STATIC STRUCTURAL AND SHAKE TABLE TESTING ON STONE CONCRETE BLOCKS AND WALLS

A

PROJECT REPORT

submitted in partial fulfillment of the requirements for the Degree

of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

Under the supervision

of

PROF. DR. ASHOK KUMAR GUPTA

(DEAN ACADEMICS AND RESEARCH)

&

DR. TANMAY GUPTA

ASSISTANT PROFESSOR (SENIOR GRADE)

By

RONIT MAHAJAN [191009]

SHIVANKAR PARTAP SINGH GULERIA [191437]

to

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

WAKNAGHAT SOLAN-173234

HIMACHAL PRADESH INDIA

MAY- 2023

STUDENT'S DECLARATION

We, the undersigned, hereby certify that the project report titled **" STATIC STRUCTURAL AND SHAKE TABLE TESTING ON STONE CONCRETE BLOCKS "** submitted in partial fulfillment of the requirements for the Bachelor of Technology degree in Civil Engineering at the Jaypee University of Information Technology, Waknaghat is a genuine and original piece of work that we completed under the supervision of **Prof. Dr. Ashok Kumar Gupta** and **Dr. Tanmay Gupta**. This project report has not previously been submitted for consideration for any other degree or credential. I am fully responsible for the contents of my project report.

Ronit Mahajan (191009)
Department of Civil Engineering
Jaypee University of Information
Technology, Waknaghat, India

Shivankar Partap Singh Guleria(191437)
Department of Civil Engineering
Jaypee University of Information
Technology, Waknaghat, India

CERTIFICATE

This is to certify that the work presented in the project report titled " **STATIC STRUCTURAL AND SHAKE TABLE TESTING ON STONE CONCRETE BLOCKS** " submitted to the Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering is an authentic record of work carried out by Ronit Mahajan (191009) and Shivankar Partap Singh Guleria (191437under the supervision of **Prof. Dr. Ashok Kumar Gupta** and **Dr. Tanmay Gupta** to the best of our knowledge, the preceding statement is correct.

Signature of Supervisor	Signature of HOD	Signature of Supervisor
Prof Dr. Ashok K. Gupta	Dr. Ashish Rohilla	Dr. Tanmay Gupta
Dean (Academics and Research)	Head Of Department	Assistant Professor(SG)
JUIT, Waknaghat	Department of CE	Department of CE
	JUIT, Waknaghat	JUIT, Waknaghat

ACKNOWLEDGEMENT

The success and end of this project necessitated a great deal of direction and assistance from a large number of people, and we are really fortunate to have received it over the duration of our project. All of what we have accomplished is due to such oversight and support, and we would want to thank everyone who gave their time and expertise to this project.

We would like to that **Dr. Tanmay Gupta** (Project Supervisor) for his invaluable assistance and compassionate supervision during the project. We owe him a great debt of gratitude for his leadership and unwavering support.

Our sincere gratitude to **Prof. Ashok Kr. Gupta**, Dean Academics and Research, for all the facilities rendered. We are also grateful to the faculty members of the department for their unwavering support throughout the project.

We'd like to express our gratitude to our panel members, who provided us with feedback and suggestions throughout the process. We would like to thank our parents for leading by example and demonstrating the importance of hard work.

Lastly, our heartfelt gratitude goes to our friends who were involved in giving us suggestions and recommendations.

ABSTRACT

In developing countries such as India, because of growing industrialization and urbanization, including the construction of infrastructure and other facilities, the consumption of natural resources is very common. In regards to this, people have begun to realize different appropriate substitutes of materials for concrete in order that the conventional resources that are existing these days may be preserved for the longer-term generations. With the addition of stone to concrete blocks, it makes blocks sustainable and cost-efficient. Masonry buildings made from passive stone/brick materials are acceleration sensitive and vulnerable to seismic forces. Also, the behaviour of Stone concrete blockshas not been checked under dynamic loading conditions. This study will help in knowing the dynamicbehavior of stone concrete blocks. This paper studies the dynamic behavior of stone concrete blockretaining wall models under shock loading or dynamic testing of reduced-scale structures using an earthquake stimulator. The purpose of this study is to compare the dynamic behavior of walls with and without stone in concrete blocks. Experimental procedures are summarized, andsample test results are presented for the testing method.

Key Words: Stone concrete blocks, Dynamic testing, shock loading, retaining wall.

TABLE OF CONTENT

STUDENT'S DECLARATION	I
CERTIFICATE	II
ACKNOWLEDGEMENT	III
ABSTRACT	IV
TABLE OF CONTENTS	V-VI
LIST OF FIGURES	VII-IX
LIST OF TABLES	X
CHAPTER 1	
INTRODUCTION	
1.1 GENERAL	1
1.2 CONSTITUENTS OF CONCRETE BLOCKS	2
1.3 PRECAST STONE MASONRY BLOCKS	3
1.4 RETAINING WALLS	3
1.5 TYPES OF RETAINING WALL	4-7
1.6 UTILIZATION OF STONE MASONRY IN ANCIENT AND MODERN TIMES	7
CHAPTER 2	
LITERATURE REVIEW	
2.1 GENERAL	13
2.2 LITERATURE SURVEY	13-16
2.3 RESEARCH GAPS	16
2.4 RESEARCH OBJECTIVES	16-17

CHAPTER 3

MATERIALS AND RESEARCH METHODOLOGY

3.1 GENERAL	18
3.2 MATERIALS USED	19-20
3.3 TEST ON MATERIALS	20-26
3.4 STONE CONCRETE BLOCKS AND NORMAL CONCRETE BLOCKS	26-32
3.5 SHAKE TABLE EXPERIMENT	32-34

CHAPTER 4

RESULTS AND DISCUSSION

4.1 GENERAL	35
4.2 RESULTS	35-50

CHAPTER 5

CONCLUSION

CONCLUSION	51
FUTURE RECOMMENDATIONS	51-52
REFERENCES	53-54
PUBLICATIONS	55

LIST OF FIGURES

Figure No.	Figure Name	Page no.
1.1	Gravity Retaining Wall	4
1.2	Crib Retaining Wall	5
1.3	Cantilever Retaining Wall	5
1.4	Buttressed Retaining Wall	6
1.5	Anchored Retaining Wall	6
1.6	Modular Block Retaining Wall	7
1.7	Ancient Tools And Plug And Feather Toolset	8
1.8	Diamond Cutter	9
1.9	Water Jet Cutter	10
1.10	Flame Thrower	10
1.11	Wire Saw	11
1.12	Cnc Machine	11
1.13	Stone Cutter Machine	12
3.1	Normal Consistency Test	21
3.2	Los Angeles Abrasion Test	22
3.3	Impact And Crushing Test	23
3.4	Fire Resistance Test	25
3.5	Ctm Machine	25

3.6	Crystallization Test	26
3.7	Size Of Mould	27
3.8	Sand And Coarse Aggregate	27
3.9	Concrete Mix	28
3.10	Stone Cutting Machine	29
3.11	Table Vibrator	29
3.12	Casting Of Blocks	30
3.13	Demoulding Of Blocks	30
3.14	Curing Tanks	31
3.15	Block Placed In CTM	31
3.16	Cube After Application Of Load	32
3.17	Uniaxial Shake Table	33
3.18	Wall Made From SCB	34
4.1	Compressive Strength Graph (M-15 NCB)	37
4.2	Compressive Strength Graph (M-15 SCB)	38
4.3	NCB Vs SCB (M-15)	39
4.4	Compressive Strength Graph (M-20 NCB)	40
4.5	Compressive Strength Graph (M-20 SCB)	41
4.6	NCB Vs SCB (M-20)	41

4.7	Max/Min Acceleration At Different Amplitude	46
4.8	Max/Min Acceleration At Different Amplitude	49
4.9	Failure Mechanism Of Wall	50

LIST OF TABLES

Table No.	Table Name	Page no.
3.1	Testing Material	19
3.2	Properties Of Cement	19
4.1	Test On Cement	35
4.2	Test On Aggregate	36
4.3	Test On Locally Available Stones	36
4.4	Compressive Strength	37
4.5	Final Result For Compressive Strength Of Stone Concrete Blocks (M-15)	38
4.6	Final Result For Compressive Strength Of Normal Concrete Blocks (M-20)	39
4.7	Final Result For Compressive Strength Of Stone Concrete Blocks (M-20)	40
4.8	Earthquake Data	42

CHAPTER 1
INTRODUCTION

1.1 GENERAL

Globalization, liberalization, and privatization are significant in the current context. As a result, India now sees an annual increase in the number of large infrastructure projects, such as airports, expressways, trains, and stations, as well as complex malls, multi-story homes, nuclear power plants, and so forth. Forsuch construction projects, a significant amount of vital natural capital is drained annually. This has caused a rapid depletion of natural resources and influenced the cost of building structures, creatinga severe issue for the construction industry, particularly in emerging nations like India.

Any building project's materials are regarded as its most crucial component. Alternatives that use less energy and have less of an impact on the environment are being studied. An option that encourages sustainable and cost-effective construction is being investigated considering the rising cost of materials.

In order to conserve the current conventional components for future generations, individuals have started looking for new suitable materials that can be utilized as an additive or replacement for traditional concrete ingredients. Concrete has been successfully made with a variety of resources, including fly ash, waste aggregate, broken bricks, demolition stones, broken glass waste, ceramic waste, blast furnace slag, tile waste, and other resources. Concrete is a composite building material, and its primary traditional ingredients are cement, sand, coarse aggregate, and water. As the most fundamental ingredient in concrete, cement affects the environment because it produces clinkers. It pollutes the environment and emits a lot of carbon dioxide. Different locally accessible replacement materials can be employed as reinforcing cementitious materials, together with other low-carbon materials, to lessen dependency on cement.

On a worldwide scale as well as at the local or regional level, demolition and building waste is a severe problem. It is crucial to effectively utilize construction and demolition waste, as well as its application in reusable structural elements, in order to reduce trash dumping and the usage of primary resources. Regarding environmental concerns and responsible long-term management, this is crucial.

1.2 CONSTITUENTS OF CONCRETE BLOCKS

In construction, concrete blocks are a common and necessary material. It is frequently utilized to constructboth residential and commercial structures. Concrete blocks can be manufactured by hand or bymachinery. They are available in a range of sizes and shapes. The most common dimensions are 40 cm in length, 20 cm in height, and 8 to 15 to 20 cm in width.

These concrete blocks are available in both Hollow and Solid blocks in a range of sizes. Solid blocks have no voids or cavities, whereas hollow blocks have one or more spaces on both sides. Strong blocks have many advantages, including a high compressive strength, strong durability, good fire resistance, andresistance to the effects of weathering or abrasion. The following benefits of hollow blocks include theirability to be made larger than solid blocks, their lighter weight, the ease and speed with which walls canbe constructed, the strong thermal insulation that the air space provides, the ability to fill voids with concrete or steel bars for high earthquake resistance, and the ability to install plumbing and electrical systems in cavities.

Sand or gravel with a maximum particle size of 10 mm and regular Portland cement are the ingredients used to create concrete blocks. The average water-to-cement ratio is 0.5, and the aggregate-to-cement ratiois 1:6 or 1:8. Depending on the required strength, the casting and curing time is 7 or 28 days.

Sustainable development is extremely relevant in the current environment. Dumped demolition and construction waste has grown to be a significant problem. For long-lasting and economical building, multiple research projects have been conducted in which various materials have been evaluated by combining them or employing them in concrete blocks, and their strengths have been noted and reviewed. This is done to protect the environment and to deal with the issue of dumping excavated material.

1.3 PRE-CAST STONE MASONRY BLOCKS

Stone, which is widely used for walls, is abundant in some areas. The typical wall thickness is from 380 to 450 millimeters, while 300-millimeter walls can occasionally be constructed at a somewhat higher cost due to the need for specialized staff and additional materials. Depending on the structural requirements and functional requirements, these walls may be exceedingly thick. Pre-cast stone blocks, also known as stone-crete blocks, are a great alternative to imported bricks because they make considerable use of local materials. The stones used to create these blocks have a diameter of between 100 and 125 mm. Concrete costs are significantly reduced when using stones. Walls made of stone-crete blocks normally measure 200 mm thick and have dimensions of 300x200x150 mm. These blocks are utilized similarly to solid concrete blocks used in wall building to create masonry walls that are hazard-resistant. If stones are present on the site, stone-crete blocks are less expensive than brick walls.

Overall, considerations including cost, availability, and the desired performance qualities of the finished product will determine the materials utilized in concrete blocks.

1.4 RETAINING WALL

A retaining wall is a structure designed to withstand the lateral pressure of soil. Retaining walls support the ground laterally while holding the ground at varied heights on either side. A retaining wall is a structure used to support the soil on a slope that has been intentionally made (typically one that is steep, nearly vertical, or vertical). They act as a link between soil layers that are different heights. It is widely used in terrain areas with undesirable slopes when the environment needs to be significantly altered and molded for more specialized applications, such as hillside agriculture or road flyovers. Retaining wall contains three major parts:

- Stem Wall
- Heel slab
- Toe slab

The stem is vertical. Cantilever retaining wall's vertical stem can bear the pressure of earth from backfillside and bend as of cantilever. Slab for foundation. The retaining wall's foundation is built by the base slab.

1.5 TYPES OF RETAINING WALL

1.5.1 GRAVITY RETAINING WALL

In civil engineering, a gravity retaining wall is a form of structure intended to hold back soil or other materials and stop them from collapsing or sliding. It resists the lateral pressure of the held material by using both its own weight and the force of gravity. The self-weight of the wall works as a stabilizing force to prevent the soil or other materials from shifting or collapsing. Brick, stone, and concrete are just a few of the materials that can be used to construct it. Up to a height of three meters, it is affordable. Gabions, bin retaining walls, and crib retaining walls are all examples of gravity retaining walls.

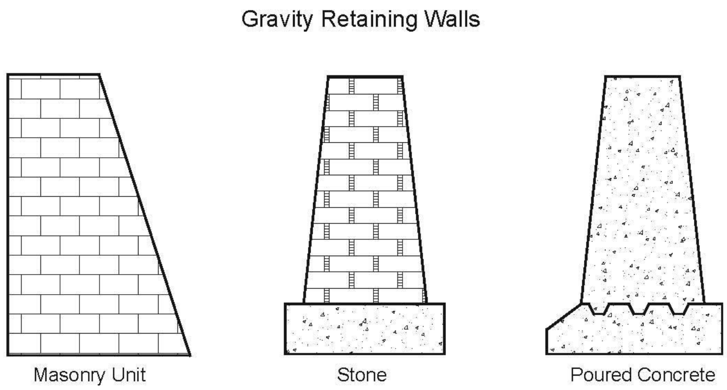


Figure 1.1 Gravity Retaining Wall

1.5.2 CRIB RETAINING WALL

A crib retaining wall is a sort of gravity retaining wall made of interlocking rectangular or square units placed in a staggered arrangement. It is also referred to as a crib wall or cribwork. These structures are often composed of wood, concrete, or precast blocks. To increase stability, they are filled with granular materials like crushed stone or dirt. Together, the crib units and fill materials can withstand lateral pressure from retained soil or other materials.

