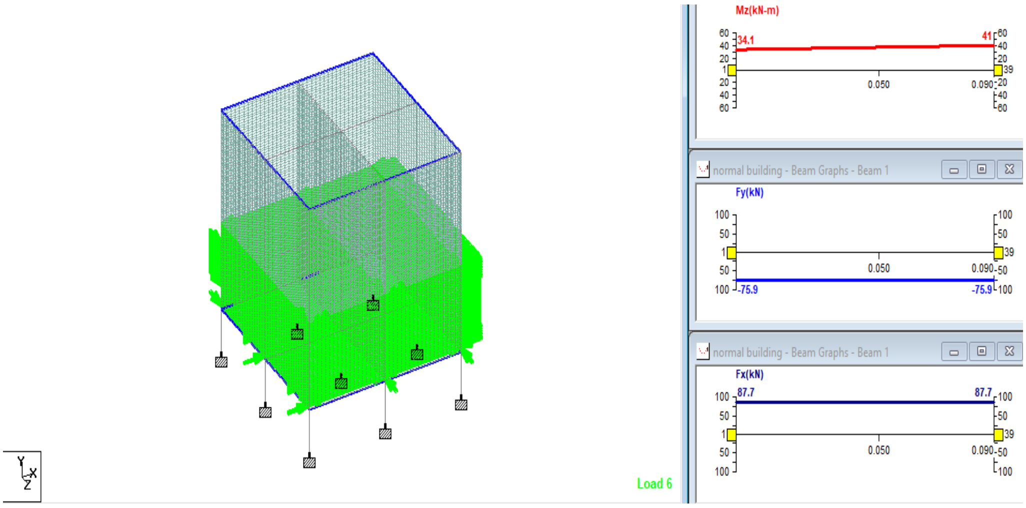

Fig 4.5 Showing deflection in beams due to flood load

As Graph shows the deflection in single beam due to flood load as in all cases this beam is considered. The deflection in beam is about 34.1 to 41

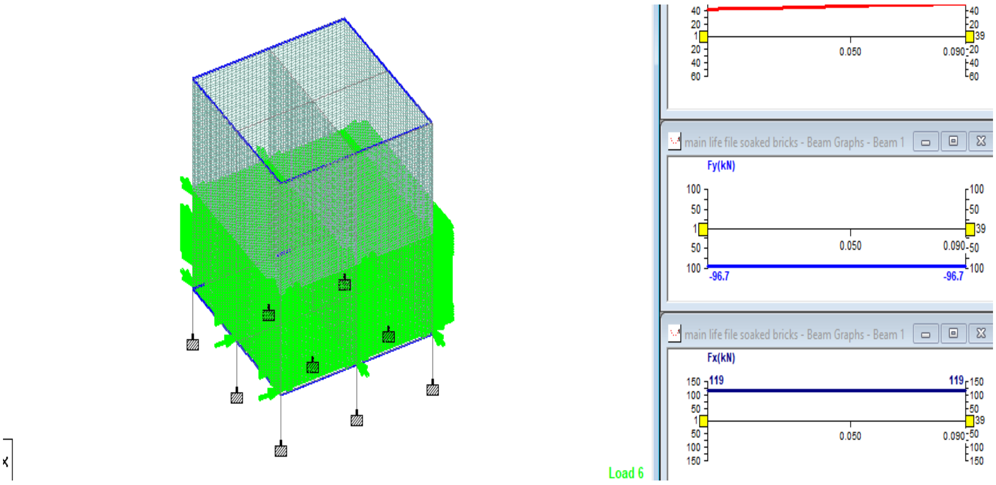

Fig4.6 Graph showing deflection of beam for soaked bricks

For soaked bricks the deflection coming out on the beam is 42.4 to 51.1 that is much more than from the normal bricks

