PERFORMANCE OF SEA SHELL POWDER ON SOIL STABILIZATION

A PROJECT REPORT

Submitted by

ANEES FATHIMA R	**110119103007**
MOHAMED MUSARAF M	**110119103017**
WASIF MUKTHAR SAC	**110119103020**

in partial fulfillment for the award of the degree of

BACHELOR OF ENGINEERING

in

CIVIL ENGINEERING

AALIM MUHAMMED SALEGH COLLEGE OF ENGINEERING

ANNA UNIVERSITY: CHENNAI 600025

MAY 2023

ANNA UNIVERSITY: CHENNAI 600025

BONAFIDE CERTIFICATE

Certified that this project report **"PERFORMANCE OF SEA SHELL POWDER ON SOIL STABILIZATION"** is the bonafide work of **"ANEES FATHIMA R (110119103002), MOHAMED MUSARAF M (110119103011), WASIF MUKTHAR S.A.C (11019103026)"** who carried out the project work under my supervision.

SIGNATURE	**SIGNATURE**
Dr. M. AFZAL ALI BAIG,	**Dr. D. ZUNAITHUR RAHMAN,**
Professor, M.Tech., Ph.D.,	**Assistant Professor, M.E., Ph.D.,**
HEAD OF THE DEPARTMENT	**SUPERVISIOR**
Department of Civil Engineering	Department of Civil Engineering
Aalim Muhammed Salegh college of Engineering	Aalim Muhammed Salegh college of Engineering
Muthapudupet, Avadi, IAF,	Muthapudupet, Avadi, IAF,
Chennai - 600055.	Chennai - 600055.

Submitted for the University Examination held on 20/5/2023

INTERNAL EXAMINER **EXTERNAL EXAMINER**

ACKNOWLEDGEMENT

We gratefully acknowledge our sincere thanks to our honourable Founder & Chairman (late) **Alhaj Dr. S. SHAIK NURDDIN** for starting this organization. We wish to express our gratitude to our secretary & Correspondent **Alhaj S. SEGU JAMALUDEEN** for granting us permission to complete our project successfully.

We would like to thank our Principal and **Prof. Dr. S. SATHISH,** Aalim Muhammed Salegh College of Engineering, for his support and guidance. We express our sincere gratitude to **Dr. M. AFZAL ALI BAIG, M. Tech, PhD,** Professor and Head of the Department of Civil Engineering, Aalim Muhammed Salegh College of Engineering for his constant help and valuable encouragement given us for completing this project on time.

We also extend our sincere thanks especially to our project Co-ordinator **Er. D. PRAKASH, M.E.,** Assistant Professor, Department of Civil Engineering, Aalim Muhammed Salegh College of Engineering.

Our heartfelt thanks to our Project Guide **Dr. D. ZUNAITHUR RAHMAN, M.E., Ph.D.,** Assistant Professor, Department of Civil Engineering, Aalim Muhammed Salegh College of Engineering for helping us with the required technical support and for his valuable contribution and commitment in solving the various problems faced during the execution of this project.

We also thank all the faculty members of Department of Civil Engineering andour Lab-Instructors for helping us in need. Our heartfelt gratitude to our Parents and Friends for their co-operation to make this design project a success. Above all we thank the almighty, for his countless blessing and hidden rendered upon us.

ABSTRACT

Usage of sea shells like clamps, mussels, oysters are wasted every day. It further raises the quantity of sea shell material waste. This contributes to numerous issues with the environment and climate. Million tons of sea shells are produced as the waste generated today create odours and promote microbial growth and emit co2 in lesser extent as they biodegrade and lead to environmental pollution will linger in the atmosphere, posing a number of environmental problems. therefore, excess will be utilized successfully in any sector of technological advancement. They have been made into necklace, buttons, belt buckles, earrings by adding sea shell powder wastes to the clay soil, we have to know about the changes in the strengths like, Atterbergs limits and Unconfined Compression test. The soil collected for the investigation is from the southern district of Tamil Nadu, India. The different percentage of plastic powder was replaced to improve the soil property. In India, increase in population coupled with heavy laden loads of vehicles conveying heavier stresses concentrates especially on roads running in clayey soil zones which create significant problems for pavement and hence need to be stabilized. And by coordinating on the sea shell powder as part of the dose of 2.5%, 5%, 7.5%, 10%, are used as stabilizers.

CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATION

g	grams
kg	kilograms
kN	kilo Newton
lit	Litre
N	Newton
mg	milligram
mm	millimetre
cm	centimetre
m	metre
mm^2	square millimetre
cm^3	cubic centimetre
m^3	cubic metre

CHAPTER 1
INTRODUCTION

1.1General

Clay soils have wide development in Bombay, western part of Madhya Pradesh, part of Gujarat, and in some parts of Tamil Nadu. Here, large area is occupied by soils derived from the Deccan trap. Clay soil absorb water heavily, swell, become soft and lose strength. These soils are easily compressible when wet and possesses a tendency to heave during wet condition.

Clay soil shrink in volume and develop cracks during summer. They are characterized by extreme hardness and cracks when dry. These properties make them poor foundation soils and earth construction material. The stability and performance of the pavements are greatly influenced by the sub grade and embankment as they serve as foundations for pavements. For developing a good and durable road network in clay soil areas, the nature of soils shall be properly understood. On such soils suitable construction practices and sophisticated methods of design need to be adopted.

1.2 Characteristics of Clay Soil

Clay soils are inorganic clays of medium to high compressibility and form a major soil group in India. Clay soil has a high percentage of clay which is predominantly montmorillonite in structure and black or blackish grey in colour. Because of its high swelling and shrinkage characteristics, the Clay soil has been a challenge to geotechnical and highway engineers. The soil is very hard when dry, but loses its strength completely when in wet condition (Balasubramaniam, et. al, 1989). The wetting and drying process causes vertical movement in the soil mass which leads to failure of a pavement, in the form of settlement, heavy depression, cracking and unevenness.

It also forms clods which cannot be easily pulverized as treatment for its use in road construction (Holtz& Gibbs, 1956). This poses serious problems as regards to subsequent performance of the road. Moreover, the softened sub grade has a tendency to heave into the upper layers of the pavement, especially when the sub-base consists of stone soling with lot of voids. Gradual intrusion of wet Clay soil invariably leads to failure of the road. However, since this soil is available easily at low cost, it is frequently used for construction purposes (Bell, 1988).Some of the factors which influence the behaviour of these expansive soils are initial moisture content, initial dry density, amount and type of clay, Atterberg limits of the soil, California bearing ratio and swell potential.

Fig.1 Shrinkage in summer

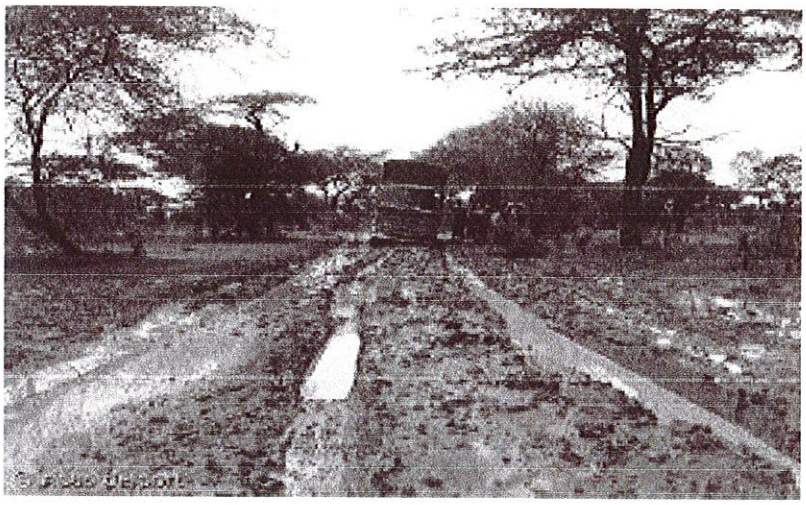

Fig.2 Swelling in rainy

1.3 Soil Stabilization

For any land-based structure, the foundation is very important and has to be strong to support the entire structure. In order for the foundation to be strong, the soil around it plays a very critical role. So, to work with soils, we need to have proper knowledge about their properties and factors which affect their behaviour. The process of soil stabilization helps to achieve the required properties in a soil needed for the construction work.

From the beginning of construction work, the necessity of enhancing soil properties has come to the light. Ancient civilizations of the Chinese, Romans and Incas utilized various methods to improve soil strength etc., some of these methods were so effective that their buildings and roads still exist.

In India, the modern era of soil stabilization began in early 1970's, with a general shortage of petroleum and aggregates, it became necessary for the engineers to look at means to improve soil other than replacing the poor soil at the building site. Soil stabilization was used but due to the use of obsolete methods and also due to the absence of proper technique, soil stabilization lost favour.

Here in this project, soil stabilization has been done with the help of sea shell powder which is obtained from the sea shore and then it is grinded to fine powder. The improvement in the shear strength parameters and California bearing ratio which plays the vital role in pavement construction has been stressed upon and comparative studies has been computed.

CHAPTER 2
LITERATURE REVIEW

2.1 G Venkatappa Raoin 1998.

Many investigators have conducted the studies on fibre-reinforced materials. The results of direct shear tests performed on sand specimens indicated increased shear strength, increased ductility, and reduced post peak strength loss due to the inclusion of discrete fibres. These results were supported by a number of researchers. Investigations were also conducted to determine the behaviour of material properties of fibre-reinforced sands. The failure envelopes for fibre-sand composites were bilinear. The critical confining stress was a function of surface friction properties of the fibres and soil. The inclusion of discrete fibres increased both the cohesion and angle of internal friction of the specimens.

2.2 Akshaya Kumar Sabat in 2002.

This paper presents the effects of waste ceramic dust on, liquid limit, plastic limit, plasticity index, compaction characteristics, unconfined compressive strength, California bearing ratio, shear strength parameters and swelling pressure of an expansive soil. The expansive soil collected locally was mixed with ceramic dust from 0 to 30% at an increment of 5%. From the analysis of test results it was found that, liquid limit, plastic limit, plasticity index, optimum moisture content, cohesion and swelling pressure decreased, maximum dry density, unconfined compressive strength, California bearing ratio and angle of internal friction increased with an increase in ceramic dust content.

2.3 Mandeep Singh, Anupam Mittal in 2003.

This paper presents the effects of waste ceramic dust on, liquid limit, plastic limit, plasticity index, compaction characteristics, unconfined compressive strength, California bearing ratio, shear strength parameters and swelling pressure of an expansive soil. The expansive soil collected locally was mixed with ceramic dust from 0 to 30% at an increment of 5%. From the analysis of test results it was found that, liquid limit, plastic limit, plasticity index, optimum moisture content, cohesion and swelling pressure decreased, maximum dry density, unconfined compressive strength, California bearing ratio and angle of internal friction increased with an increase in ceramic dust content.