Figure 1.2 Crib Retaining Wall

1.5.3 CANTILEVER RETAINING WALL

Cantilever retaining wall composed of stem and base slab. Its construction incorporates precast concrete, prestressed concrete, or reinforced concrete. The cantilever wall is the most prevalent type of retaining wall. Either a cantilever retaining wall is constructed on the spot, or precast concrete is manufactured off-site. The backfill material is only present in the base slab's heel and toe regions. A cantilever retaining wall is economical up to a height of 10m. It utilizes less concrete than a gravity wall.

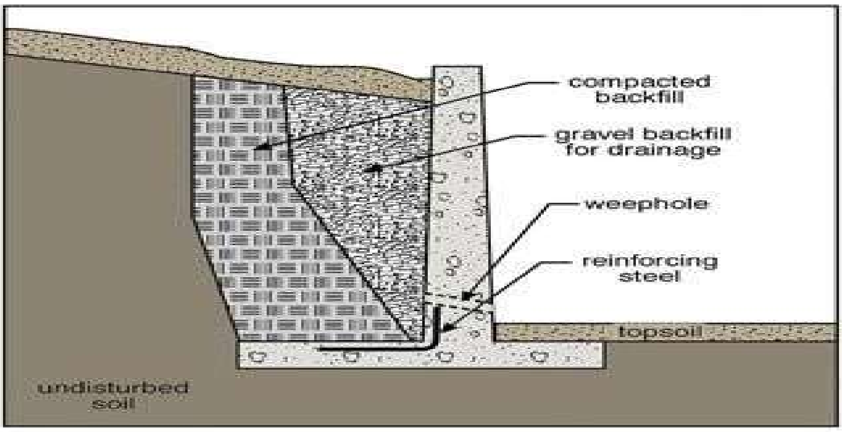


Figure 1.3 Cantilever Retaining Wall

1.5.4 BUTTRESSED RETAINING WALL

It is a cantilever retaining wall that is reinforced with monolithic counterforts made of the base and rear wall slabs. The distance between counterforts is roughly equal to or slightly greater than half of their height. The counterfort walls can be 8 to 12 meters high.

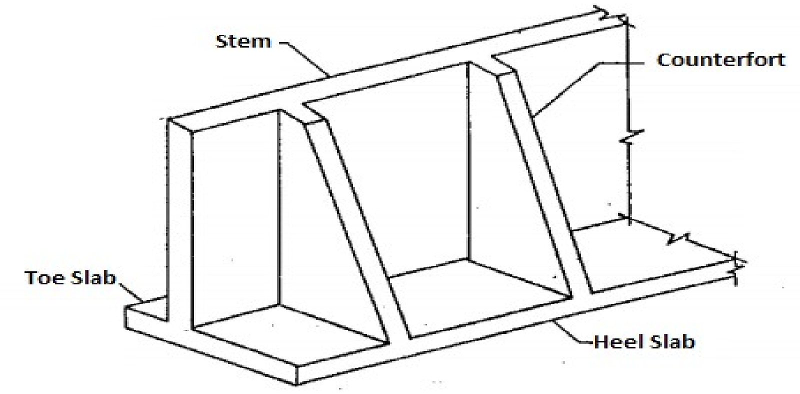


Figure 1.4 Buttressed Retaining wall

1.5.5 ANCHORED RETAINING WALLS

These walls are like cantilever walls but have additional reinforcement in the form of cables or other support structures that are anchored to the ground or to other parts of the wall. Anchored retaining walls are often used in areas with soft and loose soil.

Figure 1.5 Anchored Retaining wall

1.5.6 MODULAR BLOCK RETAINING WALLS

These walls are made of precast concrete blocks that interlock with each other. They are easy to install and can be used to create curved and terraced walls.

Each type of retaining wall has its own strength and weaknesses, and the choice of the wall will depend on factors such as the type of soil, the height of the wall, and the desired appearance.

Figure 1.6 Modular Block Retaining Wall

1.6 UTILIZATION OF STONE MASONRY IN ANCIENT AND MODERN TIMES

Stone masonry is one of the best forms of construction because it has existed since the very beginning of civilization. It is a versatile building material that can be used in different ways. The history of stone architecture dates to the prehistoric era when it was used as a shelter for cavemen. It can also be used in various modern constructions. In modern constructions, stone can be used as eithera component of a load-bearing wall or as a decorative material. Although the choice of stone for its aesthetic appeal is initially considered, it can also be beneficial for the environment by reducing the impact of the building materials on the environment. For many years, architects and builders have been using stone to create magnificent structures. Today, the architect is more aware of the needs of the commercial and residential building industry, which is looking for long-lasting and eco-friendly building, materials. This makes stone a “solid” choice.

1.6.1 EVOLUTION OF STONE MASONRY OVER TIME

Some 6000+ years ago, the man was taking rock from the ground and shaping it with primitive tools, primarily for building. The stone could be fashioned into ever-more complicated forms and patterns as skills and understanding of the material increased, tools and procedures improved, and equipment became available. The Man was building several monumentally significant monuments, many of which may still be seen today. Examples of this include the vast pyramids of Egypt, the Inca temples in South America, Greek and Roman architecture, and the medieval cathedrals of Western Europe.

1.6.2 ANCIENT STONE CUTTING TECHNIQUES

The two main processes in the stone-cutting process are the removal of the stone from the soil and its subsequent shape and treatment for the intended use.
Stones have been cut using a variety of tools and techniques throughout time.

In early ancient times, the most primitive method of stone cutting involved simply hitting a soft stone with a harder one. At that time, the stone was used primarily as a weapon.

During ancient Egyptian times, bronze tools were used to cut limestone and other softer rocks.

Stone Saws Even with the use of saws made from the toughest materials, stone other than the softest sorts was difficult to cut.

Figure 1.7 Ancient tools and plug and feather toolset

Plug and feather

A three-piece tool set was used to cut the stone into pieces. To split a single, large piece of stone multiple sets of plug and feathers were used.

1.6.3 MODERN TIME STONE CUTTING TECHNIQUES

In modern times, there are many techniques that are used for stone cutting. Some of the techniques and machines are discussed below:

FEATHER AND WEDGE TECHNIQUE

One old-school technique that is still used today to split stones is the feather and wedge technique.

DIAMOND CUTTING

Diamond-coated saws, drills, and grinders can be used to cut through stone and other particularly hard materials. For instance, the edge of a commercial circular diamond saw is completely covered in diamond tips. This is used to remove fragments of undesired stone, reducing huge boulders into usable slabs of various sizes.

Figure 1.8 Diamond cutter

WATER JET CUTTING

High-speed water is utilized in the water jet-cutting method to produce precise patterns that can be sliced or etched from almost any material. Almost any material, including stone from 1mm to

150mm thick and varies in size from the intricate up to a 4m by 2m profile, may be cut using an abrasive water jet cutting machine.

Figure 1.9 Water jet cutter

FLAMING

A more advanced method of stone-cutting is to ignite the stone's surface using a jet of fire. Here, the stone is chipped away at by a combination of cold water and high heat, which causes it to flake away. In order to leave a natural "flame finish" on stone, torches can be used to erase any prior tool marks. However, applying heat to the stone for an extended period will actually carve into the stone.

When it is more practical to work, large outdoor sculptures are typically created using flaming. Jet torches are also used to clean graffiti off walls, restore non-slip surfaces on stone steps, and even quarry tiny amounts of the material.

Figure 1.10 Flame thrower

WIRE SAW

A wire saw is a saw that mechanically cuts bulk solid materials including stone, wood, glass, ferrites, concrete, metals, crystals, etc. using a metal wire or cable.[1] Typically, industrial wire saws are powered. For chopping tree branches, hand-powered wire saws for survivalists are also available. Continuous (or endless, or loop) or oscillating (or reciprocating) wire saws are the two main types. Occasionally, the word "blade" is used to describe the wire itself.

Figure 1.11 Wire saw

CNC MACHINING

Similar to diamond saws, stone CNC tools frequently have diamonds incorporated in them to allow for material cutting. Typically, stone pillars, stone sculptures, and custom architectural features are made by CNC machines.

Figure 1.12 CNC machine

STONE CUTTER MACHINE

To cut larger stone into smaller ones with proper cut and finishing ,this stone cutter machine can be used. Its cutter can run into both directions in clockwise as well as anti-clockwise direction.

Figure 1.13 Stone cutter machine

1.6.4 MODERN-DAY PROBLEMS IN MAKING STONE BUILDING

Rocks, or stones, do not naturally take the form that is intended. They need treatment, which is a chipping procedure to transform stones with irregular shapes into packable ones. The stonework is slow and difficult for masons while brick andconcrete are faster and easiest. Stone masons are not as easily available and cheap as brick masons. Bricksare easier to make, transport, and handle. Also, with the fly ash-based bricks, we are making use of industrial discharge/pollutants. Unlike stone structures, most buildings constructed today are framed structures that transmit the load via beams & columns to the foundation. They do not transmit loads on walls. So, raising walls out of bricks is very efficient. Renovating stone structures can be hard. One cannotcut, drill holes, and insert conduits or pipes easily to implement new technologies and appliances.

CHAPTER 2
LITERATURE REVIEW

2.1 GENERAL

This chapter reviews the literature on the effects of utilizing various materials, such as stone in concrete blocks and retaining walls, and discusses those effects. The qualities of the various materials used in concrete blocks and retaining walls were reviewed. The benefits and drawbacks of employing various materials for concrete blocks and retaining walls, as well as the appropriate measures, were reviewed. Additionally, this chapter discusses earlier investigations made by many researchers on the various approaches used to understand test results and setups. This chapter gives a complete review of the finding along with directions for future explorations.

2.2 LITERATURE SURVEY

"Study on the influence of different mortar thickness on compressive strength of AAC block based on ANSYS" by "Li-Guang Xiao and Wen-Hao Xing" They researched the influence of the mortar thickness of the mortar joint which increases the compressive bearing capacity of an autoclaved aerated concrete block wall which gradually decreases, according to mechanical analysis on autoclaved aerated concrete block walls with different masonry mortar thicknesses such as 2mm and 20mm. Although the compressive bearing capacity of masonry units can be greatly increased by thin mortar joints, the compressive bearing capacity of masonry with a 2mm mortar joint thickness is 17.15% higher than that with a 20mm mortar joint thickness.

"A Shaking table test of 6-story wall frame building to investigate collapse process of RC Building" by "K.Sugimoto, M.Nishiyama, K.Nishimura"(2017) in this test for three days, a shaking table test was conducted. The specimen was a six story, 30% size RC skyscraper based on a model created in accordance with the current Japanese building code. This test was conducted to record the specimen's maximum strength and to record the specimen collapsing. The test's first and second days saw the achievement of the desired responses. On the third day, the specimen's maximum shear capacity was noted. First and second storey walls failed in shear strength on the last day.

There were torsional characteristics seen in the wall deformation. After the collision, non-structural walls sustained damage and damaged columns.

Indian Standards IS-12440 (1998), “Specification for precast concrete stone masonry blocks”, Bureau of Indian Standards, specifies the dimensions that are required to make a stone concrete block. Its dimensions are as follows: length is 300mm, height is 150mm and its width varies from 200mm, 150mm and 100mm in size. The methodology to make these stone concrete blocks is specified in this code. Material required, the stone size with 250*150*100 is taken.

“A Shaking table test of a full scale three-leaf masonry wall” presented by “Francesco Di Michele, Enrico Spacone, Luiza Dihoru, George Mylonakis”(2022) this essay presents and examines the findings of a series of experiments that were conducted in order on a three-leaf masonry wall on the university of Bristol's shaking table. The wall that was put to the test was intended to be an example of a wall in a masonry structure's top floor. It had two outer leaves made of regular stones and an inner, weaker infill that was intended to be an example of a construction where loose material was held together by a weaker mortar. When shake table test was carried out no damage was observed in stones. The existence of the inner weak core affects this mechanism. Out of plane bending of the outer leaves is caused by earlier failure of the loose material that makes up the infills and lateral expansion brought on by poison forces. This experiment demonstrates both in-plane failures and out-of-plane bending processes, demonstrating the three leaf masonry walls' significant susceptibility to ground vibrations. To boost the in-plane strength and avoid out of plane buildings, such a structural system must be reinforced.

“Dynamic Behaviour of Unreinforced masonry building” by “Md. Aminul Islam” (2018**)** he tested how the retrofitting changed the behaviour of the masonry model, wire mesh was also included. Most of the wall's fractures in this area are stair-stepped cracks that primarily develop near the corner. When there is an earthquake, corners are most at risk. Except for a vertical crack in the in-plane wall, there were no obvious flaws in the repaired wall. Retrofitted model structures have an increased capacity for undergoing more acceleration and can reduce the deformation of the structure by 4.3 to 4.8 times. It is discovered that for both the bare and modified models, the acceleration and lateral force decrease with increasing frequency.

"Utilization of demolished waste as fine aggregate in concrete" by "Mohd Monish" (2013) he did test on the workability and compressive strength of recycled concrete for the studies of 7 days and 28 days, partial replacement of course aggregates by demolition trash. Concrete made using recycled aggregate could be an alternative to standard concrete. Resulting from this experiment using recycled coarse aggregate to replace coarse aggregate by 30%. When weight from demolished structures is used in its place, it is discovered to be comparable to regular concrete. Due to its apparent ease of usage, it looks to have the strength of simple concrete cubes.

"Effects of fibres on the compressive strength of Hollow Concrete blocks" by "Sunil J and Dr. M.S Ravi Kumar" they increased fiber content results in a reduction in slump, especially when steel fiber dosage exceeds 1.5% and glass, nylon, and coconut fiber dosage exceeds 1%. Later, the mixture gets more fibrous, which makes handling difficult. The compressive strength test on the hollow concrete blocks shows that, in comparison to hollow concrete blocks without the fibers, the strengths rose proportionately with the increase in the amount of steel, glass, nylon, and coconut fibers. Steel and nylon fibers in the current study increased compressive strength by the greatest proportion when compared to hollow concrete blocks without the fibers.

"Compressive strength of masonry constructed with high strength concrete blocks" by "E.S Fortes, G.A. Parsekian, J.S. Camacho, F.S. Fonseca" there paper represents a thorough experimental programme with the aim of evaluating the compressive behaviour of high strength concrete block masonry in both grouted and ungrouted walls. This figure can be used for high-strength concrete blocks for non-grouted hollow walls for all the hollow walls that were presented to have a prism strength ratio of 0.7. In comparison to hollow walls, all grouted walls exhibit an improvement in compressive strength of at least 50%. All walls exhibit brittle fracture, with strains at failure ranging from 0.10 to 0.15 on the stress-strain graphs.