Case 3 for FRP wrapped bricks

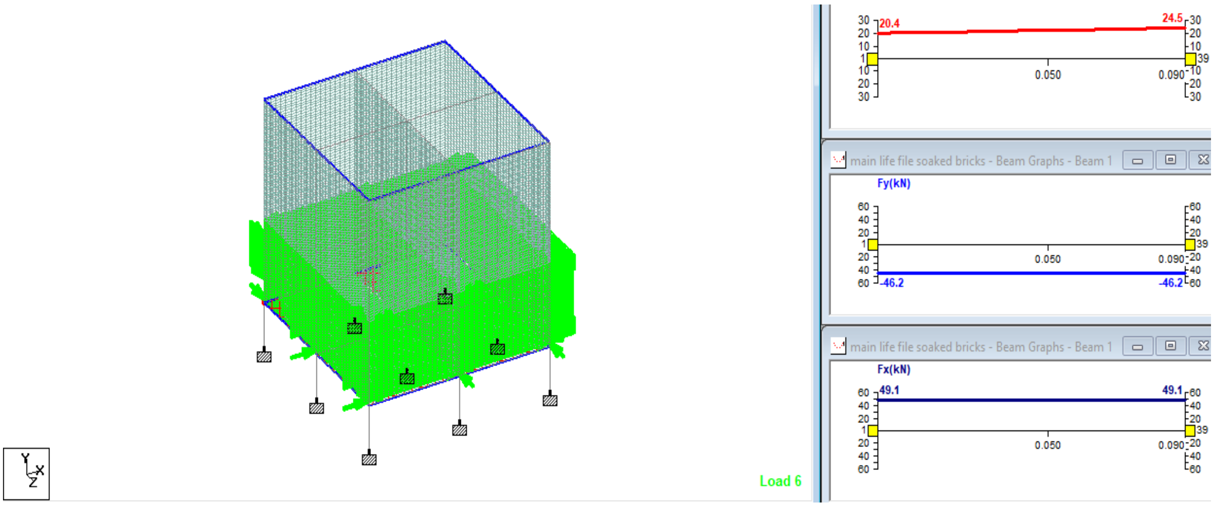

Fig 4.7 Graph for FRP wrapped bricks

Case 2 for bitumen coated bricks

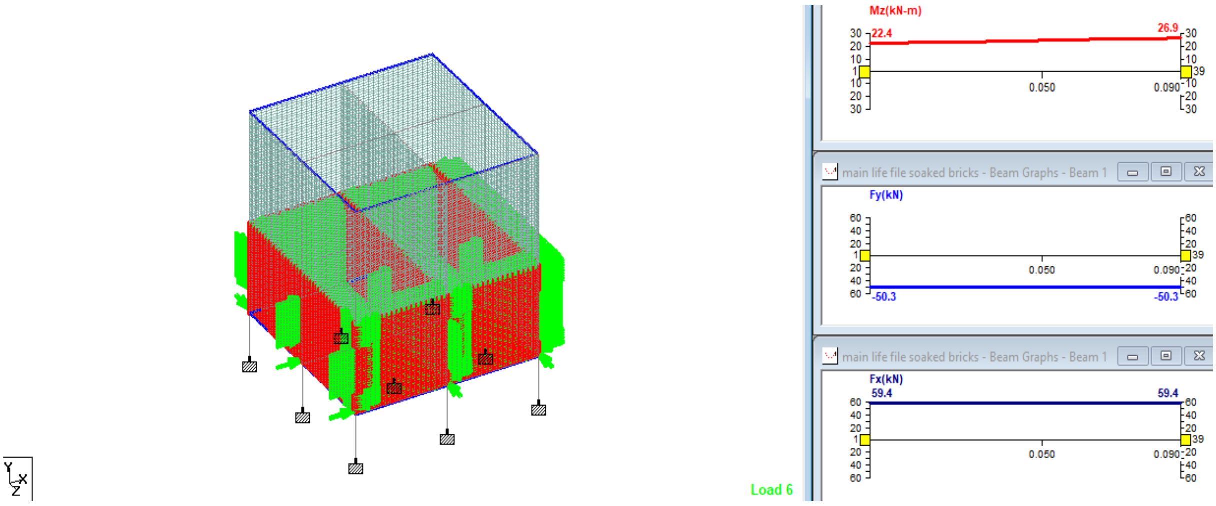

Fig 4.8 Graph for Bitumen coated bricks

Case 3 for waterproofed bricks

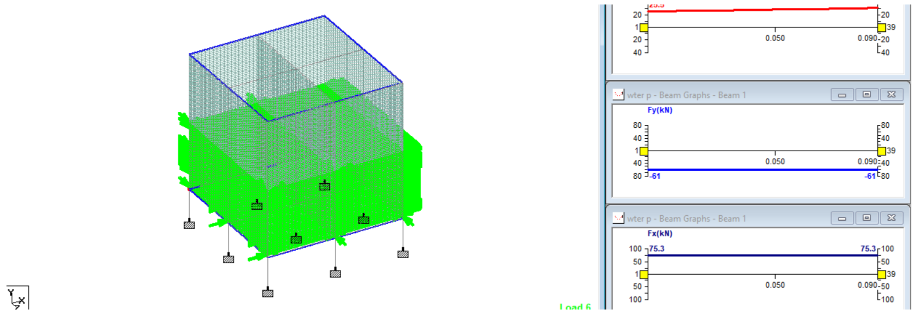

Fig4.9 Graph for waterproofed bricks

FRP sheet deflection is coming out to be 20.4 to 24.4 in kN-m on beam, as on bitumen coated bricks the deflection show is 22.4 to 26.9 and for waterproofed bricks the deflection coming out is 25.5 to 31. That specifies that these materials can be used in building materials to provide strength to the structure.

Comparison between the shear and bending moment table

For soaked bricks

MAX SHEAR FORCE & BENDING MOMENT OF BEAMS FOR SOAKED BRICKS									
	Beam	L/C	Node	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
Max Fx	13	6 FLOOD LOAD	1	144.769	-140.3	2.129	0.964	-1.63	-86.855
Min Fx	25	6 FLOOD LOAD	13	-149.18	-141.1	1.217	4.225	-1.698	-87.941
Max Fy	4265	6 FLOOD LOAD	3925	-35.815	91.571	2.069	25.49	1.974	-34.033
Min Fy	2613	6 FLOOD LOAD	2379	0.107	-227.5	-33.956	24.318	-1.811	-35.783
Max Fz	2528	6 FLOOD LOAD	2334	-22.531	3.442	43.088	-12.28	30.035	-0.456
Min Fz	838	6 FLOOD LOAD	155	-22.992	-1.878	-43.114	12.359	33.088	-0.7
Max Mx	4262	6 FLOOD LOAD	3919	-123.97	-92.42	-23.282	32.972	-0.42	-51.266