2.4 Subasis Patiin2001.

Preliminary tests were performed on three samples, A, B and C for identification and classification purposes followed by the consistency limit tests. Geotechnical strength tests (compaction, California bearing ratio (CBR), unconfined compression test and triaxial) were also performed on the samples, both at the stabilized and unsterilized states (adding 2, 4, 6, and 8% sugarcane straw ash). The results showed that sugarcane straw ash improved the geotechnical properties of the soil samples. Optimum moisture content increased from 19.0 to 20.5%, 13.3 to 15.7% and 11.7 to 17.0%, CBR increased from 6.31 to 23.3%, 6.24 to 14.88% and 6.24 to 24.88% and unconfined compression strength increased from 79.64 to 284.66kN/m2, 204.86 to 350.10kN/m2 and 240.4 to 564.6kN/m2 in samples A, B and C respectively.

CHAPTER 3
MATERIALS AND METHODS

3.1Soil Stabilization

Soil stabilization is the process of altering some soil properties by different methods, mechanical or chemical in order to produce an improved soil material which has all the desired engineering properties. Soils are generally stabilized to increase their strength and durability or to prevent erosion and dust formation in soils. The main aim is the creation of a soil material or system that will hold under the design use conditions and for the designed life of the engineering project. The properties of soil vary a great deal at different places or in certain cases even at one place; the success of soil stabilization depends on soil testing. Various methods are employed to stabilize soil and the method should be verified in the lab with the soil material before applying it on the field.

3.1.1 Principles of Stabilization

- Evaluating the soil properties of the area under consideration.
- Deciding the property of soil which needs to be altered to get the design value and choose the effective and economical method for stabilization.
- Designing the Stabilized soil mix sample and testing it in the lab for intended stability and durability values.

3.1.2 Needs and Advantages

Soil properties vary a great deal and construction of structures depends a lot on the bearing capacity of the soil, hence, we need to stabilize the soil which makes it easier to predict the load bearing capacity of the soil and even improve the load bearing capacity. The gradation of the soil is also a very important property to keep in mind while working with soils.

The soils may be well-graded which is desirable as it has less number of voids or uniformly graded which though sounds stable but has more voids. Thus, it is better to mix different types of soils together to improve the soil strength properties. It is very expensive to replace the inferior soil entirely soil and hence, soil stabilization is the thing to look for in these cases.

The various soil properties such as bearing capacity, shear strength, drainage etc. can be improved by reinforcing with plastic wastes.

- For developing a good and durable road network in clay soil area.
- Plastic bags are difficult and costly to recycle and most end up on landfill
- sites where they take around 300 years to photo degrade.

All these instances, instigated the research to conduct this study to assess the knowledge and attitude of adolescents regarding the environment hazards due to mismanagement of plastic wastes.

3.1.3 Methods of Stabilization

1. **Mechanical Method**

In this procedure, soils of different gradations are mixed together to obtain the desired property in the soil. This may be done at the site or at some other place from where it can be transported easily. The final mixture is then compacted by the usual methods to get the required density.

2. **Additive Method**

It refers to the addition of manufactured products into the soil, which in proper quantities enhances the quality of the soil. Materials such as cement, lime, bitumen, fly ash etc. are used as chemical additives.

3.2 Soil Properties

3.2.1 Atterberg Limits

1) Shrinkage Limit:

2) Plastic Limit:

This limit lies between the plastic and semi-solid state of the soil. It is determined by rolling out a thread of the soil on a flat surface which is non-porous. It is the minimum water content at which the soil just begins to crumble while rolling into a thread of approximately 3mm diameter. Plastic limit is denoted by W_P.

3) Liquid Limit:

It is the water content of the soil between the liquid state and plastic state of the soil. It can be defined as the minimum water content at which the soil, though in liquid state, shows small shearing strength against flowing. It is measured by the Casagrand's apparatus and is denoted by W_L.

3.2.2 Particle Size Distribution

Soil at any place is composed of particles of a variety of sizes and shapes, sizes ranging from a few microns to a few centimetres are present sometimes in the same soil sample. The distribution of particles of different sizes determines many physical properties of the soil such as its strength, permeability, density etc.

Particle size distribution is found out by two methods, first is sieve analysis which is done for coarse grained soils only and the other method is sedimentation analysis used for fine grained soil sample. Both are followed by plotting the results on a semi-log graph. The percentage finer as the ordinate and the particle diameter i.e., sieve size as the abscissa on a logarithmic scale. The curve generated from the result gives us an idea of the type and gradation of the soil. If the curve is higher up or is more towards the left, it means that the soil has more representation from the finer particles; if it is towards the right, we can deduce that the soil has more of the coarse-grained particles.

The soil may be of two types- well graded or poorly graded (uniformly graded). Well graded soils have particles from all the size ranges in a good amount. On the other hand, it is said to be poorly or uniformly graded if it has particles of some sizes in excess and deficiency of particles of other sizes. Sometimes the curve has a flat portion also which means there is an absence of particles of intermediate size, these soils are also known as gap graded or skip graded.

3.2.3 Specific Gravity.

Specific gravity of a substance denotes the number of times that substance is heavier than water. In simpler words we can define it as the ratio between the mass of any substance of a definite volume divided by mass of equal volume of water. In case of soils, specific gravity is the number of times the soil solids are heavier than equal volume of water.

3.2.4 Shear Strength

Shearing stresses are induced in a loaded soil and when these stresses reach their limiting value, deformation starts in the soil which leads to failure of the soil mass. The shear strength of a soil is its resistance to the deformation caused by the shear stresses acting on the loaded soil. The shear strength of a soil is one of the most important characteristics. There are several experiments which are used to determine shear strength such as DST or UCS etc. The shear resistance offered is made up of three parts:

i) The structural resistance to the soil displacement caused due to the soil particles getting interlocked,

ii) The frictional resistance at the contact point of various particles, and

iii) Cohesion or adhesion between the surface of the particles.

In case of cohesion less soils, the shear strength is entirely dependent upon the frictional resistance, while in others it comes from the internal friction as well as the cohesion.

3.2.5 Unconfined Compression Test (ucs test)

This test is a specific case of triaxial test where the horizontal forces acting are zero. There is no confining pressure in this test and the soil sample tested is subjected to vertical loading only. The specimen used is cylindrical and is loaded till it fails due to shear.

CHAPTER 4

EXPERIMENTAL INVESTIGATION

4.1 Scope of work

The experimental work consists of the following steps:

1. Specific gravity of soil
2. Determination of soil index properties (Atterberg Limits)
   i) Liquid limit by Casagrande's apparatus
   ii) Plastic limit
3. Particle size distribution by sieve analysis
4. Determination of the shear strength by:
   i) Unconfined compression test (UCS)

4.2 Materials

4.2.1. Clay soil

Clay soil is collected from avadi road which is used for our experimental study.

4.2.2.Sea shells waste powder

Sea shells waste like clamps have been collected from the marina beach and besant nagar beach. And they are washed and cleaned with water and dried completely in sunlight and then crushed by grinding stone to get the powdered sea shell

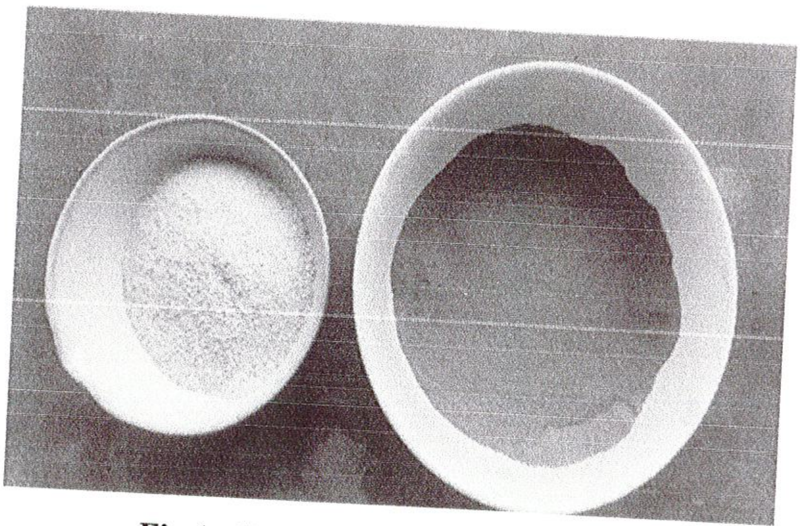

Fig 1. Clay soil and Sea shell powder

The **Sea shell powder** produced after burning the shells at high temperatures, is rich in calcium oxide (caO-52 to 57%) depending on the type and the composition of cacO3

content of the raw shells. But shells are strong and resistant to fracturing, and this is because the calcium carbonate is combined with proteins which bind the crystals together, and make them stronger and sometimes tougher

4.3 Steps Involved in Experiments

4.3.1 Specific Gravity of The Soil

The specific gravity of soil is the ratio between the weight of the soil solids and weight of equal volume of water. It is measured by the help of a volumetric flask in a very simple experimental setup where the volume of the soil is found out and its weight is divided by the weight of equal volume of water.

$$\text{Specific Gravity } G = (W2-W1)/ (W4-W1) - (W3-W2)$$

W1- Weight of bottle in gms

W2- Weight of bottle + Dry soil in gms

W3- Weight of bottle + Soil + Water

W4- Weight of bottle + Water

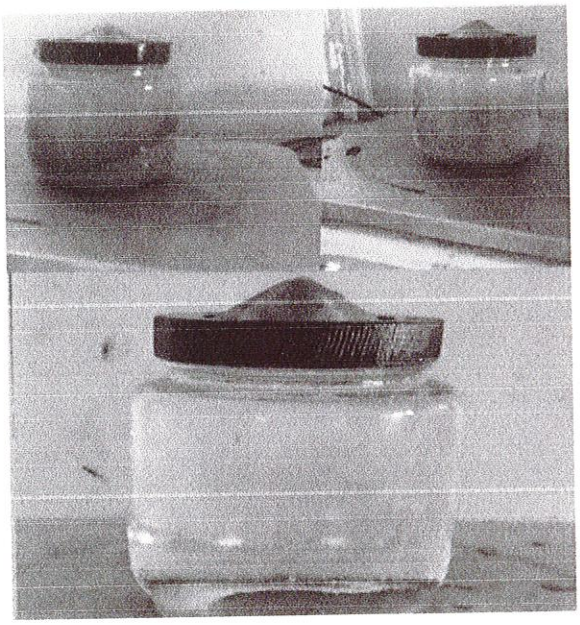

Fig.4 Pycnometer

4.3.2 Liquid limit

The Casagrande tool cuts a groove of size 2mm wide at the bottom and 11 mm wide at the top and 8 mm high. The number of blows used for the two soil samples to come in contact is noted down. Graph is plotted taking number of blows on a logarithmic scale on the abscissa and water content on the ordinate. Liquid limit corresponds to 25 blows from the graph.