"Study on Mud Concrete blocks which can be established to load bearing wall system which can also ensures indoor comfort and minimizes the impact on environment" by "F.R. Arooz and R.U. Halwatura" in this experiment dirt is used as the aggregate, and a small amount of cement will serve as the stabiliser. A large amount of water was utilised throughout the hydration procedure. According to the results of the experimental testing, the dry mix of these blocks contains 4% cement, 10% fine aggregate, 60% sand, 35% gravel, and 20% water.

“A State-of-the-art review upon stone concrete technology” by “Rajendra Desai, Rupal Desai, Pawan Jain, R.k. Mukerji and Harshad Talpada” in this bricks that are transported from a distance can be substituted with locally produced stone Crete blocks, which are depending on local materials. These blocks are created by setting a stone measuring 100 to 125 mm inside a 300x200x150 mm mould, which is subsequently covered in a concrete mix or concrete slurry. CBRI invented this choice first. According to CBRI specifications, the blocks should be excellent quality moulded in order to make the construction resistant. It must be assured that wall insulation is crucial in chilly areas such as hilly regions. Therefore, a wall with a thickness of 200 or 225 mm will have less insulation, which means that in the winter it will not keep a house with stone walls warm. As a result, the walls from which house built using this approach can save 25% floor area because its walls are 200 mm thicker than masonry walls composed of rubble, which are 450 mm thick.

2.3 RESEARCH GAPS

- Most of the literatures are concerned about using different materials in concrete blocks and checking their properties so that materials can be used for further practical uses in the practical world.
- To the author’s best knowledge very few and limited research has been conducted on the dynamic analysis of stone concrete blocks.
- Limited Literature is available which uses stone in concrete blocks.
- IS codes for precast stone masonry blocks have not been revised since 1994.
- There is very limited literature available on this topic and there is need to explore the study of pre-cast stone masonry blocks.

2.4 RESEARCH OBJECTIVES

- To evaluate the properties of the locally available stone to be utilized in stone concrete blocks.

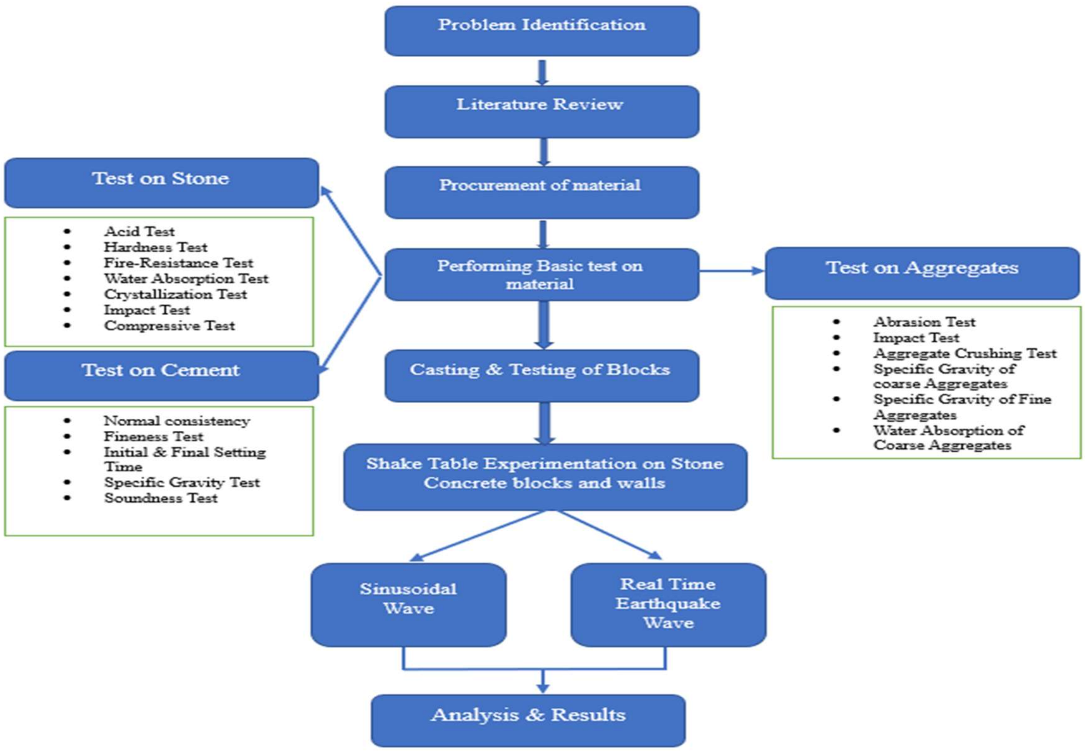
- To compare the strength parameter for Normal concrete blocks and Stone concrete blocks.
- To evaluate the performance of retaining walls created with stone concrete blocks under dynamic load conditions by shake table experimentation.

CHAPTER 3

MATERIALS AND RESEARCH METHODOLOGY

3.1 GENERAL

In this chapter, we examine the approaches that will be used in the effort to utilize stones in concrete and the strengths and qualities of both mixes i.e., conventional mix and other -mix with the use of stones. Cement, fine aggregate and coarse aggregate were all tested in labs. Cement has been checked for Normal consistency test, fineness test and the tests done on aggregates are the Abrasion test, Impact test, Crushing test, Specific gravity test and water absorption test. Test on stones are Acid test, Compressive test and Scratch test. After this the stone concrete blocks has been made with these materials and then we have further proceeded with Shake table experimentation where we have done sine sweep test to analyze natural frequency, resonance and damping ratio of M-15 and M-20 blocks and walls.



3.2 MATERIALS USED

Table 3.1 Testing Materials.

S.no.	Materials used for testing
1.	OPC Cement
2.	Aggregate (Coarse)
3.	Aggregate (Fine)
4.	Stone (Locally Available)

3.2.1 CEMENT(OPC)

The Ordinary Portland Cement is commonly called as "Ordinary Cement ". However, it is popularly called as grey cement. Its constituents include 96% of clinker along with 4 % of gypsum and some other materials.

Table 3.2 Properties of Cement

Cement Properties	Common values
Soundness	2.5mm
Bulk density	830-1650m^3
Fineness	330 kg/m^2
Final Setting time	500 min
Specific Gravity	3.12

3.2.2 AGGREGATES

COARSE AGGREGATES

The Coarse Aggregates are basically defined as either crushed or uncrushed or sometimes they are also referred to as partially crushed stone that are retained on the IS sieve of size 4. 75mm..The coarse aggregates should be dense, hard as well as strong and durable. The coarse aggregates should not be flaky and elongated.

FINE AGGREGATES

In case of mortar and cement, sand is used as a fine aggregate. Sand is basically a granular form of silica. In order to make mortar, cement etc. sand is used. In addition to this, the fine aggregates are also used as a filling, so that the free rise of water can be checked to form the soil below the ground floors of buildings as well as foundations. It should not consist of organic impurities.

3.2.3 STONES

We use locally available or demolished stones. The stones we generally found are Limestone and Slate which are weathered.

3.3. TEST ON MATERIALS

The test on cement, coarse aggregate, fine aggregate and locally available stones are shown below:

3.3.1 TESTS FOR ORDINARY PORTLAND CEMENT(OPC)

3.3.1.1 NORMAL CONSISTENCY TEST

A process called a "normal consistency test" is used to figure out how much water is needed to make cement paste with a particular consistency. This test is significant in the construction industry since it aids in determining the cement's workability and setting properties. The consistency of cement was tested in accordance with IS code 4031 Part 4. Consistency was determined by mixing water with cement and waiting for cement paste. After the vicat mould had been fully filled with cement paste and compacted to the top, readings were obtained on the vicat measuring scale. Stop watch, Vicat Apparatus, Gauging Trowel, Needle and Vicat mould are the apparatus used.

Figure 3.1 Normal Consistency test

3.3.1.2 FINENESS TEST

The size of the cement powder's particles is referred to as the cement's fineness. The fineness of cement, a crucial component that can affect the hydration and growth of concrete's strength, is determined using a fineness test. There are numerous ways to measure the fineness of cement, but the sieve analysis method is the one that is most used.

Cement was tested for fineness in accordance with IS code 4031 Part 1. The IS standard sieve was used to assess the cement's fineness using a 100g cement sample. The weight of cement particles larger than 90 microns and the percentage of retained cement particles were determined. The apparatus used were a lid, a pan, a 90-micron sieve, and a weighing scale. The Fineness Test Sieve is made of stainless-steel No. 325 wire cloth and a single-piece brass frame.

3.3.1.3 SETTING TIME TEST

The Settling Time Test of cement was performed as per code IS code 4031 Part 5 to determine the initial and final settling time. It is the period of time that elapses between the addition of water to the cement and the point at which the paste has become sufficiently solid to withstand a specific amount of pressure. For OPC cement, it should not exceed 600 minutes. The apparatus used for this test are the Vicat apparatus, a weighing scale, a stopwatch, a gauge, and a Tray.

3.3.2 TESTS ON AGGREGATES

3.3.2.1 ABRASION TEST

The Abrasion Test of coarse aggregates was performed as per IS code 2386 Part 4 to determine its abrasion resistance. The relative quality of aggregates is frequently determined using the Los Angeles (L.A.) Abrasion Test. When normal aggregate gradings are subjected to impact and abrasion in a rotating steel drum with an abrasive charge of steel balls, it quantifies the amount of degradation that occurs. With each revolution, the charge and sample are raised and lowered by an internal shelf in the drum, creating impact pressures. The appropriate rpm is reached by the machine, the contents are taken out, and the percentage loss is calculated.

Apparatus used were the Los angles abrasion testing machine, Steel drum, Steel balls or Sphere charges, Abrasive charge, Sieve shaker, and Balance.

Figure 3.2 Los Angeles Abrasion Test

3.3.2.2 IMPACT TEST

The impact test of coarse aggregate is determined using the procedure described in I.S. code 2386 part 4. The toughness and resistance to impact forces of aggregate are assessed by an impact test. This test is determining if aggregate is suitable for used in a variety of construction use including road construction, pavement laying, and railway ballast.

Figure 3.3 Impact and crushing test

3.3.2.3 CRUSHING TEST

The crushing test of coarse aggregates was performed as per IS code 2386. Crushing tests are commonly performed on aggregates to assess their strength and durability. his test aids in determining if aggregates are suitable for use in a variety of construction projects. Apparatus used for this test is Steel Cylinder with open ends, Steel Tamping rod, Balance, Cylinder, Compression TestingMachine (CTM).

3.3.2.4 SPECIFIC GRAVITY AND WATER ABSORPTION TEST OF COARSE AGGREGATE

In civil engineering, the specific gravity test of aggregates is often used to compare the relative densities of course and fine aggregates. The Specific Gravity Test was performed as per IS code 2386 Part 3. Knowing the specific gravity of aggregates is crucial because it facilitates the calculation of aggregate voids the determination of the quantities of different elements in concrete mix designs. As we know that aggregate occupies 70 to 80% volume of concrete, and its testing becomes essential before use. Apparatus used for this test is balance, Specific gravity bottle, oven, brush, drying pan, suspension hook, wire basket.

The aggregates are subjected to a water absorption test to measure how much water is absorbed by the aggregate particles. As the moisture content and porosity of aggregates, which may have an impact on the workability, strength, and durability of concrete, are assessed, it is a crucial test in civil engineering. The apparatus used are oven, balance, water tank, wire basket, water impermeable tray, absorbent cloth to towel, tamping rod and moisture container.

3.3.2.4 SPECIFIC GRAVITY OF SAND-

A density bottle is used to measure the specific gravity of sand. Range of basic gravity of sand particles ranges from 2.65 to 2.80.

Specific gravity with density bottle for sand=2.7, Zone -3

3.3.3 TESTS ON STONES

There are various tests that can be performed on stones depending on their type and intended use. Here are some common tests: -

3.3.3.1 ACID TEST

An acid test is a method of identifying the type of material a stone is made of by using a small amount of acid to test its reaction. This method is often used to test for the presence of calcium carbonate, which is commonly found in limestone and marble. After 7 days, there is no presence of Calcium Carbonate was noticed and sharp edges were maintainedduring the acid test.

3.3.3.2 FIRE RESISTANCE TEST

The stone which does not have calcium carbonate in it can resist fire. By adding a few drops of dilute sulphuric acid, the presence of calcium carbonate can be detected as it will produce bubbles.

Fig 3.4 Fire resistance test

3.3.3.3 HARDNESS TEST

This test is used to determine the hardness of a stone. A steel nail or knife blade is used to scratch the surface of the stone. If the stone is easily scratched, it is soft and if it is difficult to scratch it is hard. As the stone scratches glass and is not scratched by steel as well. It comes under Moh's scale 7. The locally available stone we are using is hard to scratch so stone can be considered as hard stone.

3.3.3.4 COMPRESSIVE TEST

This test is used to determine the strength of a stone. A sample of stone is placed in a UTM machine and a force is applied until the stone fractures. The maximum force applied is recorded and used to calculate the compressive strength of the stone.

Figure 3.5 CTM machine

3.3.3.5 WATER ABSORPTION TEST

The proportion of water that an air-dried stone absorbs after being submerged in water for 24 hours is known as the stone's water absorption. A good construction stone must only absorb 5% or less water, while stones that absorb more than 10% must be rejected. We found a water absorption value of 0.51%.

3.3.5.6 CRYSTALLIZATION TEST

Test pieces of 50mm dia. and 50 mm height dried for 1 day and then weighed. Then specimens are suspended in 14% sodium sulphate solution for 16 hours, then dried for 4 hrs in air and after that oven dried at a temperature 105 degrees Celsius for 24 hrs. and then cooled at room temperature. The difference in weight is then found.

Fig 3.6 Crystallization test

3.4 STONE CONCRETE BLOCKS AND NORMAL CONCRETE BLOCKS

As "Pre-cast Stone Blocks," are an excellent substitute for bricks. These blocks are made by putting stones of a particular size in concrete blocks. Stone use reduces the need for concrete, which leads to cost savings. Stone-concrete blocks are typically 300x200x150 mm in dimension, with a 200 mm wall thickness as a result. Stone concrete blocks could be less expansive if the stones are easily available at the site. The dimension of size of stone we used in SCB is 250x150x100 mm.

3.4.1 SIZE OF BLOCKS

The block's nominal dimensions are 300 mm in length, 150 mm in height, and has three widths of 200 mm, 150 mm, and 100 mm for convenience of usage and other characteristics. To fit the mortar line, the block's real size must be 10 mm smaller. The weight of these blocks ranges from 90 to 180 N. When the blocks are put into the wall, their bottom faces are visible because the blocks' width and height are maintained equal to those of the moulds, which ensures that the blocks are cast in this manner. Different textures may be generated on one face by adding various textures to the top face during casting, such as exposed pebble or crushed aggregate.