Min Mx	4540	6 FLOOD LOAD	6248	-120.34	-87.99	21.864	-32.749	1.519	-49.58
Max My	9860	6 FLOOD LOAD	22	-26.95	13.555	37.747	-8.755	50.479	-4.614
Min My	3352	6 FLOOD LOAD	8	-26.751	12.224	-38.286	8.734	-50.144	-4.532
Max Mz	15	6 FLOOD LOAD	10	0.578	-158.6	2.583	1.459	1.138	132.746
Min Mz	15	6 FLOOD LOAD	2	0.578	-158.6	2.583	1.459	-2.737	-105.162

Fig 4.10 Showing the max. Shear and bending moment for soaked bricks

MAX SHEAR FORCE & BENDING MOMENT OF BEAMS FOR WATER PROOFED BRICKS									
	Beam	L/C	Node	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
Max Fx	13	6 FLOOD LOAD	1	118.783	-115.1	1.969	0.92	-1.524	-71.159
Min Fx	25	6 FLOOD LOAD	13	-123.003	-116.5	0.947	2.861	-1.293	-72.726
Max Fy	4265	6 FLOOD LOAD	3925	-29.729	74.933	1.429	17.428	1.477	-27.776
Min Fy	2613	6 FLOOD LOAD	2379	0.429	-187.9	-28.088	22.246	-1.53	-29.417
Max Fz	2528	6 FLOOD LOAD	2334	-19.805	2.996	37.886	-11.398	25.273	-0.409
Min Fz	838	6 FLOOD LOAD	155	-20.204	-1.647	-37.877	11.454	27.953	-0.621
Max Mx	4262	6 FLOOD LOAD	3919	-102.218	-73.57	-16.75	22.4	-0.26	-42.181
Min Mx	4540	6 FLOOD LOAD	6248	-99.047	-70.03	15.881	-22.265	1.07	-40.789
Max My	2532	6 FLOOD LOAD	21	-21.714	7.042	33.177	-10.454	42.694	-2.637
Min My	3352	6 FLOOD LOAD	8	-21.175	9.968	-31.193	7.32	-40.041	-3.692
Max Mz	15	6 FLOOD LOAD	10	0.605	-130.4	2.321	1.401	1.095	109.185
Min Mz	15	6 FLOOD LOAD	2	0.605	-130.4	2.321	1.401	-2.387	-86.47