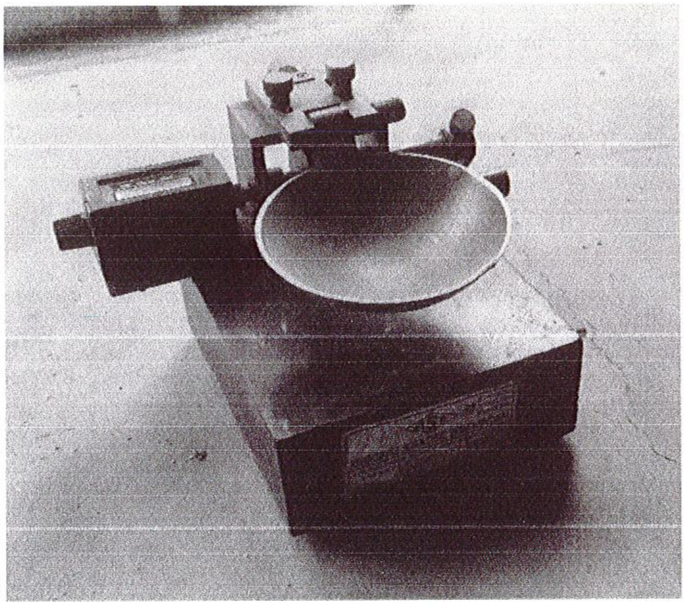

Fig.5 Casagrande Apparatus

4.3.3 Plastic Limit

This is determined by rolling out soil till its diameter reaches approximately 3 mm and measuring water content for the soil which crumbles on reaching this diameter. Plasticity index (Ip) was also calculated with the help of liquid limit and plastic limit;

$$I_p = W_L - W_P$$

W_L-Liquid limit

W_P- Plastic limit

4.3.4 Particle Size Distribution

The results from sieve analysis of the soil when plotted on a semi-log graph with particle diameter or the sieve size as the abscissa with logarithmic axis and the percentage passing as the ordinate gives a clear idea about the particle size distribution. From the help of this curve, D10 and D60 are determined. This D10 is the diameter of the soil below which 10% of the soil particles lie. The ratio of, D10 and D60 gives the uniformity coefficient (Cu) which in turn is a measure of the particle size range.

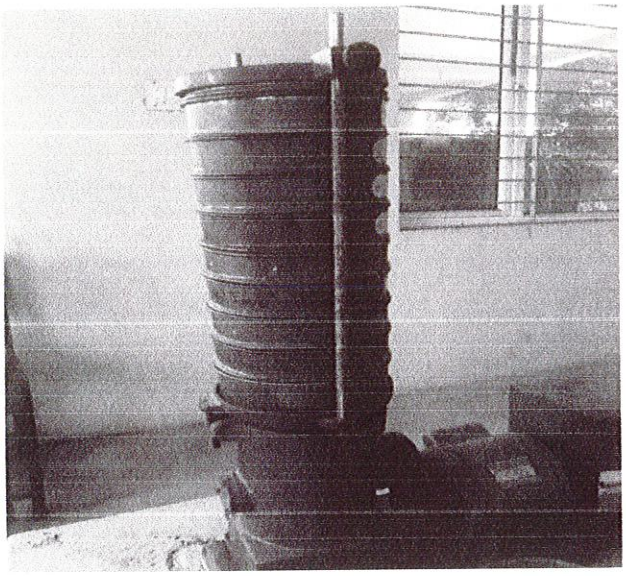

Fig 6. Sieve Shaker

4.3.6 Unconfined Compression Test

This experiment is used to determine the unconfined compressive strength of the soil sample which in turn is used to calculate the unconsolidated, undrained shear strength of unconfined soil. The unconfined compressive strength (qu) is the compressive stress at which the unconfined cylindrical soil sample fails under simple compressive test. The experimental setup constitutes of the compression device and dial gauges for load and deformation. The load was taken for different readings of strain dial gauge starting from $\varepsilon = 0.005$ and increasing by 0.005 at each step. The corrected cross-sectional area was calculated by dividing the area by $(1-\varepsilon)$ and then the compressive stress for each step was calculated by dividing the load with the corrected area.

qu= load/corrected area (A')

qu- compressive stress

A'= cross-sectional area/ $(1-\varepsilon)$

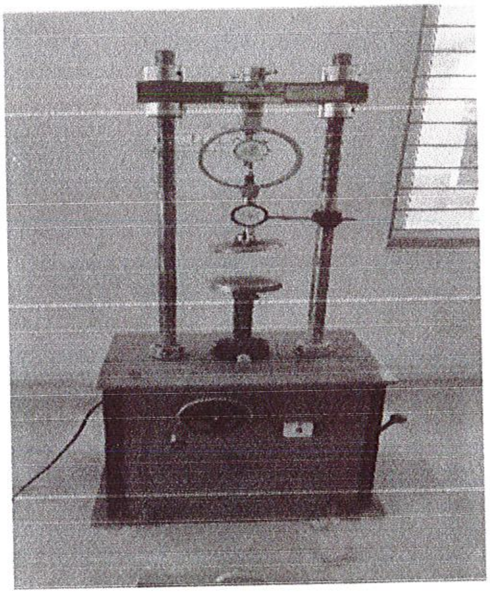

Fig 7. Ucc Apparatus

CHAPTER 5

RESULT AND DISCUSSION

5.1 Specific Gravity

Table :1 Specific Gravity

SPECIFIC GRAVITY	NORMAL CLAY	2.5% OF SEA SHELL POWDER	5% OF SEA SHELL POWDER	7.5% OF SEA SHELL POWDER	10% OF SEA SHELL POWDER
G	2.55	2.63	2.71	2.87	2.72

Average specific gravity G=2.77

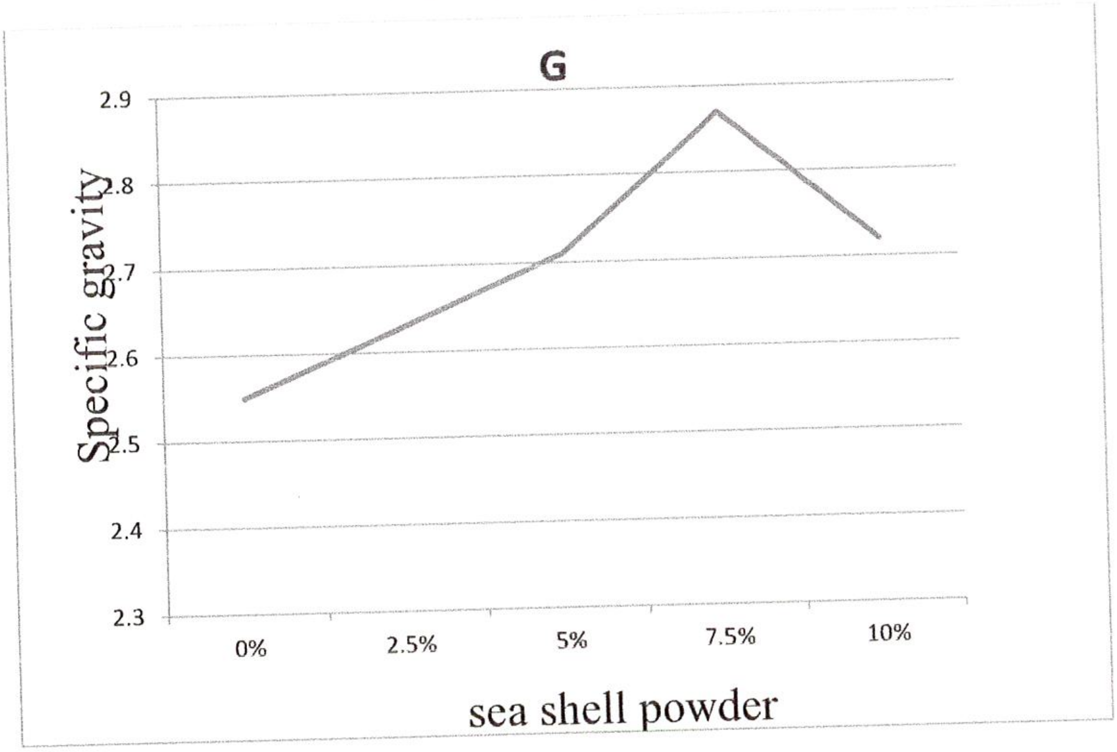

Fig 8: Specific Gravity

5.2 Particle Size Distribution (sieve analysis)

Table 2: Particle Size Distribution:

IS SIEVE	WT OF SOIL RETAINED Kg	CUMUL WT. RETAINED Kg	SOIL RETAINED %	% OF FINER SOIL
4.75 mm	0.007	0.007	0.7	99.3
2.36 mm	0.053	0.060	6.0	94
1.18 mm	0.190	0.250	25	75
600 μ	0.309	0.559	55.9	44.1
425 μ	0.213	0.772	77.2	22.8
300 μ	0.078	0.850	85	15
150 μ	0.136	0.986	98.6	1.4
75 μ	0.007	0.993	99.3	0.7
Pan	0.007	1.000	100	0

i. Uniformity co.eff. (C_u) = 2.36

ii. Co.eff of curvature (C_c) = 0.816

C_c = 1-3 for well graded soil

C_u must be greater than 4 for gravel and 6 for sand **so, it is poorly graded clay soil.**

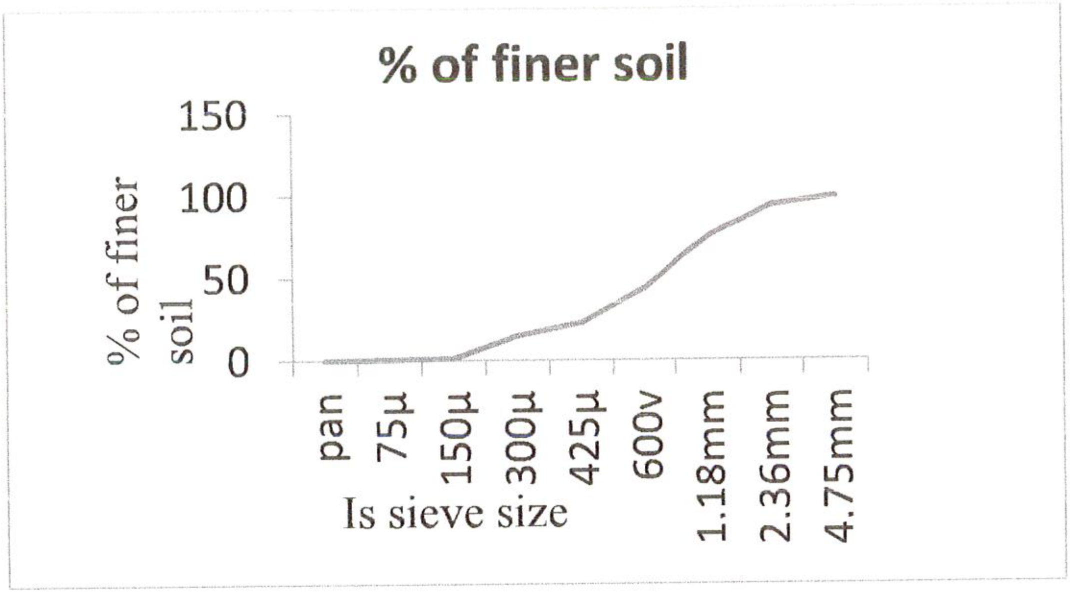

Fig 9: Sieve Analysis

5.3 Index Properties

5.3.1. Liquid Limit

Table: 3: Liquid limit with percentage of sea shell powder

LIQUID LIMIT	NORMAL CLAY	2.5% OF SEA SHELL POWDER	5% OF SEA SHELL POWDER	7.5% OF SEA SHELL POWDER	10% OF SEA SHELL POWDER
W_L	64%	60%	52%	**45%**	51%