Figure 3.7 Size of Mould

Figure 3.8 Sand and Coarse Aggregate

Figure 3.9 Concrete Mix

3.4.2 MATERIAL

The stone blocks are constructed from lean cement concrete and stone fragments that are acquired by breaking rocks such that at least one face is smooth and range in length from 50 to 250 cm. The stones should be solid, durable, devoid of impurities, and hard. It is recommended to utilize crushed stones or natural material that has a diameter of 10 mm or less, is impurity-free, and complies with IS 383-1970. Given that the concrete used is lean and lacking in fine particles, which causes a loss of flexibility and workability, sand should contain fine particles, 15-20% of which pass IS Sieve No 300 micron and 5-15% of which pass IS Sieve No 150 micron. If this sand is insufficient, the ratio of sand to aggregate should be adjusted suitably after a few tests in order to obtain satisfactory workability and plasticity at the green level. This might take the place of the tiny sand grains. When graded, the cumulative aggregate's fineness modulus should fall between 3.6 and 4. Use should be made of regular Portland cement or Portland Pozzolana cement that complies with appropriate Indian requirements. Water should be devoid of salts and hazardous substances to avoid efflorescence.

3.4.3 CASTING OF BLOCKS

The mould and the platform both should be cleaned, after that on the inner side of mould, oil and grease should be applied. The moulds should be placed individually so that they become easy to de mould.

Figure 3.10 Stone cutting Machine

For making stone concrete blocks cut the stones in the desired shape, which is 42% by volume of block with the use of a stone cutting machine and to ensure proper concrete filling, place stone spall at the bottom of the moulds with a minimum gap of 15mm between stone and the mould to ensure proper concrete filling. Fill the gaps between mould and stone with the concrete.

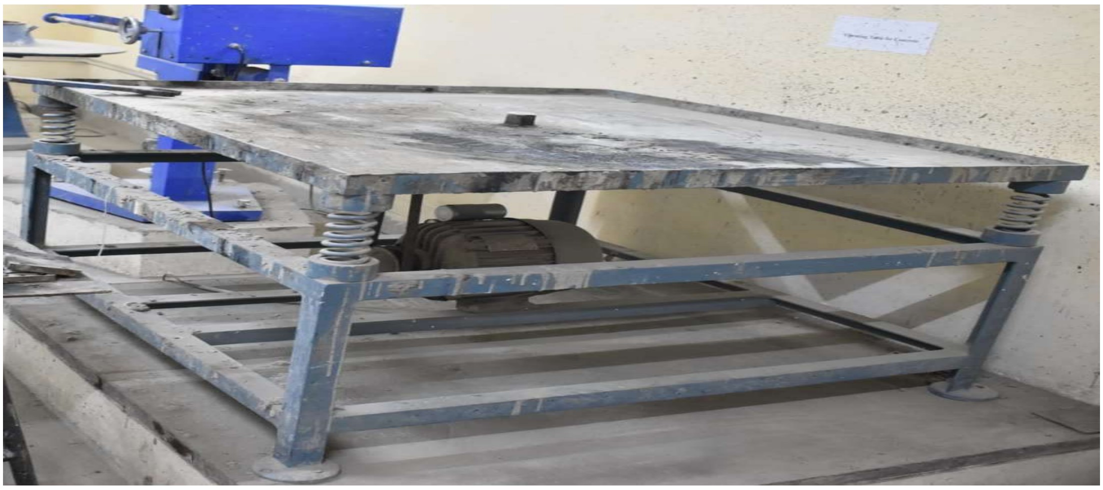


Figure 3.11 Table Vibrator

Correctly vibrate the concrete mix with a table vibrator and after 10–12 hours of manufacturing, demould the block and place the blocks in a water tank for curing.

Figure 3.12 Casting of blocks

Figure 3.13 Demoulding of blocks

Figure 3.14 Curing tanks

3.4.4 TESTING OF BLOCKS

There are many blocks made with and without stone in it. These block's compressive strengths were evaluated at 3, 7, and 28 days after curing, respectively. The main goal of this experiment is to determine whether adding stone to a block makes it stronger and produces the desired outcomes or not. A CTM machine was used to assist with the testing.

Figure 3.15 Block placed in CTM

Figure 3.16 Cube after application of load

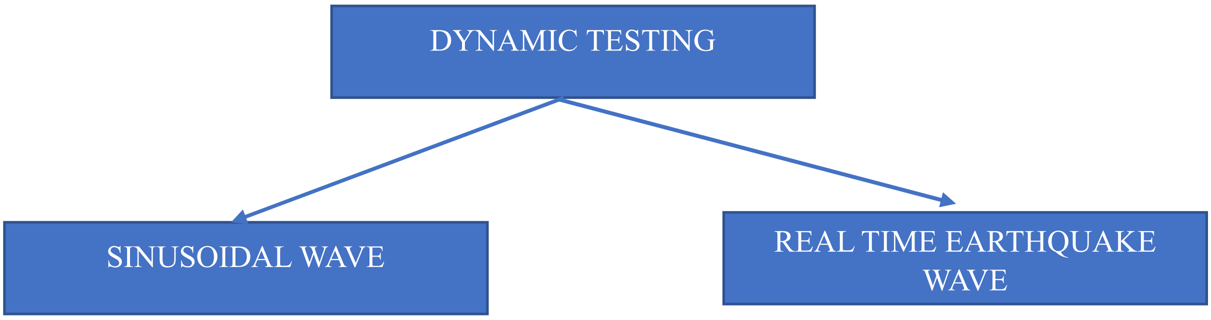
After casting of stone concrete blocks and normal concrete blocks we have compared their compressive strengths with each other.

Then we move forward to analyze the dynamic behaviour of stone concrete blocks using shake table.

3.5 SHAKE TABLE EXPERIMENT-

After curing the blocks of M-15 for 28 days, we let those blocks to dry. After this we must mark the points on the blocks to drill the 10mm dia. hole in the block to set that block on the uniaxial Shake table. After this we made a cement mortar of ratio 1:4 to fill gaps between stone concrete wall made by M-15 blocks.

Fig 3.17 Uniaxial shake table



3.5.1 CONSTRUCTION OF WALL WITH STONE CONCRETE BLOCKS –

For checking the dynamic and seismic properties of wall made from M-15 stone concrete blocks we use a shake table to perform this experiment. We had drilled holes of 10mm dia. through the drilling machine in the bottom blocks which we have to fix in the shake table. To bind these blocks with each other we use 1:4 mortar in which 1 represents the cement ratio and 4 represents the fine aggregate ratio. Before performing dynamic testing, we have done curing of these walls for 7 days.

Fig. 3.18 Wall made from SCB

After curing, we have to send sine waves and real-time earthquake waves of Bhuj and Chile's earthquakes, then analyze the acceleration-time graph, displacement -time graph and cracking pattern in wall made from M-15 stone concrete blocks.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 GENERAL

This chapter presents the findings of a compression test that was performed on both normal concrete blocks and stone concrete blocks. The findings of the compressive tests conducted on stone and regular concrete blocks of the three classes (M15, M20, and M25) were then compared. The compressive strength is checked in 3, 7, and 28 days on normal concrete blocks and stone concrete blocks. During such times, the blocks are maintained within the water tank to cure. This chapter includes an experimental investigation into the testing of locally available stones. This chapter's study focuses on the static and dynamic testing of walls and blocks. The next section of this chapter deals with the dynamic response of wall made from stone concrete blocks to seismic loads, and thorough experimental research is conducted.

4.2 RESULTS

RESULTS OF PRELIMINARY TESTS

The stone concrete blocks used were of size 300x200x150mm. Different experiments were conducted prior to the construction of the concrete block and the following are the results

4.2.1 Preliminary Test of cement

Table 4.1 Test on Cement

Sr. No.	Experiment on Cement	Experimental Values
1	Normal Consistency of cement	32%
2	Fineness value of cement	6.08%
3	Initial setting time of cement	40 min
4	Final setting time of cement	460 min
5	Specific gravity test	3.129
6	Soundness test	4.2 mm

4.2.2 Preliminary Test of Aggregates

Table 4.2 Test on Aggregate

Sr. No.	Experiment on aggregates	Experimental Values
1	Abrasion Test value	38%
2	Impact Test value	14.37%
3	Crushing Test value	18.5%
4	Specific gravity of coarse aggregates	2.54
5	Water absorption of coarse aggregates	0.81
6	Specific gravity of sand	2.67

4.2.3 Preliminary Test of Locally available stones

Table 4.3 Test on Locally available stones

Sr. No.	Experiment on Locally available stones	Experimental Values
1	Hardness test	On Moh's scale-7, Hard in nature
2	Acid test	Sharpe edges are maintained
3	Fire resistance test	Free from calcium carbonate, didn't produce bubbles on stones
4	Water absorption test	0.54%
5	Impact test	24 cm
6	Crystallization test	Little difference in weight

4.2.4 RESULT FOR COMPRESSIVE STRENGTH

Table 4.4 Compressive strength

Sr. No.	Type	Days	Strength (MPa)
1	NCB	3	6.61
2	NCB	7	9.63
3	NCB	28	14.41

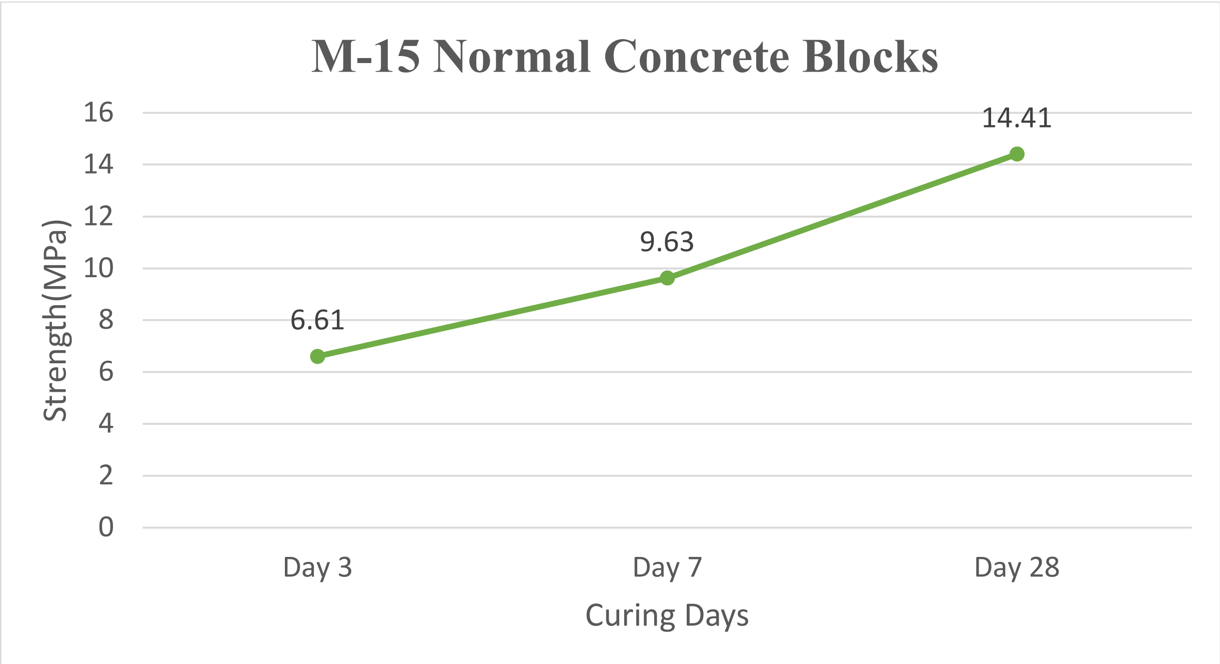


Fig.4.1 Compressive strength graph (M-15 NCB)

The average compressive strength of M-15 Normal concrete blocks after 3 days of curing is 6.61 MPa and after 7 days of curing is 9.63 MPa and after 28 days of curing, it is 14.41 MPa.

Table 4.5 Final Result for Compressive Strength of Stone Concrete Blocks (M-15)

Sr. No.	**Type**	**Days**	**Strength (MPa)**
1	SCB	3	9
2	SCB	7	11.24
3	SCB	28	18.07

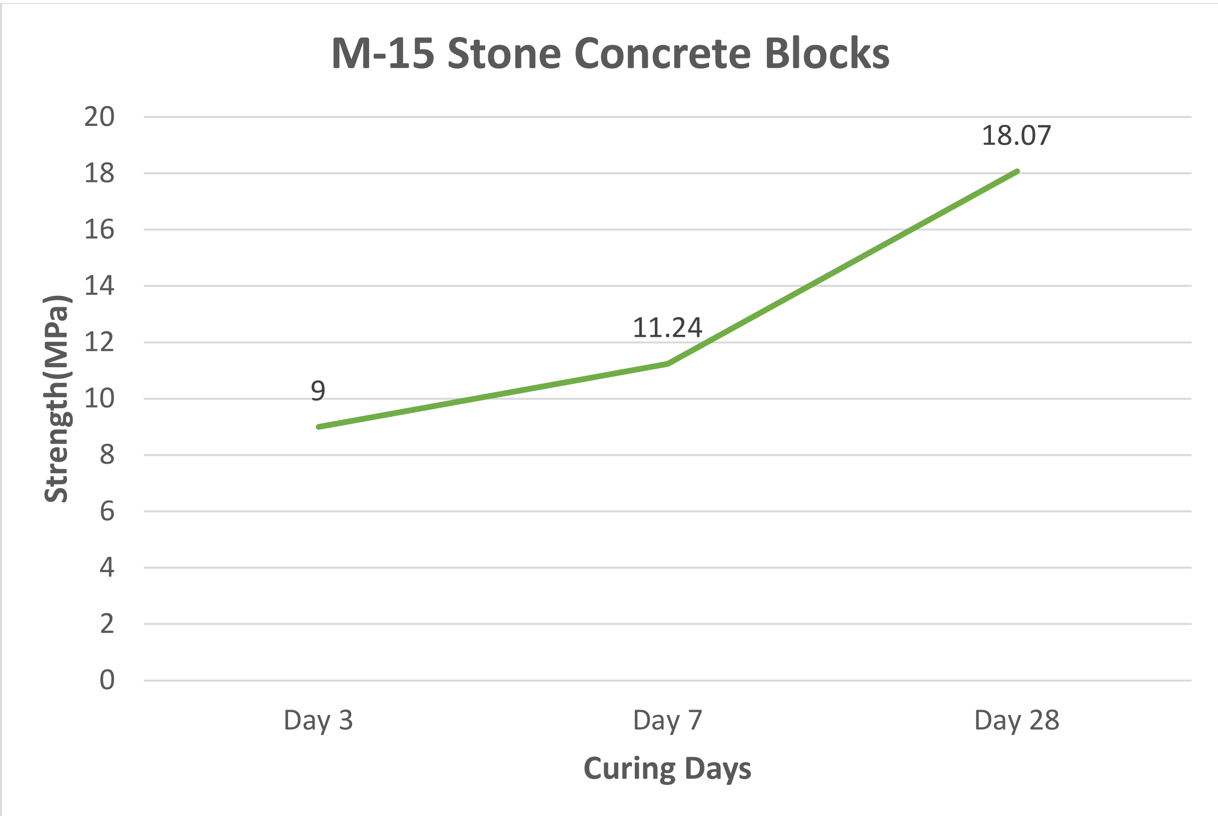


Fig. 4.2 Compressive strength graph (M-15 SCB)

The average compressive strength of M-15 stone concrete blocks after 3 days of curing is 9 MPa and after 7 days of curing is 11.24 MPa and after 28 days of curing, it is 18.07 MPa.