Fig 4.11 Showing the max, shear and bending moment for water proofed bricks

MAX SHEAR FORCE & BENDING MOMENT OF BEAMS (BITUMEN)									
	Beam	L/C	Node	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
Max Fx		6 FLOOD LOAD	1	114.719	-108.8	1.801	0.866	-1.39	-67.221
Min Fx	25	6 FLOOD LOAD	13	-118.49	-110	0.886	2.658	-1.205	-68.67
Max Fy	4265	6 FLOOD LOAD	3925	-29.535	70.74	1.3	16.243	1.372	-26.27
Min Fy	2613	6 FLOOD LOAD	2379	0.43	-178.6	-25.863	20.573	-1.413	-27.755
Max Fz	2528	6 FLOOD LOAD	2334	-19.816	2.849	37.432	-10.639	24.518	-0.383
Min Fz	838	6 FLOOD LOAD	155	-20.133	-1.556	-37.265	10.683	27.163	-0.583
Max Mx	4262	6 FLOOD LOAD	3919	-98.821	-70.22	-15.417	20.816	-0.25	-39.837
Min Mx	4540	6 FLOOD LOAD	6248	-95.759	-66.92	14.633	-20.692	0.994	-38.548
Max My	2532	6 FLOOD LOAD	21	-21.795	6.72	33.144	-9.778	41.816	-2.505
Min My	3352	6 FLOOD LOAD	8	-21.585	9.379	-30.691	6.836	-38.967	-3.474
Max Mz	15	6 FLOOD LOAD	10	0.591	-123.2	2.14	1.289	1.009	103.152
Min Mz	15	6 FLOOD LOAD	2	0.591	-123.2	2.14	1.289	-2.201	-81.652

Fig4.12 Showing deflection and bending moment from bitumen coated bricks

MAX SHEAR FORCE & BENDING MOMENT OF BEAMS (FRP)									
	Beam	L/C	Node	Fx kN	Fy kN	Fz kN	Mx kN-m	My kN-m	Mz kN-m
Max Fx	13	6 FLOOD LOAD	1	91.204	-85.01	1.404	0.674	-1.077	-52.538
Min Fx	25	6 FLOOD LOAD	13	-94.031	-85.982	0.677	2.05	-0.926	-53.65
Max Fy	4265	6 FLOOD LOAD	3925	-23.992	55.257	0.991	12.558	1.061	-20.549
Min Fy	2613	6 FLOOD LOAD	2379	0.343	-140.204	-19.803	15.807	-1.088	-21.67
Max Fz	2528	6 FLOOD LOAD	2334	-16.177	2.212	30.352	-8.174	19.546	-0.294
Min Fz	838	6 FLOOD LOAD	155	-16.357	-1.2	-29.999	8.206	21.727	-0.448
Max Mx	4262	6 FLOOD LOAD	3919	-78.639	-55.326	-11.805	16.057	-0.195	-31.128
Min Mx	4540	6 FLOOD LOAD	6248	-76.187	-52.753	11.2	-15.963	0.77	-30.123
Max My	2532	6 FLOOD LOAD	21	-17.85	5.239	27.132	-7.517	33.632	-1.945
Min My	3352	6 FLOOD LOAD	8	-17.86	7.221	-24.758	5.249	-31.161	-2.674
Max Mz	15	6 FLOOD LOAD	10	0.464	-96.279	1.652	0.986	0.783	80.624
Min Mz	15	6 FLOOD LOAD	2	0.464	-96.279	1.652	0.986	-1.695	-63.795

Fig 4.13 Showing Max. shear force and bending moment by using FRP on bricks

These Figures are showing the overall conclusion of the modeling. Max. Bending moment and shear force values are determining from this.as the lowest value of shear and bending moment is coming out is in FRP and maximum in soaked bricks.