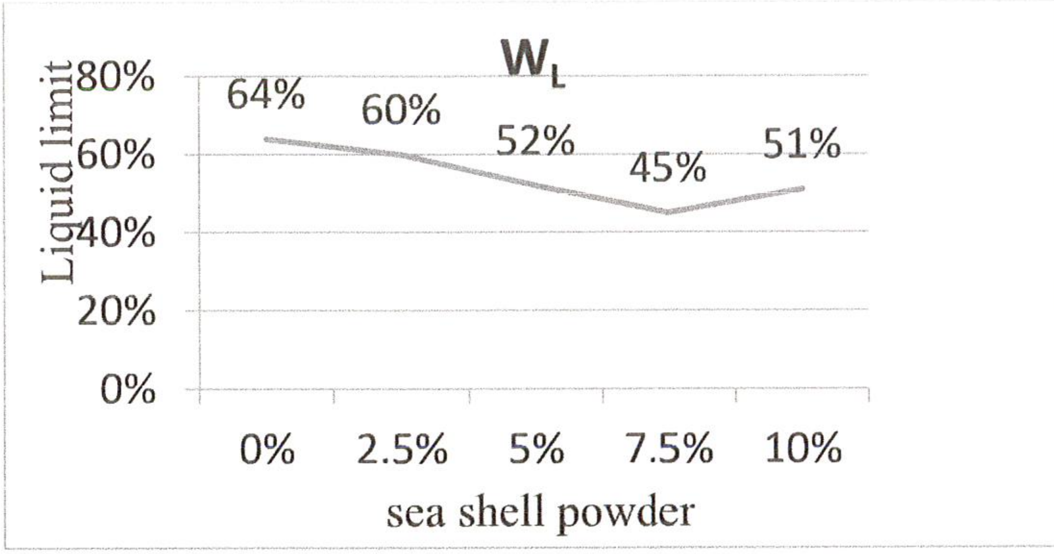

Fig10: Liquid Limit

- The results of liquid limit tests on clay soil treated with different percentage of sea shell powder waste shown in graph.
- From the graph it can be seen that with increase in percentage of sea shell powder the liquid limit of soil goes on increasing.

5.3.2 Plastic Limit

Table 4: Comparison of Plastic limit with percentage of sea shell powder

PLASTIC LIMIT	NORMAL CLAY	2.5% OF SEA SHELL POWDER	5% OF SEA SHELL POWDER	7.5% OF SEA SHELL POWDER	10% OF SEA SHELL POWDER
W_P	30%	27%	25%	**24%**	25%

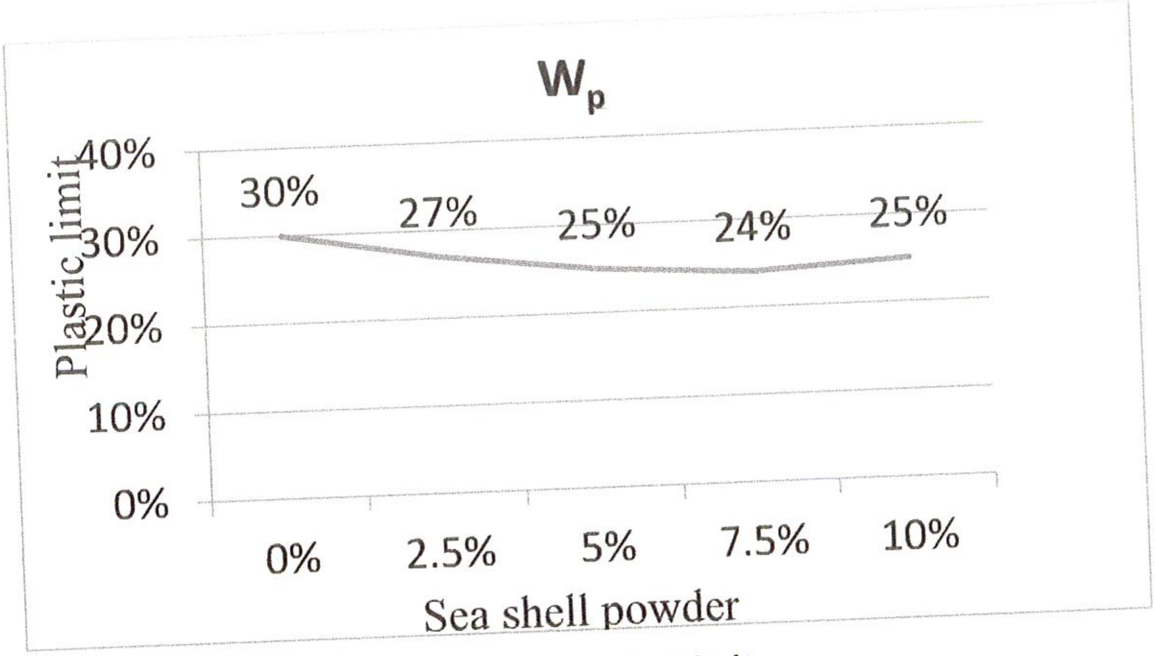

Fig 11: Plastic Limit

- The results of plastic limit tests on clay soil treated with different percentage of sea shell powder are shown in graph.
- From the graph it can be seen that with increase in percentage of sea shell powder the plastic limit of soil goes on decreasing.
- The plastic limit of the soil increases from 30% to 24% with increase in sea shell powder up to 7.5%.
- Further we combine the liquid limit of the soil decreases from30% to 24% with increase in sea shell powder waste.

5.3.3 Plasticity Index

Table 5: Plastic Index

I_P	SOIL PLASTICITY
0-3	NON-PLASTIC
3-15	SLIGHTLY PLASTIC
15-30	MEDIUM PLASTIC
30 ABOVE	HIGH PLASTIC

Table 6: Plastic Index decrease with increase in sea shell powder

PLASTICITY INDEX	NORMAL CLAY	2.5% OF SEA SHELL POWDER	5% OF SEA SHELL POWDER	7.5% OF SEA SHELL POWDER	10% OF SEA SHELL POWDER
I_p	34%	33%	27%	**21%**	25%
SOIL PLASTICITY	HIGH PLASTIC	HIGH PLASTIC	MEDIUM PLASTIC	**MEDIUM PLASTIC**	MEDIUM PLASTIC

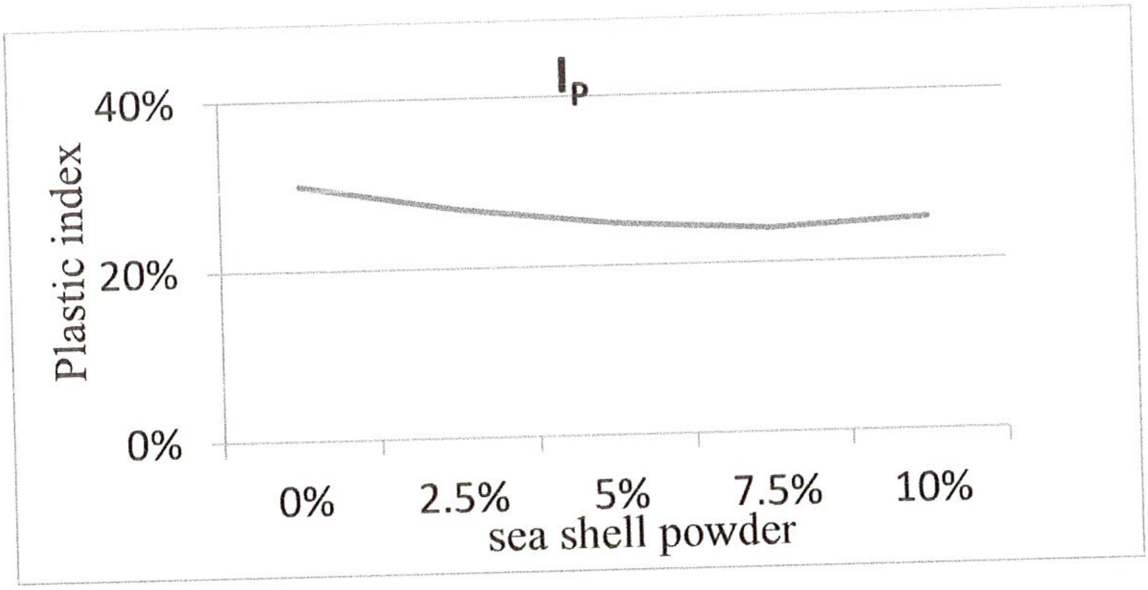

Fig 12: Plastic Index

- The results of plasticity index tests on clay soil treated with different percentage of sea shell powder are shown in graph.
- From the graph it can be seen that with increase in percentage of sea shell powder the plasticity index of soil goes on decreasing. It decreases from 34% to 21 %.
- The plasticity index of the soil decreases from 34% to 21 %with increase in sea shell powder up to 7.5%.

5.4 Unconfined Compression Strength

Table7: comparison of UCC with percentage of sea shell powder.

UNCONFINED COMPRESSION STRENGTH	NORMAL CLAY	2.5% OF SEA SHELL POWDER	5% OF SEA SHELL POWDER	7.5% OF SEA SHELL POWDER	10% OF SEA SHELL POWDER
UCS(KN/m^2)	74	78	86	**92**	88

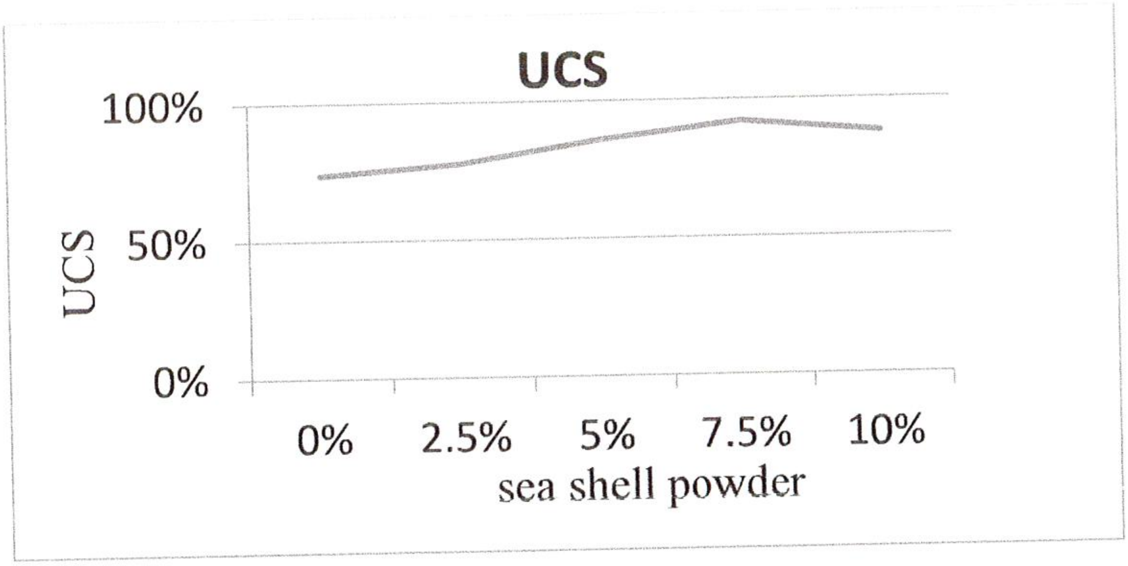

Fig 13: unconfined compression strength

- From the graph it can be seen that with increase in percentage of plastic powder, the UCS of soil goes on increasing.
- The UCS of soil goes on increasing.The UCS increases from 74Kn?/m^2 when sea shell is increased from 0 to 7.5%.