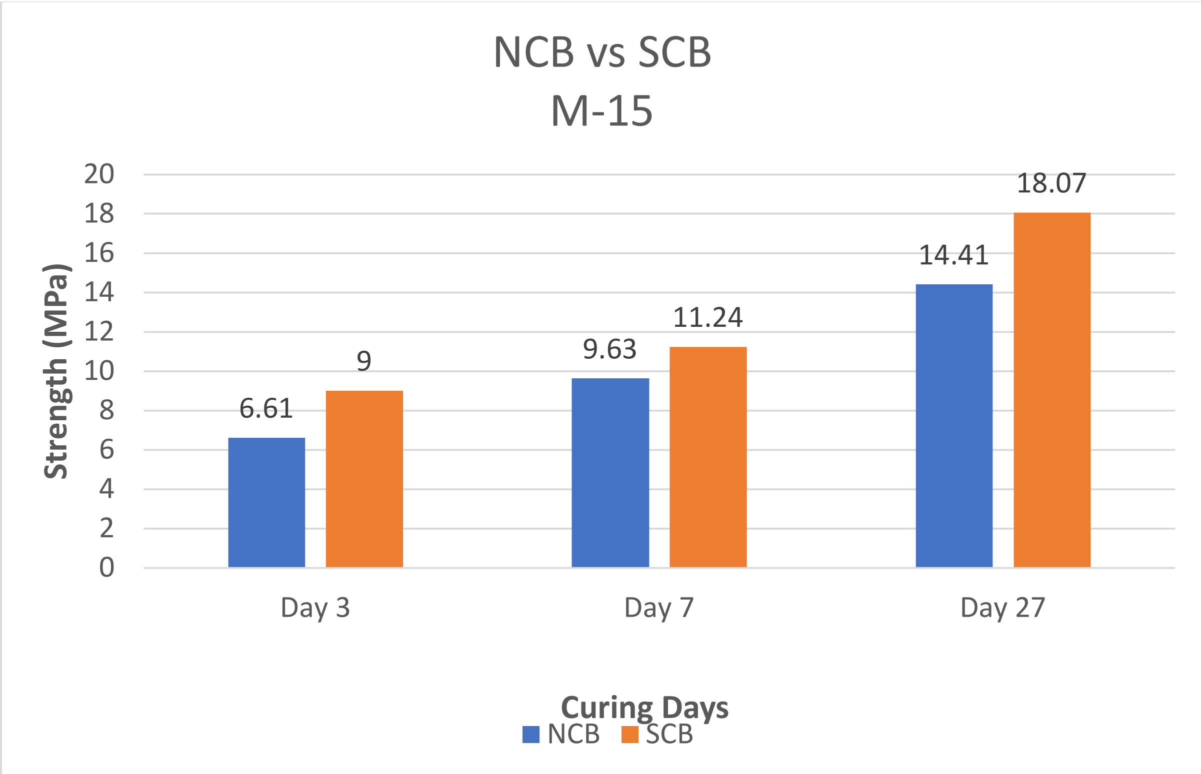


Fig. 4.3 NCB vs SCB (M-15)

From the graph, we can conclude that there is a 20.46% increase in the compressive strength of M-15 stone concrete blocks as compared to normal concrete blocks.

Table 4.6 Final Result for Compressive Strength of Normal Concrete Blocks(M-20)

Sr. No.	Type	Days	Strength (MPa)
1	NCB	3	8.61
2	NCB	7	12.31
3	NCB	28	20.23

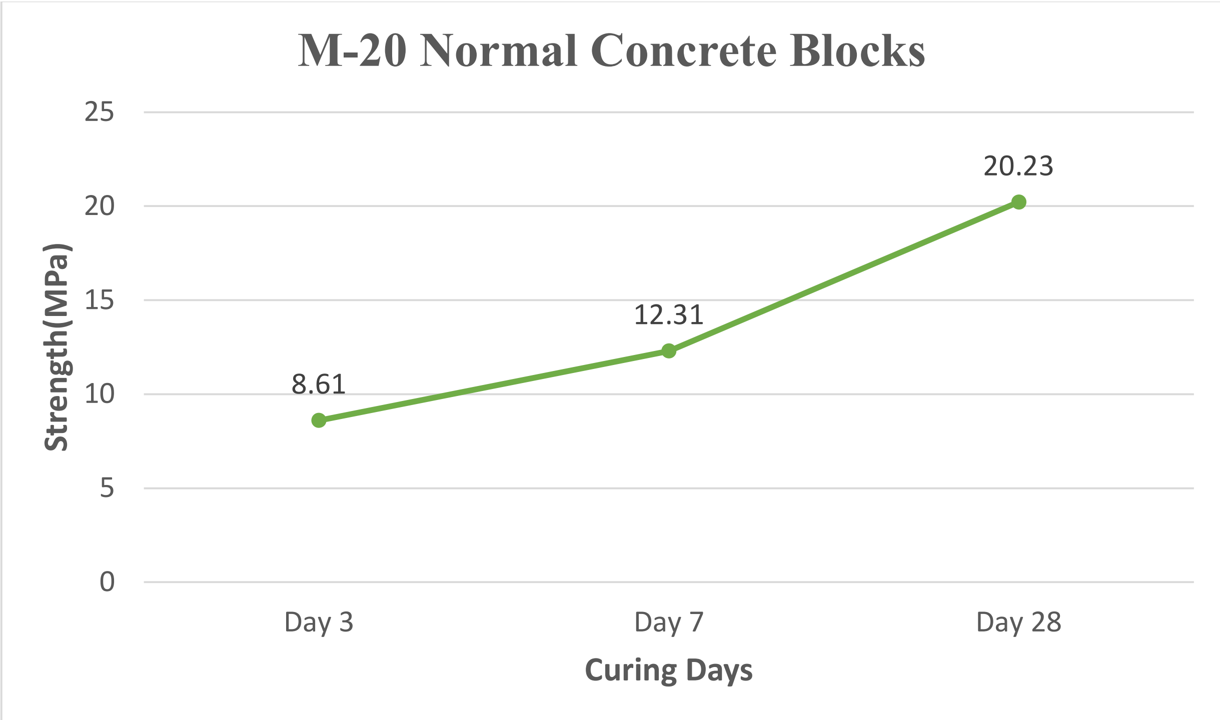


Fig. 4.4 Compressive strength graph (M-20 NCB)

The average compressive strength of M-20 stone concrete blocks after 3 days of curing is 8.61 MPa and after 7 days of curing is 12.31 MPa and after 28 days of curing, it is 20.23 MPa.

Table 4.7 Final Result for Compressive Strength of Stone Concrete Blocks (M-20)

Sr. No.	**Type**	**Days**	**Strength (MPa)**
1	SCB	3	12.4
2	SCB	7	17.54
3	SCB	28	24.96

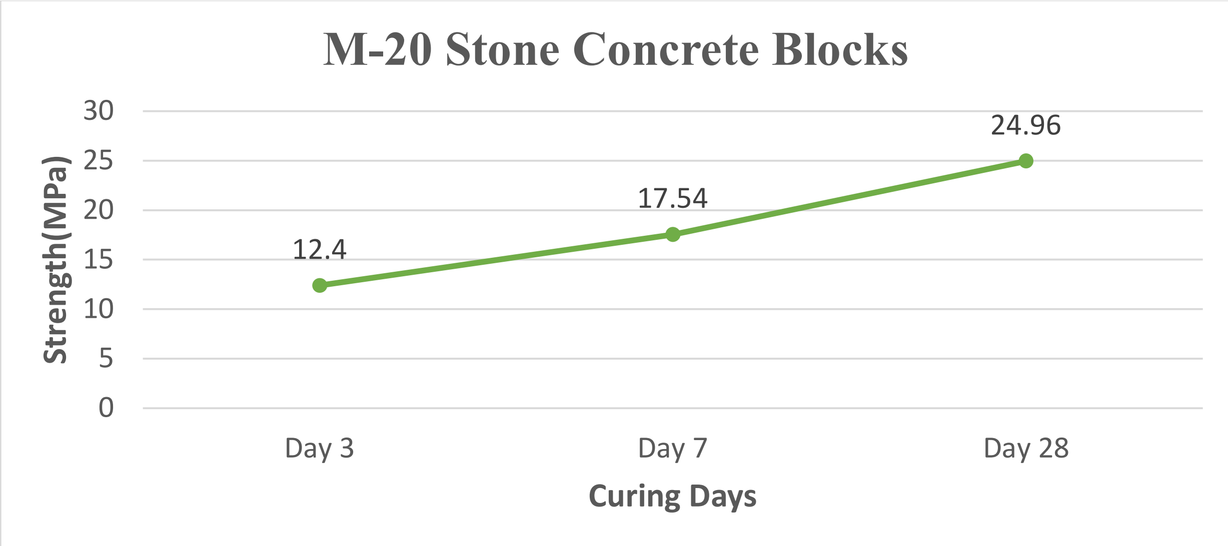


Fig. 4.5 Compressive strength graph (M-20 SCB)

The average compressive strength of M-20 stone concrete blocks after 3 days of curing is 12.4 MPa and after 7 days of curing is 17.54 MPa and after 28 days of curing, it is 24.96 MPa.

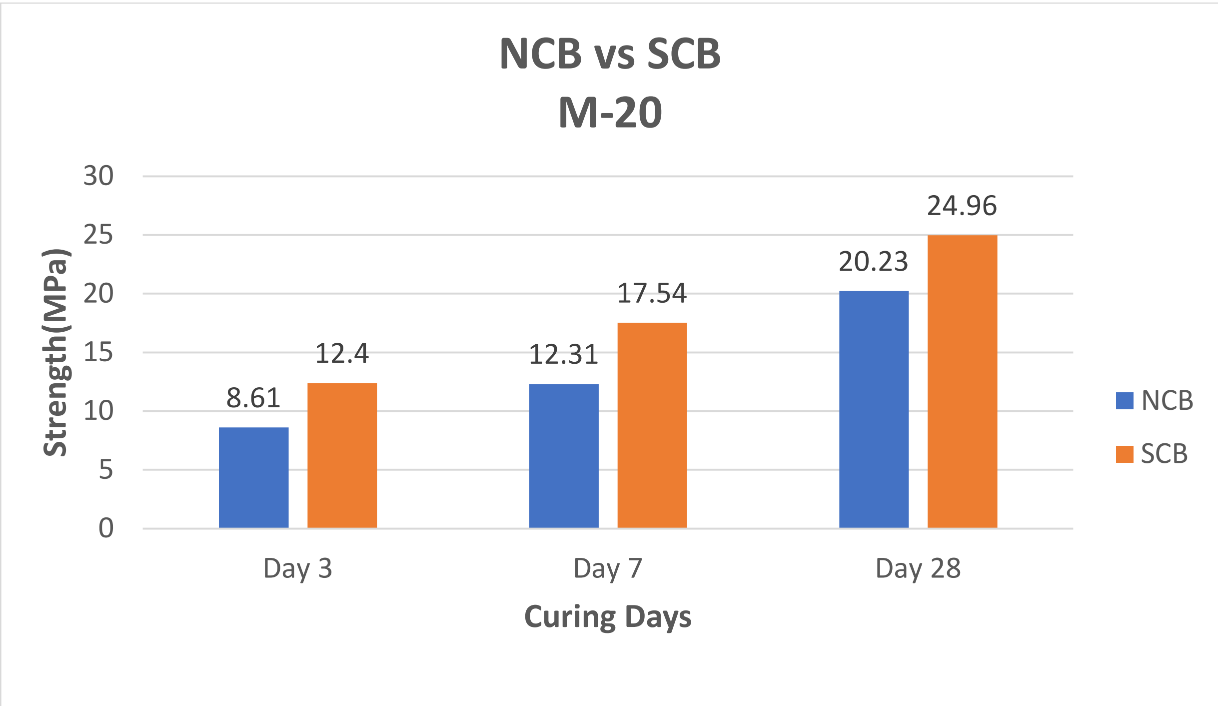


Fig. 4.6 NCB vs SCB (M-20)

From the graph, we can conclude that there is an increase of 24.8% in compressive strength of M-20 stone concrete blocks as compared to normal concrete blocks.

5.2.5 RESULT FOR DYNAMIC ANALYSIS ON WALL AND BLOCK

While performing the sine sweep test on M-15 and M-20 stone concrete blocks, we involve the sinusoidal excitation in which we can change the amplitude and frequency. During this test, we have collected acceleration data from the accelerometer which we mount on the top of the block but because of the block's rigid nature, we are not able to find M-15 and M-20 natural frequency as we were not able to get the instant peak acceleration at different given frequencies and amplitude. So, we further proceed with our testing on a wall made from M-15 stone concrete blocks**.**

The shaking table, the ground movements, the accelerometer, and the equipment are the basic parts of the shake table test setup. These criteria have a significant impact on the quality of the data and their analysis. The wall specimens were tested under dynamic excitation, and their seismic performance was assessed, using the uniaxial shaking table.

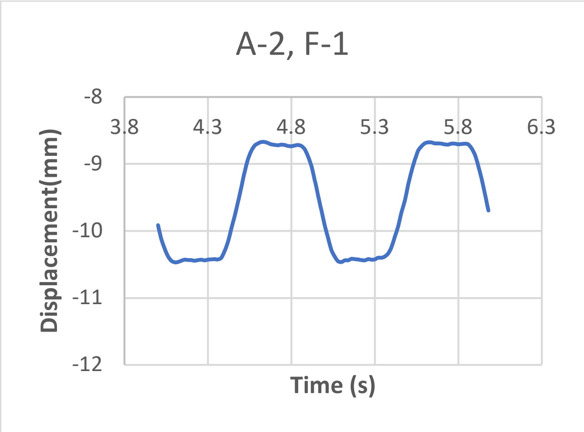
For the dynamic excitation, both Bhuj's and Chile's earthquake signals were employed. First, a Chile earthquake from 2010 was selected. The signal's brief duration and peak ground acceleration of 0.42 g are both characteristics. Four copies of the signal were made, each at a different intensity. Thus, during testing with this signal, peak ground accelerations of up to 0.42 g were attained. Due to the shorter duration of the second signal, which represents a ground motion from the Bhuj earthquake in 2001.

To achieve accelerations, successive sine waves were applied to M-15 wall.