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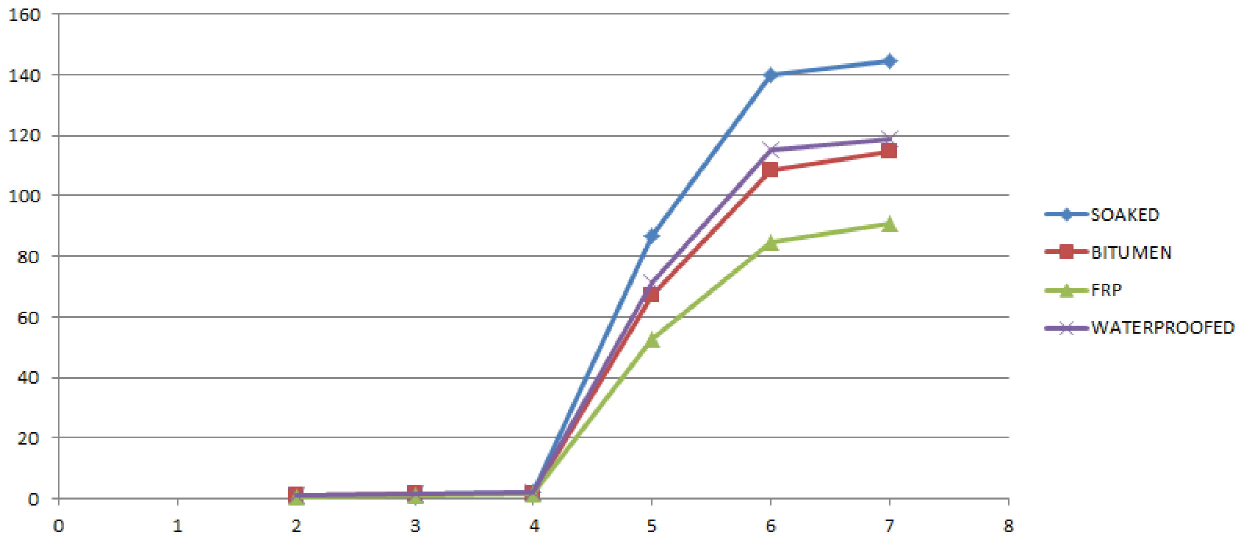

Fig 4.14 Deflection in a structure

4.6 ABAQUS WORK RESULTS

Case 1 Normal brick wall

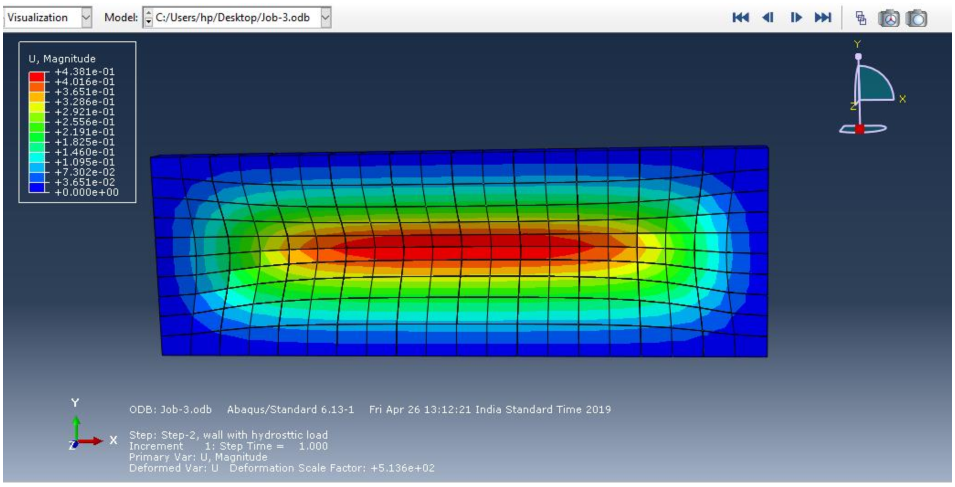

Fig 4.15 Showing Contour Graph results for normal brick wall

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Case 2 soaked bricks used for wall