ECONOMY OF STABILIZATION

To study the economy of stabilization, a flexible pavement has been designed for cumulative traffic of 1,5 and 10 msa (million standard axles), based on the guide lines provided by IRC: 37-2001(Guidelines for the design of Flexible Pavements) for CBR values of both unstabilized and stabilized soil. According to IRC:37-2001, if the soaked CBR value of a subgrade is less than 2%, then the design of the pavement should be done by taking the soaked CBR value as 2% and a capping layer of 150 mm thickness with materials having minimum CBR value of 10% should be provided in addition to sub base. Hence the soaked CBR of unstabilized soil subgrade has been taken as 2% instead of 1.6% for design purpose. The soaked CBR value is 4% for the mix having proportion of soil 70% and sea shell powder 30%. Hence the soaked CBR of stabilized soil subgrade has been taken as 4% for the design purpose. The variation of pavement thickness for both the unstabilized and stabilized subgrade, with cumulative traffic (1, 5 and 10 msa) has been shown in Figure . It can be seen from this figure that the pavement thickness varies from 660 mm to 850mm for unstabilized soil and from 480 mm to 700 mm for stabilized soil for cumulative traffic 1 -10 msa.

As per the schedule of rates - 2012, Government of Tamilnadu, India, the cost of stabilized and unstabilized pavement per m2 of pavement for cumulative traffic 1-10 msa in Indian Rupees has been shown in Figure 13. It includes the cost of transportation of sea shell powders from a distance of 20 km, grinding of sea shell powders and mixing of sea shell powder with soil. It can be seen from this figure, that the cost of pavement per m^2 variess from 914.5/ -1931/- Rupees for unstabilized subgrade (which includes the cost of capping layer of 150mm thickness) and from 687.4/- t 1635.4/- Rupees for syabilization sub grade for cumulative traffic of 1-10 msa.

CONCLUSION

A series of laboratory tests were conducted to study the effects of waste sea shell powder on the, liquid limit, plastic limit, plasticity index, UCS, soaked CBR, shear strength parameters of an clay soil. Based on the observations and discussions, following conclusions are drawn from this study.

- The liquid limit gradually increases with increasing %of sea shell powder.
- Plastic limit and plasticity index go on decreasing of the percentage of addition of Sea shell powder.
- The UCS goes on increasing with increase in percentage of addition of sea shell powder.
- Further we add sea shell powder by 2.5%,5%,7.5%,10% respectively. The liquid limit of the soil decreases from 64% to 45% with increase in sea shell powder.
- The plasticity index of the soil decreases from 34% to 21% with increase in sea shell powder.
- The UCC of the soil increases from 74% to 92% with increase in sea shell powder.
- From the economic analysis it is found that sea shell powder up to 7.5% can be utilized for strengthening the sub grade of flexible pavement with a substantial save in cost of construction.

REFERENCE

1. Sabat, A.K.(2012) "A study on some geotechnical properties of lime stabilized expansive Soil –quarry dust mixes, " International Journal of Emerging Trends in Engineering.
2. Broderick, G. and Daniel, D.E. (1990). "Stabilizing compacted clay against chemical
3. Baser, O.(2009) "Stabilization of expansive soils using waste marble dust, " Master of Science thesis submitted to Civil Engineering Department, Middle East, Technical University.
4. Sabat, A.K.(2012) "A study on some geotechnical properties of lime stabilized expansive soil –quarry dust mixes, " International Journal of Emerging Trends in Engineering and Development, Vol.1(2), pp 42-49.
5. Soil Mechanics And Foundation – Dr.B.C.Punmia, Ashok Kumar Jain
6. Soil Mechanics And Engineering Practice – Karl Terzaghi
7. Engineering Properties Of Soil And Their Measurements – Joseph E.Bowls
8. IRC: 37-2001, "Guidelines for the Design of Flexible Pavements".
9. IS2720 Code Book Part 1,2,3, 4,5,7&40.
10. Prasanna, S. (2019). Utilization of Waste Plastic Shreds for Stabilization of Soil. Geotechnics for Transportation Infrastructure, 619–628
11. Dave, M. (2017). Clay Soil Stabilization Using Plastic (Polythene) Waste as Admixture. International Journal for Research in Applied Science and Engineering Technology, V(IX), 352–357.
12. Attom, M. (1998). Soil stabilization with burned olive waste. Applied Clay Science, 13(3), 219–230.
13. V. M. (2016). Soil Stabilization Using Plastic Waste. International Journal of Research in Engineering and Technology, 05(05), 391–394.

14. Investigation Of Soil Stabilization Using Waste Fiber Materials. (2017). International Journal of Recent Trends in Engineering and Research, 3(8), 1–7.
15. Canakci, H., AL-Kaki, A., & Celik, F. (2016). Stabilization of Clay with Waste Soda Lime Glass Powder. Procedia Engineering, 161, 600–605.
16. Performance of Eggshell Powder Addition to Clay Soil for Stabilization. (2019). Special Issue, 8(3S3), 532–535.
17. Modarres, A., & Nosoudy, Y. M. (2015). Clay stabilization using coal waste and lime — Technical and environmental impacts. Applied Clay Science, 116-117, 281–288. Canakci, H., AL-Kaki, A., & Celik, F. (2016). Stabilization of Clay with Waste Soda Lime Glass Powder. Procedia Engineering, 161, 600–605.
18. Performance of Eggshell Powder Addition to Clay Soil for Stabilization. (2019). Special Issue, 8(3S3), 532–535.
19. Modarres, A., & Nosoudy, Y. M. (2015). Clay stabilization using coal waste and lime — Technical and environmental impacts. Applied Clay Science, 116-117, 281–288.
20. Performance of Eggshell Powder Addition to Clay Soil for Stabilization. (2019). Special Issue, 8(3S3), 532–535.
21. Modarres, A., & Nosoudy, Y. M. (2015). Clay stabilization using coal waste and lime — Technical and environmental impacts. Applied Clay Science, 116-117, 281–288..
22. Kumar, J. K., & Kumar, V. P. (2020). Soil stabilization using E-waste: A retrospective analysis. Materials Today: Proceedings, 22, 691–693.
23. Kiran Kumar, J., & Praveen Kumar, V. (2020). Experimental analysis of soil stabilization using e-waste. Materials Today: Proceedings, 22, 456–459.
24. Parihar, N. S., Garlapati, V. K., & Ganguly, R. (2019). Stabilization of Black Cotton Soil Using Waste Glass. Handbook of Environmental Materials Management, 3099–3114.

25. Soil Stabilization using Brick Kiln Dust and waste Coir Fibre. (2019). 2, 8(2), 2574–2578.
26. Investigation Of Soil Stabilization Using Waste Fiber Materials. (2017). International Journal of Recent Trends in Engineering and Research, 3(8), 1–7

AN EMPIRICAL STUDY ON THE BARRIERS IN IMPLEMENTATION OF CONSTRUCTION SAFETY PRACTICES

A PROJECT REPORT

Submitted by

F.S. MOHAMED SAYEED JALWATHI	110119103012
S. NAVIN KUMAR	110119103016
SUHAIL AHAMED	110119103023
S. AATHIQUE	110119103501

in partial fulfillment for the award of the degree

of

BACHELOR OF ENGINEERING

IN

CIVIL ENGINEERING

AALIM MUHAMMED SALEGH COLLEGE OF ENGINEERING

ANNA UNIVERSITY: CHENNAI 600025

MAY 2023

ANNA UNIVERSITY: CHENNAI 600 025

BONAFIDE CERTIFICATE

Certified that this project report **"AN EMPIRICAL STUDY ON THE BARRIERS IN IMPLEMENTATION OF CONSTRUCTION SAFETY PRACTICES"** is the bonafide work of **"F.S. MOHAMED SAYEED JALWATHI (110119103012); S. NAVIN KUMAR (110119103016) SUHAIL AHAMED (110119103023); S. AATHIQUE (11019103501)"** who carried out the project work under my supervision.

SIGNATURE	**SIGNATURE**
Prof. Dr. M. AFZAL ALI BAIG, M.Tech., Ph.D., M.I.S.T.E.,	**Er. M. NAZEER AHAMED, M.E., (Ph.d)**
	ASSISTANT PROFESSOR
HEAD OF THE DEPARTMENT	**SUPERVISOR**
DEPARTMENT OF CIVIL ENGINEERING	DEPARTMENT OF CIVIL ENGINEERING
AALIM MUHAMMED SALEGH COLLEGE OF ENGINEERING	AALIM MUHAMMEDSALEGH COLLEGE OF ENGINEERING
MUTHAPUDUPET, AVADI IAF CHENNAI – 600055.	MUTHAPUDUPET, AVADI IAF CHENNAI – 600055.

Submitted for the University Examination held on 20/05/2023

INTERNAL EXAMINER **EXTERNAL EXAMINER**

ACKNOWLEDGEMENT

We gratefully acknowledge our sincere thanks to our honourable chairman (late) **Alhaj Dr. S. SHAIKNURDDIN**, Founder, Chairman, for starting this organization. We wish to express our gratitude to our secretary & correspondent **Alhaj S. SEGU JAMALUDEEN** for granting us permission to complete our Design project successfully.

We would also like to thank our Principal, **Prof. Dr. S. SATHISH**, Aalim Muhammed Salegh College of Engineering, for his support and guidance. We express our sincere gratitude to **Prof. Dr. M. AFZAL ALI BAIG, M. TECH, PhD**, **Head** & our **Project Co-Ordinator**, Department of Civil Engineering, Aalim Muhammed Salegh College of Engineering, for his constant help and valuable encouragement given us for completing this project on time.

Our heartfelt thanks to our Project Guide **Er. M.F. NAZEER AHAMED, M.E., (Ph.D)** Assistant Professor, Department of Civil Engineering, Aalim Muhammed Salegh College of Engineering for helping us with the required technical support and for his valuable contribution and commitment in solving the various problems faced during the execution of this project.