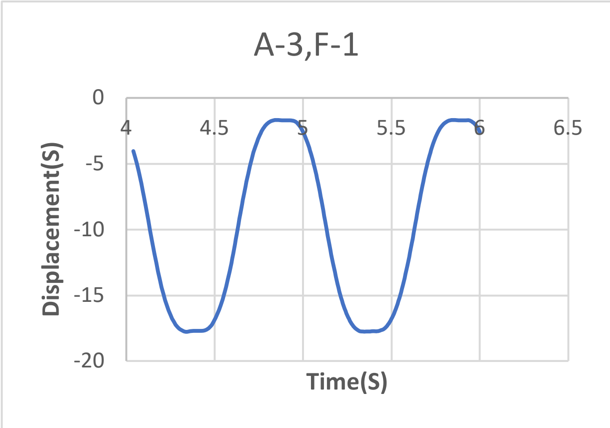
Table 4.8 Earthquake data

NAME	EARTHQUAKE	PGA(g)	PGD (cm)	Duration(s)
Signal 1	Chile (2010)	0.31-0.37	180	120
Signal 2	Bhuj (2001)	0.42	20	90

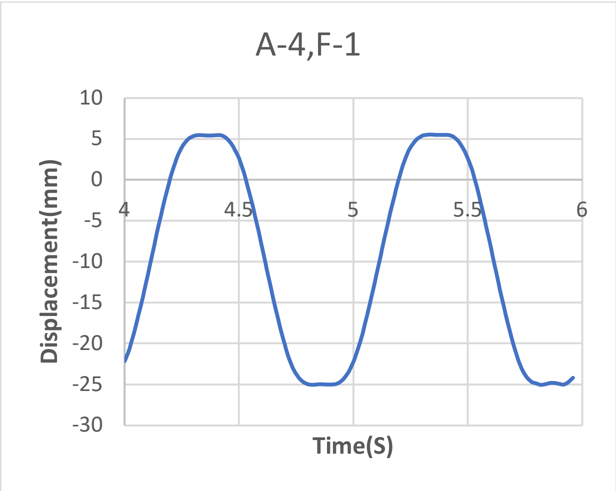
SINE WAVES



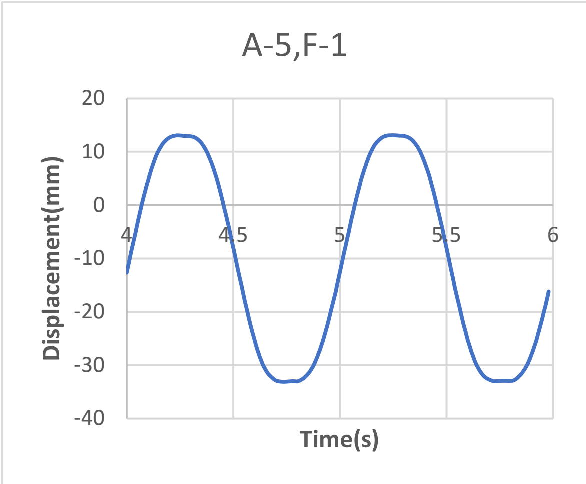
A-2, F-1
Displacement(mm)
Time (s)
-8
-9
-10
-11
-12
3.8
4.3
4.8
5.3
5.8
6.3



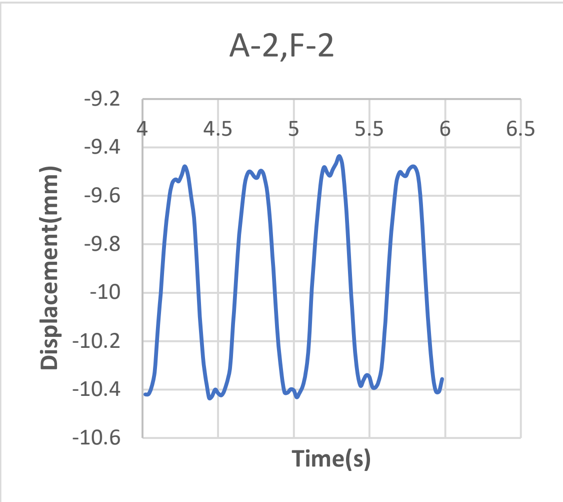
A-3,F-1
Displacement(S)
Time(S)
0
-5
-10
-15
-20
4
4.5
5
5.5
6
6.5



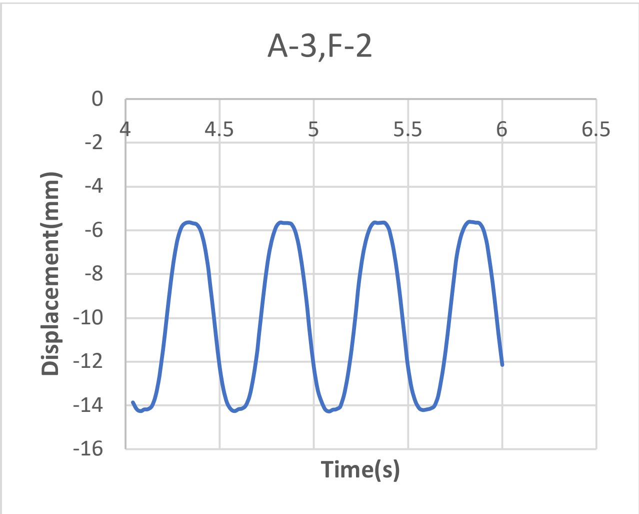
A-4,F-1
Displacement(mm)
Time(S)
10
5
0
-5
-10
-15
-20
-25
-30
4
4.5
5
5.5
6



A-5,F-1
Displacement(mm)
Time(s)
20
10
0
-10
-20
-30
-40
4
4.5
5
5.5
6



A-2,F-2
Displacement(mm)
Time(s)
-9.2
-9.4
-9.6
-9.8
-10
-10.2
-10.4
-10.6
4
4.5
5
5.5
6
6.5

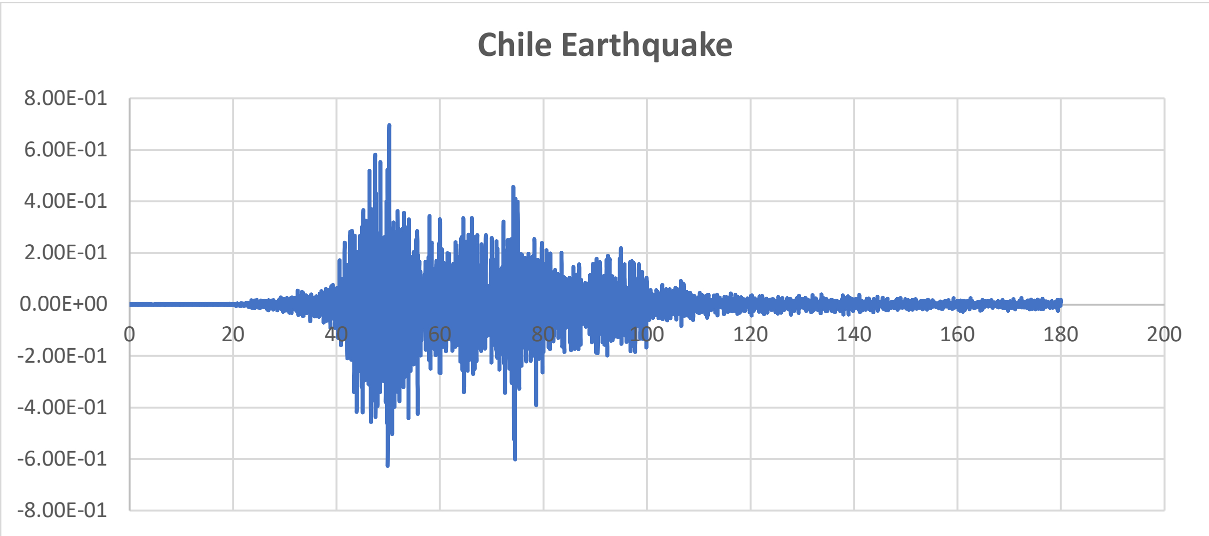


A-3,F-2
Displacement(mm)
Time(s)
0
-2
-4
-6
-8
-10
-12
-14
-16
4
4.5
5
5.5
6
6.5

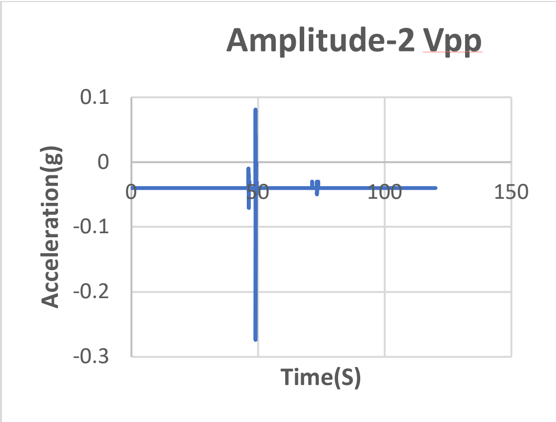
Frequency (Hz)	Amplitude (Vpp)	PGA(g)
1	2	0.04
1	3	0.11
1	4	0.13
1	5	0.16
2	2	0.06
2	3	0.16

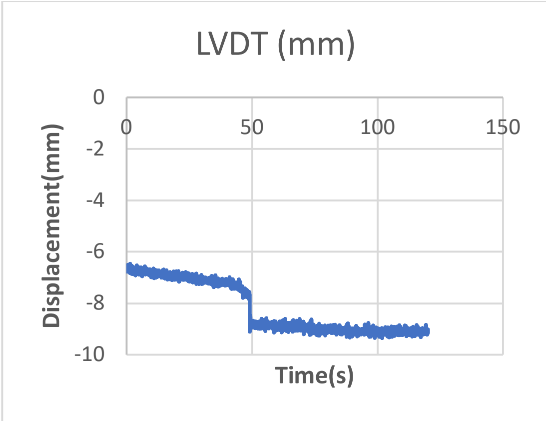
The above table shows the peak ground acceleration at different frequencies and amplitudes. We have achieved 0.16g max. PGA.

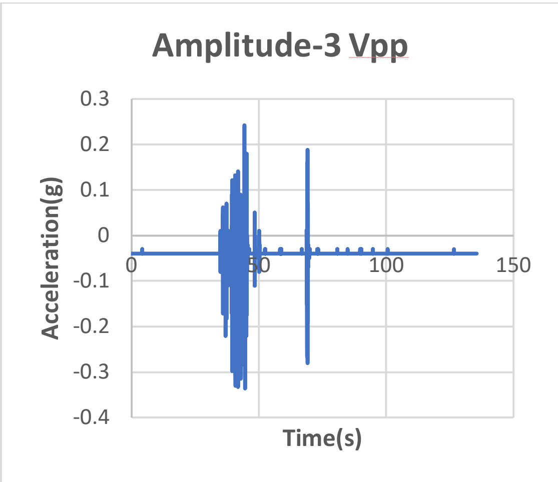
After this, we have moved forward to do our testing on wall by sending real time earthquake data in shake table.

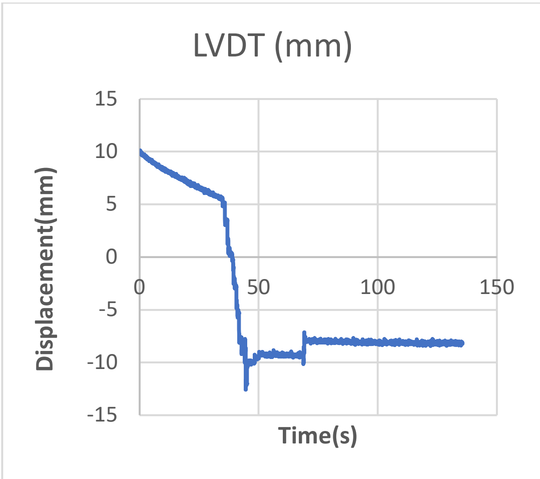


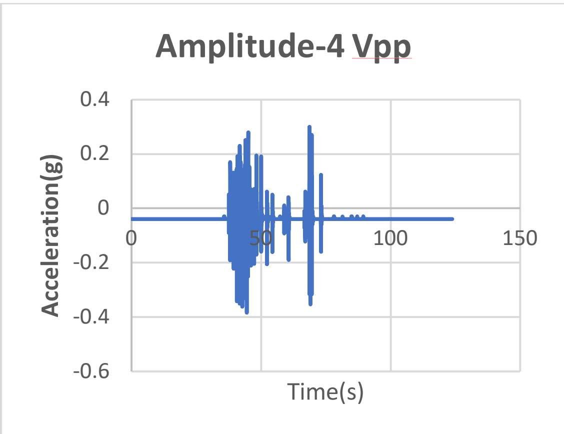
ACCELERATION VS TIME GRAPH AND DISPLACEMENT VS TIME GRAPH (CHILE-2010)