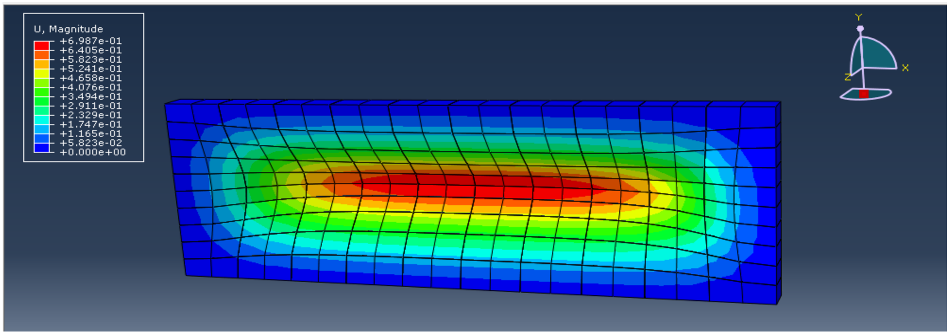

Fig 4.16 Showing contour Graph for the soaked bricks used in wall

Case 3 FRP sheet is used on wall

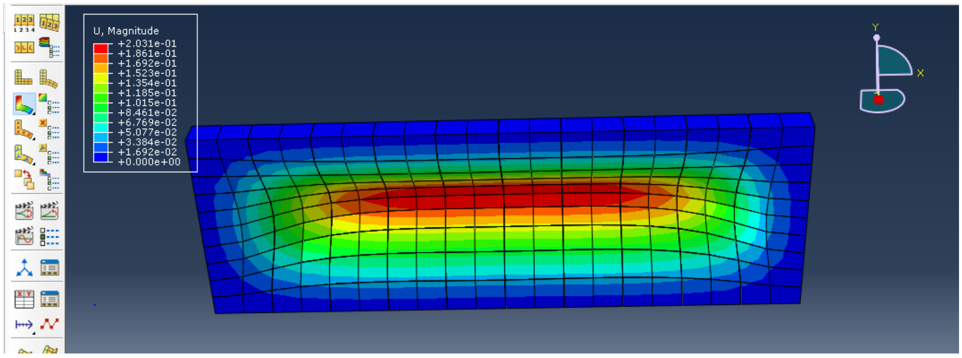

Fig 4.17 Showing Contour Graph result for FRP sheet used for making wall

Case 4 waterproofing agent coat on wall

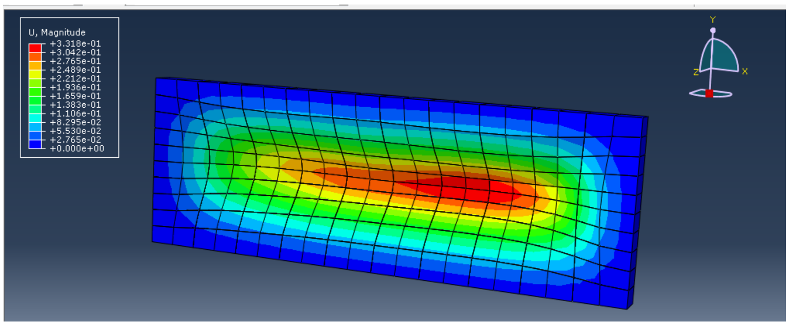

Fig 4.18 Showing Contour Graphs showing results for waterproofing agent coat done on bricks

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Case 5 bitumen layer on brick wall