We also thank all the Faculty members of Department of Civil Engineering and our Lab-Instructors for helping us in need. Our heartfelt gratitude to our Parents and Friends for their co-operation to make this design project a success. Above all we thank the almighty, for his countless blessing and hidden rendered upon us.

ABSTRACT

Construction industry sites are one of the most hazardous workplace environments to work in with regard to health and safety of employees. There is high risk in the construction industry because of the production processes, labour intensive characteristics and occupational mishaps that result in large scale financial losses and bad reputation of the firm. Even though the management desires to implement safety practices, there are many barriers towards the implementation of safety practices.

Taking this as a motive, the study has been conducted to study the barriers in the implementation of safety practices by taking a survey directly with the constructional personnel in the field.

With a detailed literature review and focused interview with the constructional workers, 18 barriers were identified. Then a survey was taken and the responses were studied category wise to identify the issues and barriers. Furthermore, the results were analysed by software to get a detailed picture of the study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

The poor performance of the construction industry in terms of health and safety is well-known on a global scale. The national economy and the financial health of construction companies are both negatively impacted by this subpar performance. Construction companies have created and executed a variety of safety plans in response to the requirement to improve health and safety performance. A safety programme is an integrated collection of rules and activities that aims to increase safety. A safety programme is "a systematic combination of activities, procedures, and facilities designed to promote and maintain a safe and healthy workplace," according to the Industrial Accident Prevention Association. The client, architect/engineer, contractor, construction manager, subcontractor, and suppliers are all members of the construction team, and it is their responsibility to implement safety programmes to make sure that every project is completed without incidents that result in injuries or accidents being reported.

In construction projects, safety programs are considered leading mechanisms in the promotion of health and safety. Its implementation has reduced accident rates and created safe working environments. Moreover, the application of safety programs, as well as the development of safety culture, is capable of facilitating cooperation among the top management level and their employees. Despite the proven benefits, the implementation of safety programs in the construction sector is still very limited. Safety programs are non-existent or not rigorously implemented due to poor management and lack of attention to safety. Outdated safety rules and regulations and their lack of enforcement contribute to poor performance in the construction industry.

In India, construction industry is the second largest employer next to agriculture whereas it is next to the road accidents in our country. Construction industry is one of the world's major industries. Its achievement in rebuilding areas devastated by both natural and manmade disasters, and in providing power, services and communications to meet the rising needs and expectations of people throughout the world, has conferred great benefits on the human race. Despite mechanization, construction remains a major employer of labour – it often employs between 9 and 12 per cent of a country's working population, and sometimes as much as 20 per cent. However, there has been a price to pay for this continuous growth and activity.

Safety at all job sites does not just occur. A safe operation is one which is organized, clean and efficient. If all the employees view accidents in the same way as we consider all other aspects of the company operations, we will be in excellent position not only to control accidents but also to improve the total performance of our company. Therefore, it is of utmost importance that all aspects of our safety management be strictly enforced and followed. Although it is difficult to obtain accurate statistics in an industry in which many accidents go undetected and unreported, in many countries known fatal accidents, and those involving loss of working time, frequently exceed those in any other manufacturing industry.

2. RESEARCH METHODOLOGY

For this research paper consider a poll overview strategy or questionnaire survey method has been received to discover the out the impact of various attributes on construction productivity in Indian construction sector. This method is utilized broadly in various worldwide research papers.

First, literature review was conducted to identify barriers to the implementation of safety programs. Second, semi-structured interviews were conducted with 11 experts in the Iraqi construction industry. The purpose of the interviews is two-fold; first, to confirm the barriers found in the literature and, second, to identify potential barriers not previously established. The interviewees confirmed that all barriers are relevant to the Iraqi construction industry.

18 qualities influencing construction profitability that were recognized from the writing audit and through individual meeting with industry specialists. The questionnaire was designed with a 5-point Likert scale format to assess the relevance of the barriers to the implementation of safety programs. Construction professionals were separated into 3 sectors; Top management level, Safety Supervisor Level and the Workers Level in the construction industry were the target population of the survey.

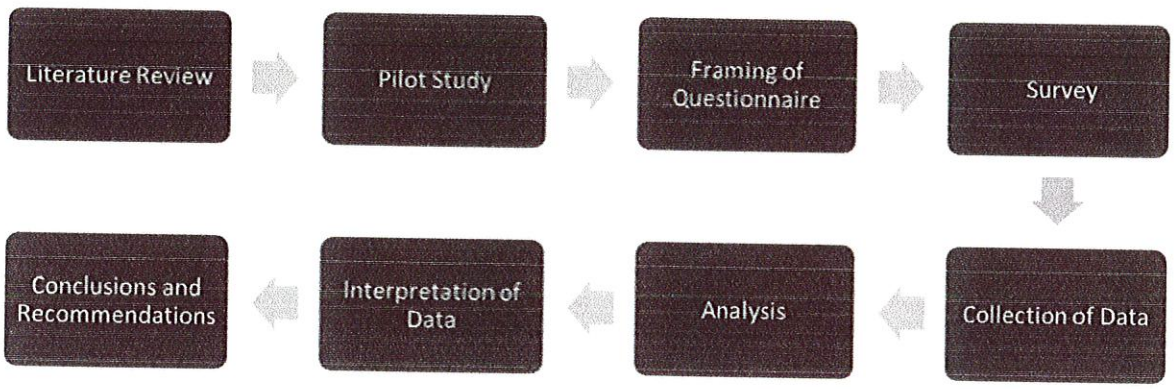

Fig. 1 – Research Methodology Flow Chart

3. LITERATURE REVIEW

Construction sites are dynamic activities where workers engage in many activities that may expose them to a variety of safety hazards, such as falling objects, working from rooftops or scaffolding, exposure to heavy construction equipment, or the use of temporary electrical circuits while operating electrical equipment and machinery in damp locations. Through implementation of safe work practices, training, and compliance with federal, state, and local regulatory requirements, the Workplace Safety program aims to identify, control, or eliminate construction-related hazards.

A literature review is a comprehensive summary of previous research on a topic. The literature review surveys scholarly articles, books, and other sources relevant to a particular area of research. The purpose of a literature review is to gain an understanding of the existing research and debates relevant to a particular topic or area of study, and to present that knowledge in the form of a written report.

The following are the papers referred for this project:

- "Implementation of Safety Management through Review of Construction", a project carried out by S. R. Meena, P. M. Nemade, S. N. Pawar, A. S. Baghele in 2013. In this research, a study was conducted to recognize the significant factors for the low productivity in Singapore construction industry. The focus was on the relationship among different factors through qualitative and quantitative analysis, so as to identify the most direct factors and their root causes. The eight critical wastes for every project are correlated with the respective project organization and management characteristics. These eight factors are, waiting due to inspection, waiting due to crew's interference, waiting for equipment, waiting for instruction, waiting for materials, rework due to design changes.

- "Barriers to safety program implementation in the construction industry", a project carried out by Mohanad K. Buniya , Idris Othman , Riza Yosia Sunindijo , Ahmed Farouk Kineber , Eveline Mussi , Hayroman Ahmad in 2010. The research methodology used was qualitative analysis. Qualitative analysis is a research that produces descriptive data in the form of written words from a journal under studies. The first component of the barriers to the implementation of safety program is unconducive work climate. It includes the following barriers: lack of resources, lack of commitment to OSH and the assumption that safety is the sole responsibility of safety personnel. These barriers are interlinked and determine the success of the implementation of the safety program
- "Implementation of Safety Management System for Improving Construction Safety Performance: A Structural Equation Modelling Approach", a project carried by Nicole S.N. Yiu, DanielW.M. Chan, N.N. Sze, Ming Shan, Albert P.C. Chan in 2019. This research was conducted with by a comparison of 24 factors affecting the constructional productivity, from which there were the 8 critical wastes on site were recognized as the most direct affecting factors for productivity.
- "Effective Safety Management in Construction", a project carried out by M. Samuel Thanaraj, M.Priya in 2019. They conducted a study and found the major parameters which are considered in the safety management were discussed. The different stages of safety management have been observed and analyzed.

- "Saftey Practices in Ralway Civil Engineering Construction Projects", a project carried out by Anakor, Ajayi, Ola-Ade, Posun, Gbadamosi in 2020. The findings of the research were; the The study concludes that 15 safety practices on railway civil engineering projects are not available.

4. PILOT STUDY

A pilot study, pilot project, pilot test, or pilot experiment is a small-scale preliminary study conducted to evaluate feasibility, duration, cost, adverse events, and improve upon the study design prior to performance of a full-scale research project. Pilot experiments are frequently carried out before large-scale quantitative research, in an attempt to avoid time and money being used on an inadequately designed project.

Experts from various fields of construction have been interacted to conduct this study. One to one interaction, discussions leading to the exchange and sharing of ideas and information that are related for this project. A total of 11 personnel from various field have been directly interacted. They are 2 contractors, 4 Site Engineers, 2 Safety Engineers, 2 Site Supervisors and a Project Manager.

The observation collected from these personnel are:

Table 1 – Data of Pilot Study

Response No.	Designation	Observation
1	Retired PWD Engineer, Present Contractor	• Poor Work Methodology • Poor Safety Guidelines • Improper house keeping • Lack of Saftey Signs • Conflicts between Workers • Not taking actions to violaters • Carelessness of workers • Lack of Safety Supervision • Lack of PPE Usage
2	Project Manager	• Lack of importance of safety prectices • Insufficient Safety Resources • Lack of addressing safety issues • Unsafe acts of workers • Lack of supply of PPE • Engaging of Unskilled labours • Unsafe work environment • Lack of health of workers
3	Renovation Contractor	• Lack of safety training • Improper safety inspection • Work Overload • Lack of safety awareness • Poor work methodology

		• Carelessness of Workers
4	Safety Engineer	• Lack of supply of safety resources • Fights between workers • Miscommunication • Unavailability of safe environment • Lack of recognition for employees • Improper housing keeping. • Accidents and its chain effects • Lack of proper working environment • Overload work for employees • Mechanical failures of machines • Improper safety inspection • Change of working plan • Delays due to Rain • Lack of usage of PPE
5	Site Engineer	• Material Price hikes. • **Labour and Engineer skillset** • Lack of safety signs • Insufficient Safety resources • **Changes in Plan after execution** • Lack of unskilled labour • **Lack of safety trainng** • **Lack of usage of PPE** • Lack of Proper design documents. • Carelessness of workers • Low soil stability. • Inflation

		• Scope Creeping
6	Site Supervisor	• Labour disputes • Shortage of power supply and water • Shortage of labours • Lack of Coordination between labours and supervisors • **Lack of safety training.** • Labour Faults • Lack of proper communications • Over Pressure from managers • Language barriers • Lorry Strikes • **Poor work methodology**