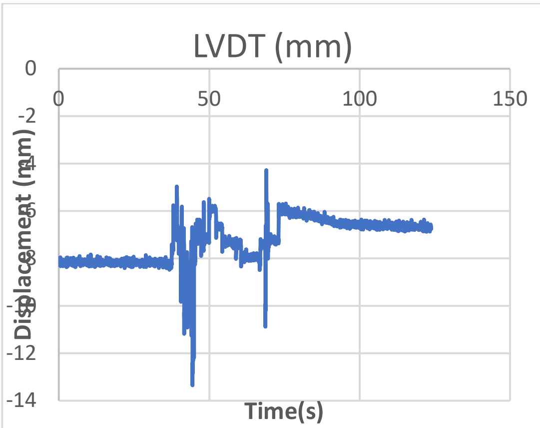


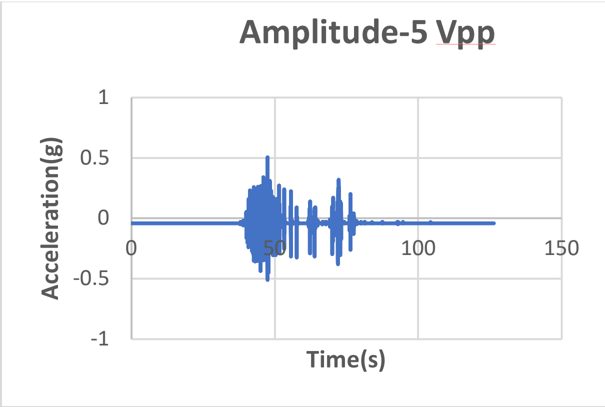


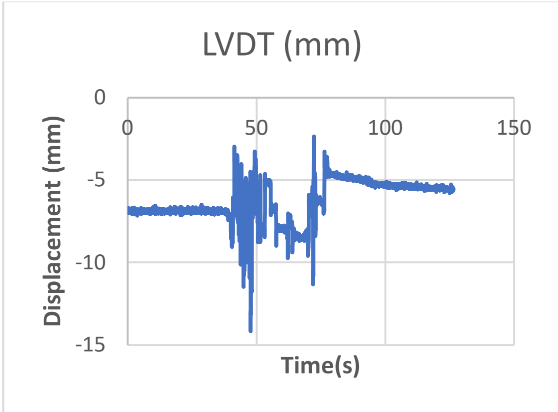












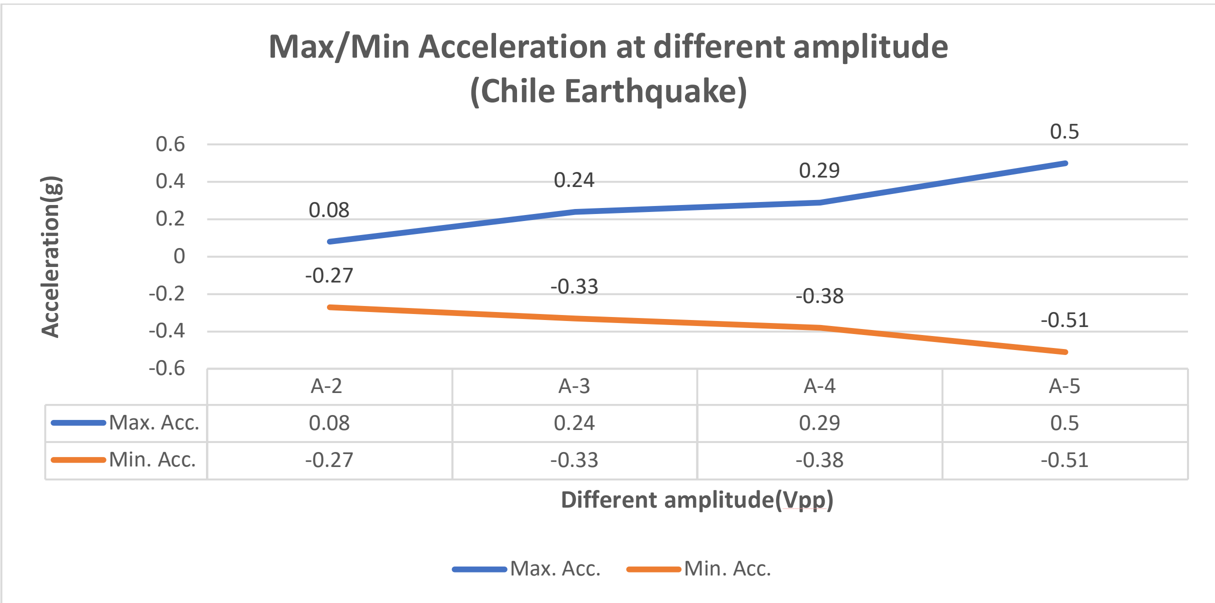
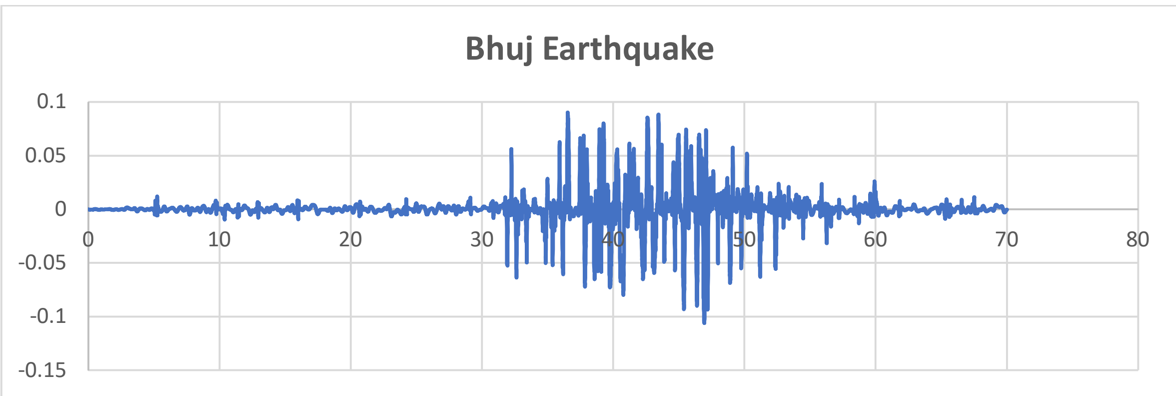
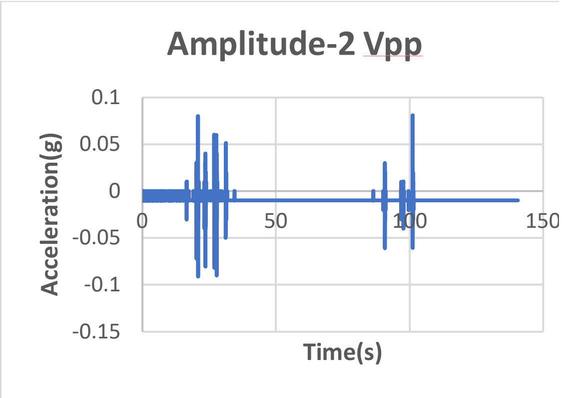
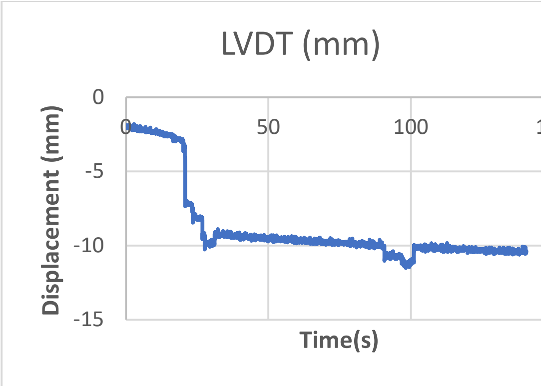


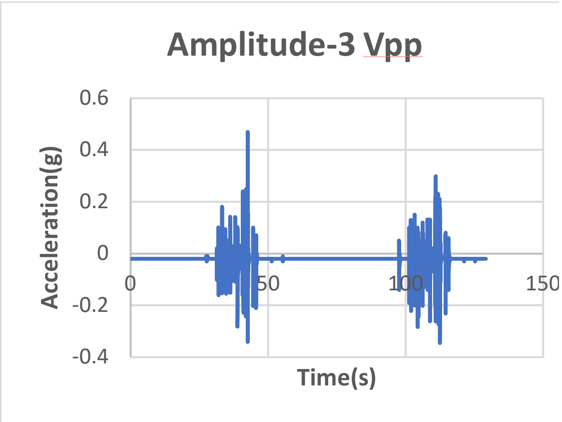
Fig.4.7 max/min acceleration at diff. amplitude

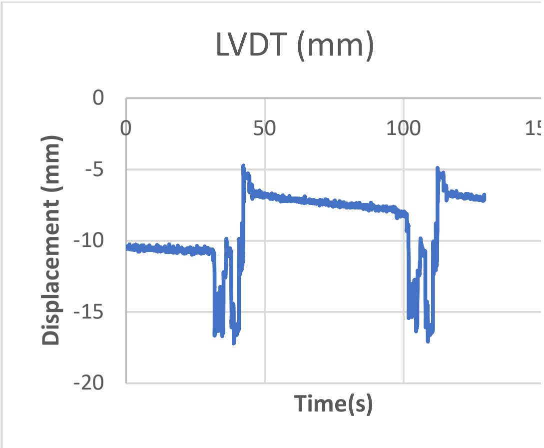


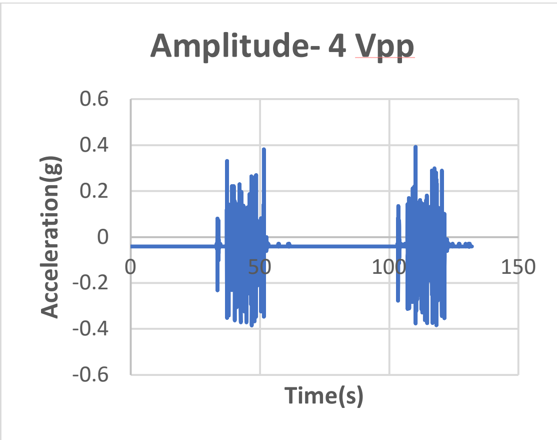
ACCELERATION VS TIME GRAPH AND DISPLACEMENT VS TIME GRAPH (BHUJ-1960)

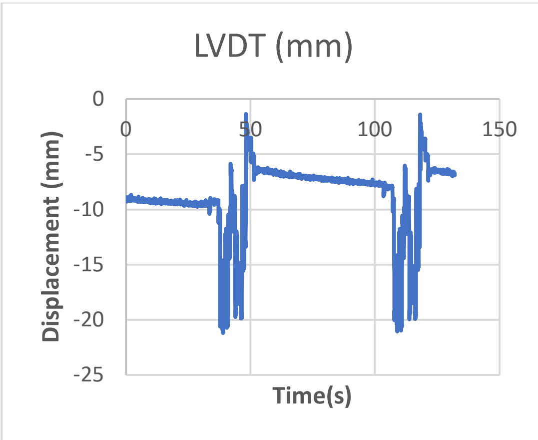


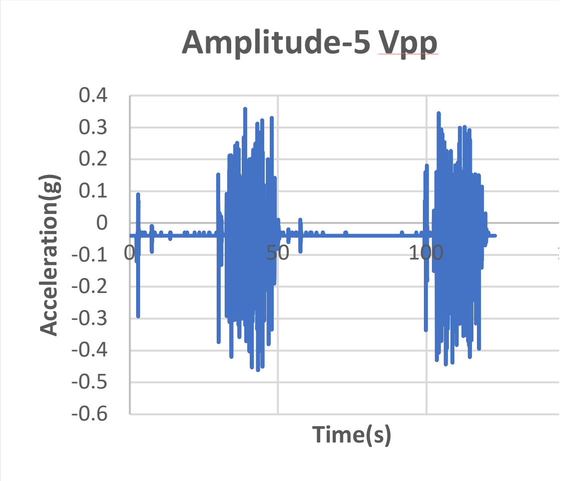


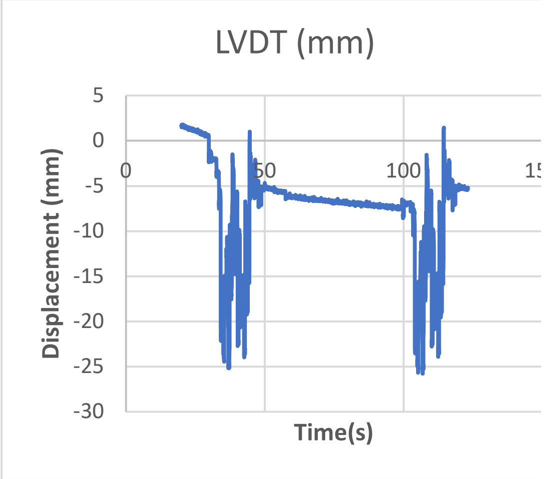


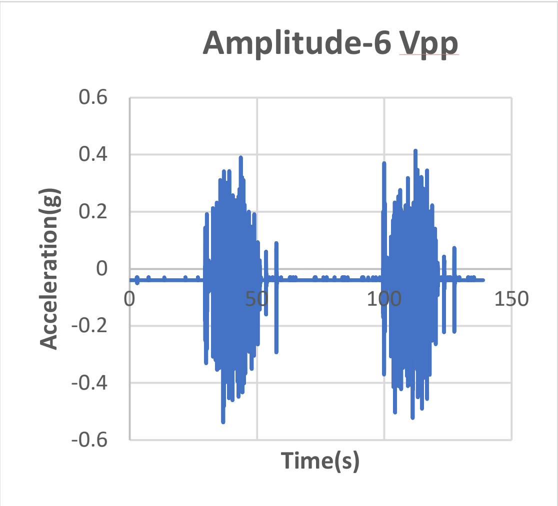


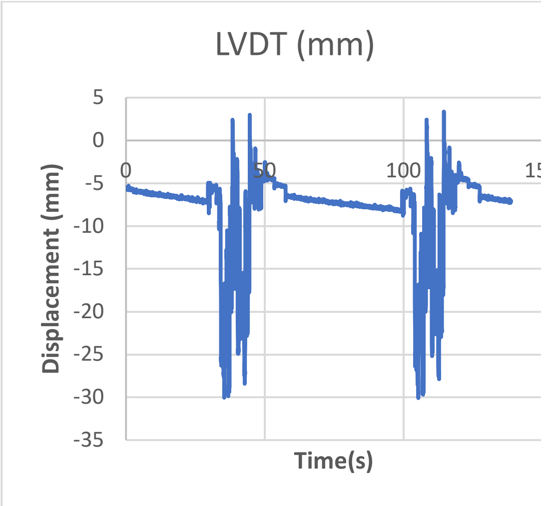


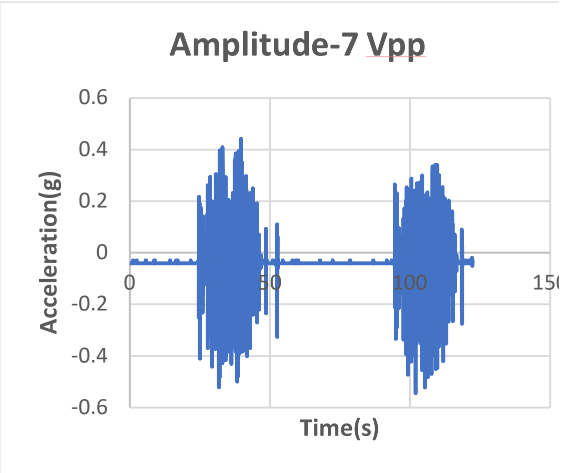


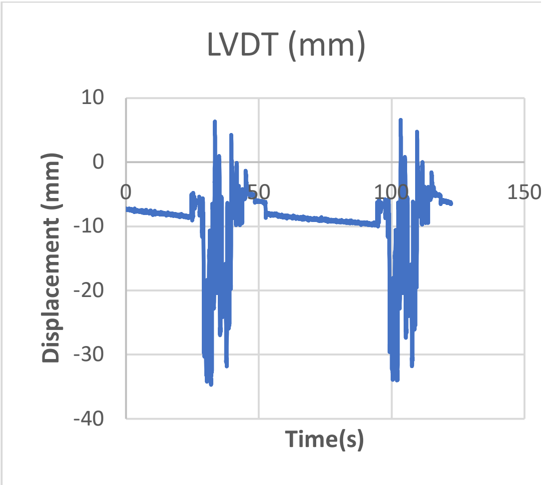

Amplitude-5 Vpp
Acceleration(g)
0.4
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
0
50
100
Time(s)


LVDT (mm)
Displacement (mm)
5
0
-5
-10
-15
-20
-25
-30
0
50
100
Time(s)


Amplitude-6 Vpp
Acceleration(g)
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
0
50
100
150
Time(s)


LVDT (mm)
Displacement (mm)
5
0
-5
-10
-15
-20
-25
-30
-35
0
50
100
Time(s)


Amplitude-7 Vpp
Acceleration(g)
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
0
50
100
Time(s)


LVDT (mm)
Displacement (mm)
10
0
-10
-20
-30
-40
0
50
100
150
Time(s)