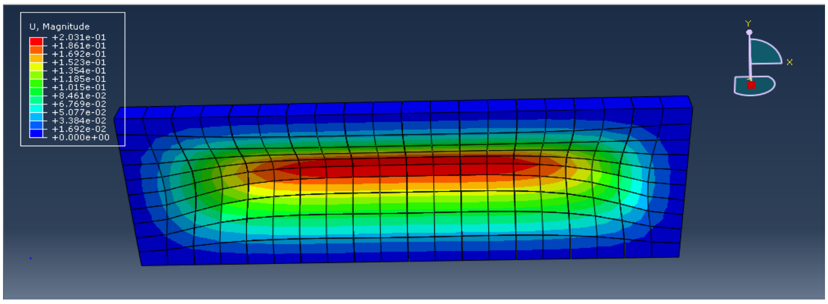

Fig4.19 Showing Contour Graph showing results for bitumen layered on brick

Final result for ABAQUS analysis

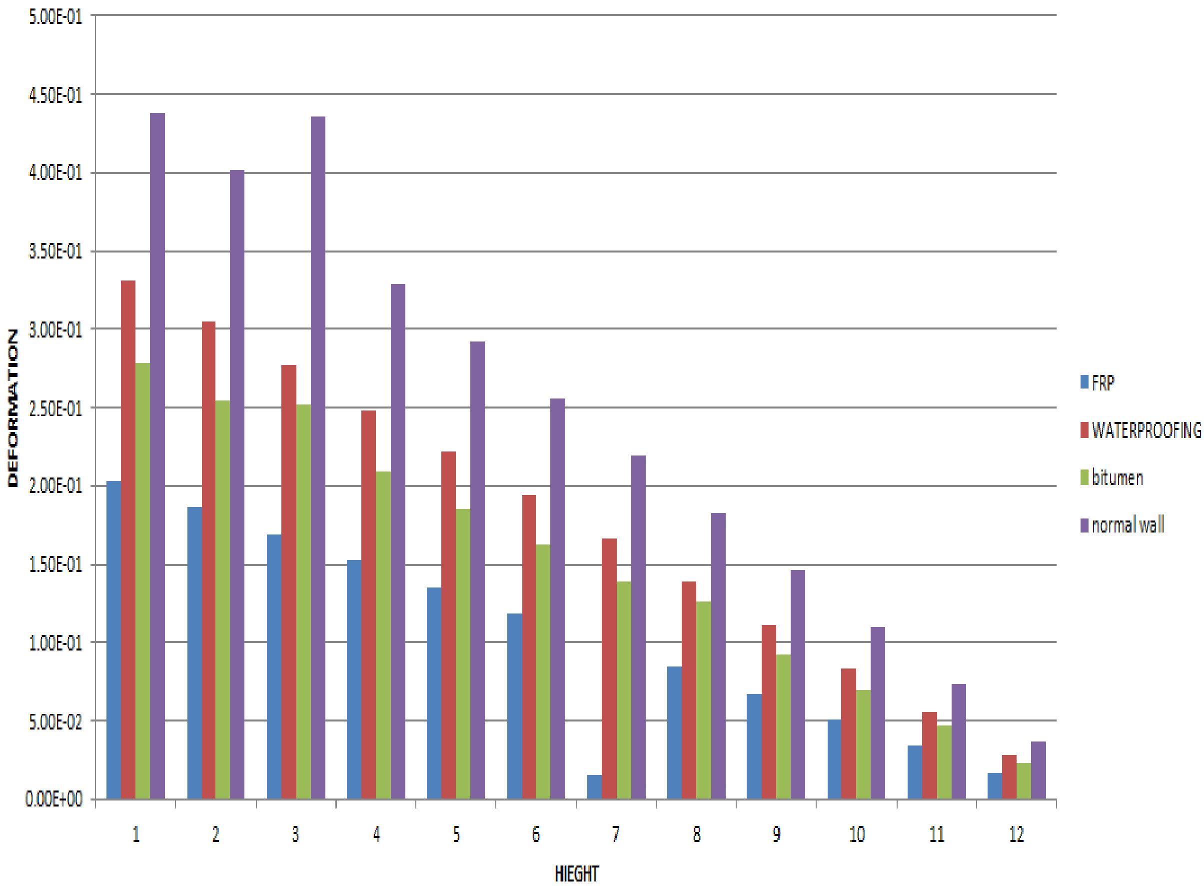

Fig 4.20 Graph showing the deformation vs. height for all cases

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CHAPTER 5

CONCLUSION

5.1 Conclusion

From the overall analysis which I performed in this project, leads me to these following conclusions which are mentioned below:-

1. With the help of waterproofing agent, bitumen and FRP sheets properties i.e. compressive strength and water absorption of bricks and blocks get enhanced which helps in reduction of their degradation.
2. For bricks increase in the compressive strength is up to 27% by using FRP, 18% for waterproofing agent and 20% for the bitumen coated bricks.
3. For blocks increase in the compressive strength is up to 29.18% by using FRP, 14.35% for waterproofing agent and 22.48 % for the bitumen coated blocks are found.
4. Water absorption capacity for bricks also get reduced to 17.5% for FRP same as for bitumen coated bricks and 17 % for waterproofing agent and for blocks it also gets reduced to 60.9% for FRP, 35.5% for bitumen coated blocks and 51.1% for waterproofing agent.
5. Software analysis also shows the increase in strength up to 18 to 23% in wall made up of bricks and AAC blocks.
6. Deflection in soaked bricks is 19 to 23 % more as compared to other bricks coated with bitumen, FRP and waterproofing agent.
7. Deflection in soaked blocks is 20 to 26 % more as compared to AAC blocks coated with bitumen, FRP and waterproofing agent.

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5.2 Future Scope

1. Research on new methods to reduce the degradation of the building materials.
2. Corrosion effects on plinth beam submerged in floodwater.
3. Effects on the whole structure due to settlement of foundation by flood water.
4. Research can be done on the methods to reduce the permeability in building material.

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