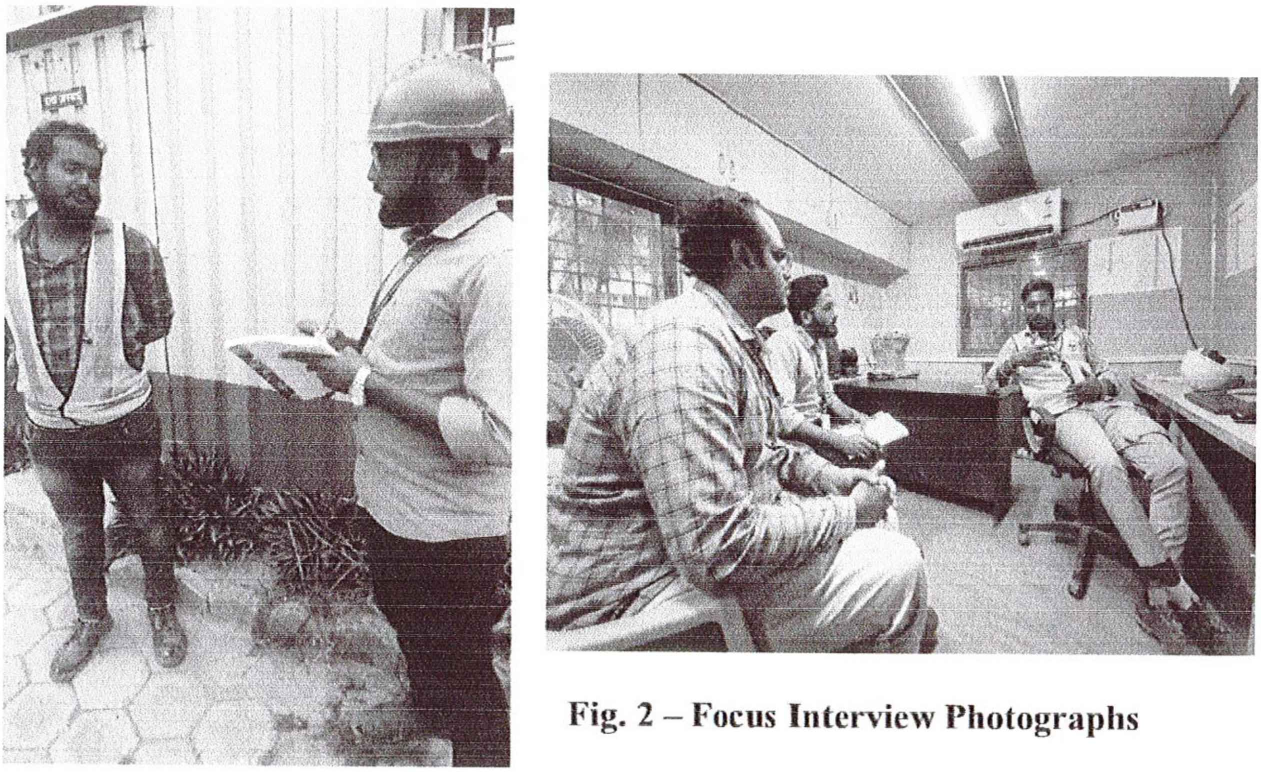

Fig. 2 – Focus Interview Photographs

5. FRAMING OF QUESTIONNAIRE

5.1 GENERAL

With the data and information collected through the pilot study, a structured questionnaire consisting of 18 attributes grouped into 3 categories has been formed. These are Management Level, Supervisor Level, Worker Level. Each factor consists of 6 questions. The questions were designed in such a way that they were simple and can easily understand by the respondents.

For each question, the respondents were asked to rate the specified attribute on a Likert scale of 1 to 5 with respect to their observation in construction productivity.

The value given to the Likert scale rating for the impact:

1. Highly Disagree
2. Disagree
3. Neither Agree nor Disagree
4. Agree
5. Highly Agree

5.2 SETTING OF HYPOTHESIS

H1: There is a significant relationship between Management issues and barriers to safety measures

H2: There is a significant relationship between Supervisor issues and barriers to safety measures

H3: There is a significant relationship between Worker issues and barriers to safety measures

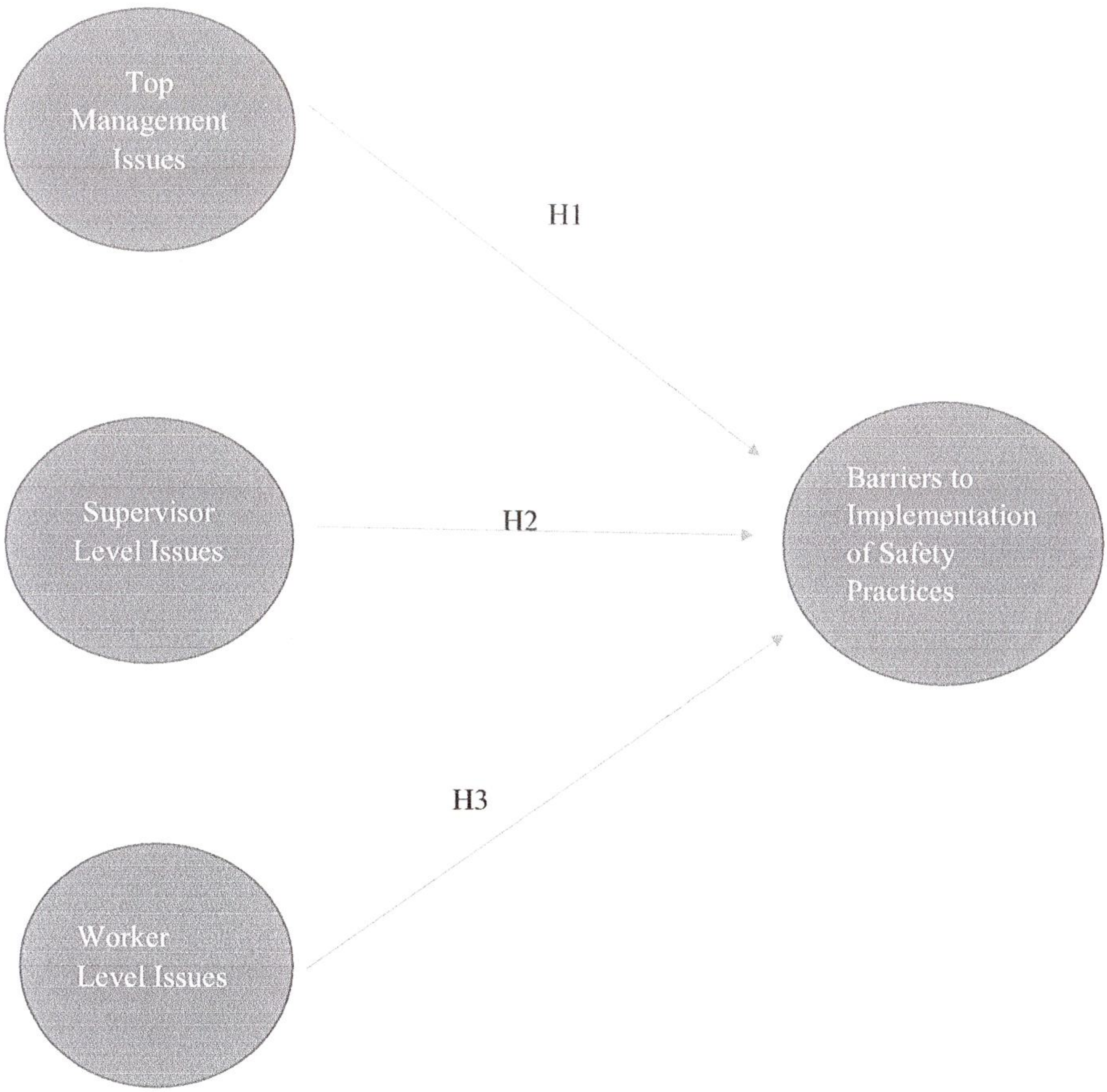

Fig. 3 – Model representing the relation between contributing factors and the major issue.

5.3 CLASSIFICATION OF CATEGORIES

5.3.1 Management Level:

It refers to the top management personnel working in the construction industry. Questions are referred directly to these personnel addressing the issues related to the implementation of safety practices. Top Management Level questions addresses to the Managing Directors, General Managers, Project Managers, Planning Engineers etc.

5.3.2 Supervisor Level:

Questions are addressing the supervisors and safety personnel and the issues faced and experienced by them. Supervisor Level questions addresses the Site Engineers, Safety Engineers and other supervisor Personnel.

5.3.3 Labour Level:

Questions are directly addressed to the labours and workers working in the construction field. The workers form the major part of the industry and these are the workers who are directly going to practice and benefit from the safety practices.

5.4 QUESTIONNIARE

Table 2 – Questionnaire

Sl. No.	Questions	Code
Management level		
1	Lack of importance towards safety measures from management	T1
2	Insufficient safety resources	T2
3	Lack of ensuring proper awareness/training to supervisors and workers.	T3
4	Lack of health care of workers.	T4
5	Unavailability of safe working environment at construction site.	T5
6	Not taking appropriate actions towards safety violators.	T6
Supervisor level		
1	Not conducting safety training periodically	S1
2	Lack of Safety Inspection/Supervision at Construction Site	S2
3	Lack of addressing of safety issues related to workers	S3
4	Engaging of Unskilled Labours	S4
5	Improper Housekeeping.	S5
6	Lack of Proper Safety Guidelines	S6
Workers level		
1	Lack of usage of PPEs	W1
2	Unsafe acts of Workers	W2
3	Poor Work Methodology	W3
4	Carelessness of Workers	W4
5	Communication Gap Between Workers and Supervisors	W5
6	Conflicts between Workers	W6