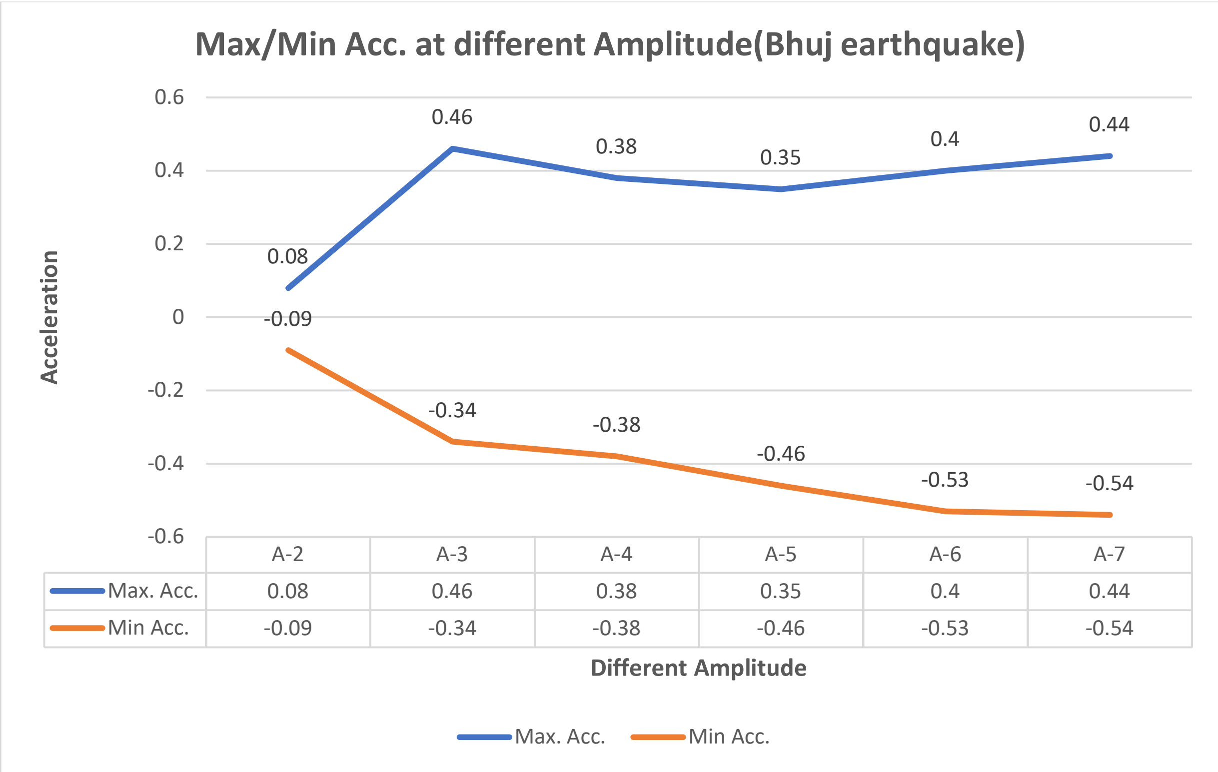


Fig. 4.8 Max/Min acceleration at diff. amplitude

FAILURE MECHANISM OF WALL

By applying Bhuj earthquake 2001, with amplitude of 7 the failure mechanism of wall was as shown in fig. below, as we know wall had a great mass around 182 kg, When the wall is subjected to earthquake with low amplitude with same frequency there was no sign of damage to be found on the wall surface. At last, the structure was subjected amplitude of (7 Vpp) with same frequency it achieves the high PGA and absorbed failure mode of the wall under this excitation. Failure mode wall, the recorded acceleration and displacement time history shows the brittle failure of wall with the last excitation.

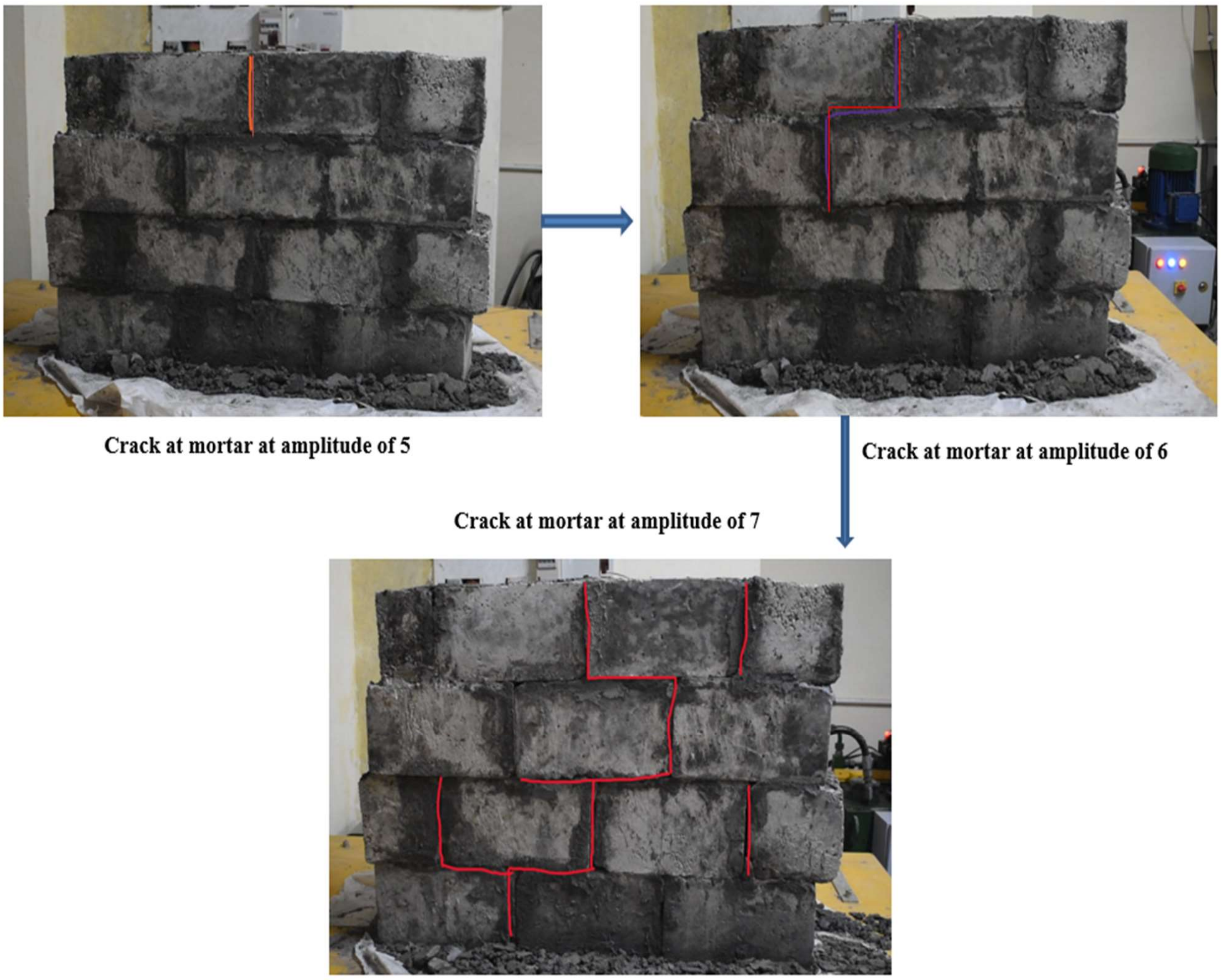


Fig. 4.9 Failure mechanism of wall

CHAPTER 5

CONCLUSION

5.1 CONCLUSION

- The stone concrete blocks used were 300x200x150mm in size. Many experiments on cement, sand, coarse aggregates, and locally available stones were conducted prior to the construction of concrete blocks. After the materials were examined in the laboratory, the casting of the blocks was further inferred.
- The strength of stone concrete blocks gives 20% increase in compressive strength in grade M-15 and gives 25% increase in grade M-20. Also, the stone can be used in concrete blocks as these can be made easily on the site and lowers the cost of construction as compared to normal concrete blocks.
- Wall made from M-15 stone concrete wall perform better even after high amplitude the cracks formed are on mortar not on blocks. We can see that bonding is good here that is the reason its failure mechanism starts showing at very high intensities, when we pass sinusoidal waves and real-time earthquake waves in dynamic testing, the wall didn’t fail at high intensities as well.
- Wall made from Stone concrete blocks is effective to use in retaining walls as it is more cost-efficient than normal concrete blocks and it doesn’t fail at lower intensities like Random rubble masonry wall.

5.2 FUTURE RECOMMENDATIONS

For future research, the following points can be considered for other results outcomes upon dynamic testing of stone concrete blocks study:

- This study was carried out on dynamic study of M15, M20 grades of concrete blocks. In future, this research can also be done by different grades of blocks.

- In this work we have used M15 grade of stone concrete blocks to construct a wall but same can extend with other grades.
- Dynamic analysis of wall is done, only on bhuj earthquake or chile earthquake.
- In future work grade of cement can be replaced with other type of Geopolymer concrete.

REFERENCES

[1] K.Sugimoto, M.Nishiyama, K.Nishimura(2017). “Shaking table test of 6-story wall frame building to investigate collapse process of RC building”. 16^{th} world conference on earthquake,Santiago Chile.

[2] Bin Liang and Hai Zhiang (2023), “The influence of different types of mortar on the compressive strength of masonry”. Journal of Building Engineering, Volume 65.

[3]A. Papadopoulou, O. Fisher and S.L. Lissel(2018). “Dynamic Testing of Masonry shear walls strengthened with core-fill retrofits. Masonry Today and Tomorrow.

[4] Francesco Di Michele, Enrico Spacone, Luiza Dihoru, George Mylonakis(2022). “Shaking Table test of a full scale three-leaf masonry wall”. Research Square.

[5]Md. Aminul Islam(2018). “Dynamic Behaviour of unreinforced masonry building”. Bangladesh University of Engineering and technology Dhaka-1000, Bangladesh.

[6] Sunil J, Dr. M.S. Ravi Kumar(2018). “Effect of fibres on the compressive strength of hollow concrete blocks”. International Journal of Civil Engineering and Technology.

[7] Abhishek Kapil(2020). “Utilization and testing of materials using concrete block technology”. Jaypee University of Information Technology Waknaghat,Solan-173234 India.

[8] Mohd Monish(2012). “Utilization of demolished waste as fine aggregate in concrete”. Civil Engg. Department, MNNIT, Allahabad-211004, UP, India. J.Acad.I ndus. Res. Vol.

[9] E.S. Fortes, G.A Parsekian, J.S. Camacho, F.S. Fonseca (2017). “Compressive strength of masonry constructed with high strength concrete blocks”. Rev. IBRACON Estrut. Mater. 10 (06) .

[10] Nathanael Savalle, Eric Vincens, Stephane Hans, Joachim Blanc- Gonnet (Dec 2020). “Dynamic Behaviour of Drystone retaining walls: shaking table scaled-down tests”. European Journal of Environmental and Civil Engineering.

[11] Masaru Kitaura, Youhei Umeda, Masahiro Terada (2004). “The Shaking Table test on an SDOF model steel structure for simulated critical earthquake using target earthquake”. 13th World Conference on Earthquake Engineering.

[12] Li-guang Xiao and Wen-hao Xing(2020). “Study on the influence of Different mortar thickness on Compressive strength of AAC block based on ANSYS”. IOP Conf. Series: Earth and Environmental series 526.

[13] Ramiro Vargas, Michel Bruneau (2004). “Seismic Response of SDOF structural fuse systems”.13th World Conference on Earthquake Engineering.

[14] Hua Wen, Jiu-jiang Wu, Jiao-li Zou, Xin Luo, Min Zhang, and Chengzhuang Gu (2016). “Model Tests on the Retaining Walls Constructed from Geobags Filled with Construction Waste”.International Research Journal of Engineering and Technology (IRJET).

[15] Ganesh C. Chikute, Ishwar P. Sonar. “Techno-Economical Analysis of Gabion Retaining Wall Against Conventional Retaining walls”. International Research Journal of Engineering and Technology (IRJET).

[16] Indian Standards IS-12440 (1998), “Specification for precast concrete stone masonry blocks”, Bureau of Indian Standards.

[17] Central Building Research Institute (CBRI), “Precast Stone Masonry Block Walling Scheme”. CBRI Roorkee-247667 Building research note 7.

[18] Sihan Li et al. (2020) “Dynamic behavior of reinforced soil retaining wall under horizontal seismic loading”. The Third International Workshop on Environment and Geoscience.

[19] Ankit C. Mahure, Prof.M.N.Umare(2019) “Investigation on Dynamic Behavior of different types of Retaining Walls with Different Heights”. International Journal for Research in Applied

PUBLICATIONS

CONFERENCE

Ronit Mahajan, Shivankar Partap Singh Guleria, Dr. Tanmay Gupta (2022). Utilization of stone masonry in Historic and Modern Structures. *Proceedings of the International Conference on Advances in Civil Engineering* [East West Institute of Technology Vishwaneedam Post, Bengaluru, India:9-10 November,2022], pp.45,46.

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

PLAGIARISM VERIFICATION REPORT

Date: ....

Type of Document (Tick): PhD Thesis | M.Tech Dissertation/ Report | B.Tech Project Report | Paper

Name: __________________________ __Department: ________________ Enrolment No _________

Contact No. _____________________________E-mail. _____________________________________

Name of the Supervisor: ____

Title of the Thesis/Dissertation/Project Report/Paper (In Capital letters): _______________________

____

____

UNDERTAKING

I undertake that I am aware of the plagiarism related norms/ regulations, if I found guilty of any plagiarism and copyright violations in the above thesis/report even after award of degree, the University reserves the rights to withdraw/revoke my degree/report. Kindly allow me to avail Plagiarism verification report for the document mentioned above.

Complete Thesis/Report Pages Detail:

- Total No. of Pages =
- Total No. of Preliminary pages =
- Total No. of pages accommodate bibliography/references =

(Signature of Student)

FOR DEPARTMENT USE

We have checked the thesis/report as per norms and found **Similarity Index** at ....(%). Therefore, we are forwarding the complete thesis/report for final plagiarism check. The plagiarism verification report may be handed over to the candidate.

(Signature of Guide/Supervisor) **Signature of HOD**

FOR LRC USE

The above document was scanned for plagiarism check. The outcome of the same is reported below:

Copy Received on	**Excluded**	**Similarity Index (%)**	**Generated Plagiarism Report Details** (Title, Abstract & Chapters)	
	• All Preliminary Pages • Bibliography/Images/Quotes • 14 Words String		Word Counts	
Report Generated on			Character Counts	
		Submission ID	Total Pages Scanned	
			File Size	

Checked by
Name & Signature **Librarian**

....

Please send your complete thesis/report in (PDF) with Title Page, Abstract and Chapters in (Word File) through the supervisor at plagcheck.juit@gmail.com