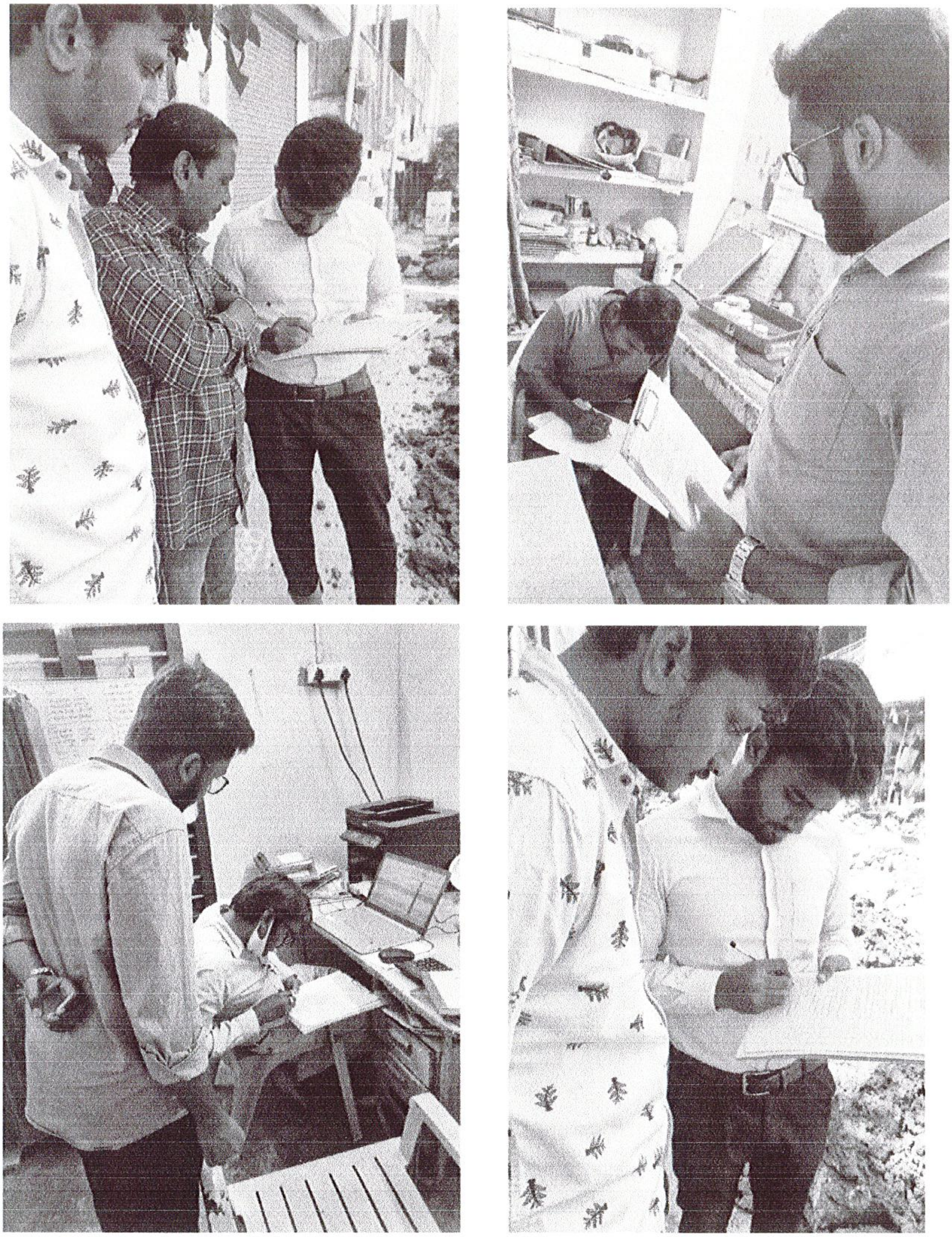

Fig. 4 – Survey Photographs

6. DATA ANALYSIS

6.1 RESPONDENTS PERCENTAGE

Table 3 – Respondents Percentage Table

Category	No. of Responses	Percentage
Management Level	14	13%
Supervisor Level	27	26%
Worker Level	63	61%
Total	**104**	**100%**

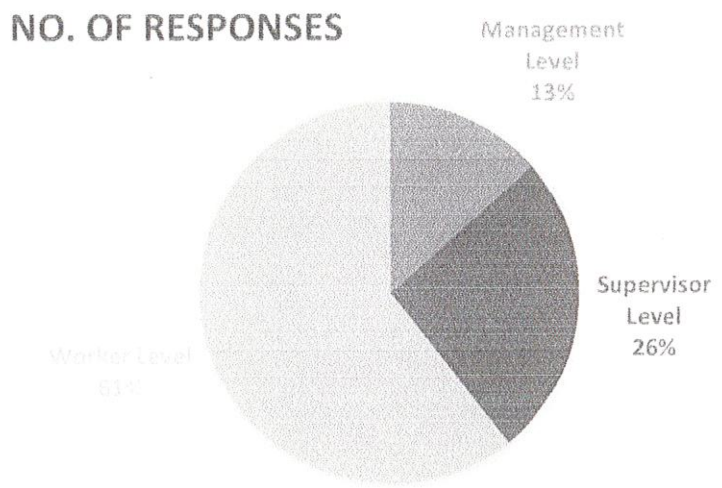

Fig. 5 – Respondents Percentage Chart

6.2 GENDER WISE DISTRIBUTION

Table 4 – Gender Distribution Table

Gender Category	No. of Responses	Percentage
Male	93	89%
Female	11	11%
Total	**104**	**100%**

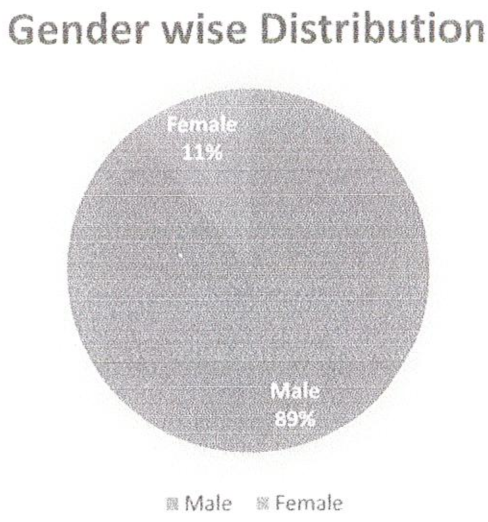

Fig. 6 – Gender Distribution Chart

6.3 AGE WISE DISTRIBUTION

Table 5 – Age Distribution Table

Age Category	No. of Responses	Percentage
18-30	31	30%
31-40	26	25%
41-50	21	20%
Above 50	26	25%
Total	**104**	**100%**

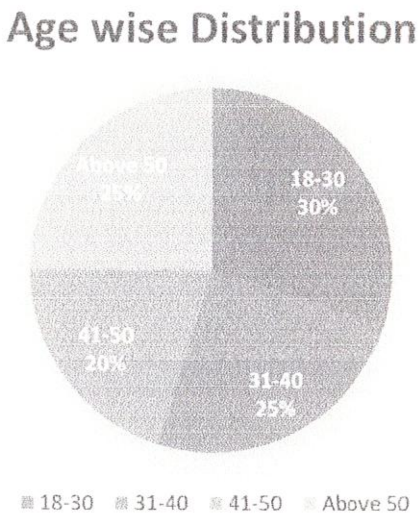

Fig. 7 – Age Distribution Chart

6.4 EXPERIENCE WISE DISTRIBUTION

Table 6 – Experience Distribution Table

Experience Category	No. of Responses	Percentage
Less than 5	24	23%
6-10	15	14%
11-15	27	26%
16-20	16	15%
Above 21	22	21%
Total	**104**	**100%**

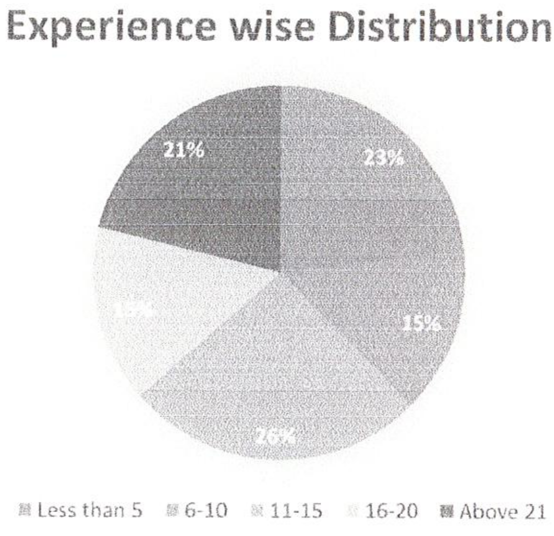

Fig. 8 – Age Distribution Chart

6.5 RANKING OF ATTRIBUTES

6.5.1 Top Management Ranking:

Table 7 – Ranking of Top Management Level

Top Management Ranking			
Code	**Attributes**	**Score**	**Rank**
T1	Lack of importance towards safety measures from management	3.61	**1**
T2	Insufficient safety resources	3.48	**4**
T3	Lack of ensuring proper awareness/training to supervisors and workers.	3.56	**2**
T4	Lack of health care of workers.	3.51	**3**
T5	Unavailability of safe working environment at construction site.	3.45	**5**
T6	Unavailability of safe working environment at construction site.	3.42	**6**

Fig. 9 – Ranking of Top Management Level Chart

FRIEDMAN TEST FOR TOP MANAGEMENT LEVEL

Table 8 – Friedman Test for Top Management Level

Test Statistics, a	
N	104
Chi-Square	3.245
df	5
Asymp. Sig.	0.046
a. Friedman Test	

The above table shows the Friedman test for T (contributing factor 1) and P (Major Issue 1), where the $\chi 2$ values relative to the degrees of freedom are calculated. The results revealed that $\chi 2(2) = 3.245$ with a p value of 0.046. A significance level (p-value) less than or equal to 0.05 indicates the acceptance of Hypothesis 1.

6.5.2 Supervisor Ranking:

Table 9 – Ranking of Supervisor Level

Supervisor Ranking			
Code	**Attributes**	**Score**	**Rank**
S1	Not conducting safety training periodically	3.50	**3**
S2	Lack of Safety Inspection/Supervision at Construction Site	3.58	**1**
S3	Lack of addressing of safety issues related to workers	3.47	**4**
S4	Engaging of Unskilled Labours	3.45	**5**
S5	Improper Housekeeping.	3.44	**6**
S6	Lack of Proper Safety Guidelines	3.55	**2**

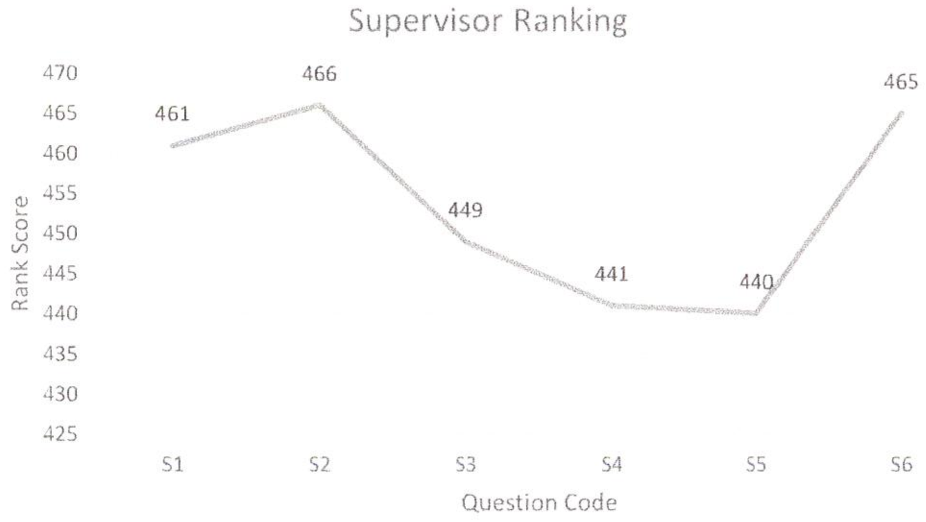

Fig. 10 – Ranking of Supervisor Level Chart

FRIEDMAN TEST FOR SUPERVISOR LEVEL

Table 10 – Friedman Test for Supervisor Level

Test Statistics, b	
N	104
Chi-Square	3.221
df	5
Asymp. Sig.	0.047
b. Friedman Test	

The above table shows the Friedman test for T (contributing factor 2) and P (Major Issue 1), where the $\chi 2$ values relative to the degrees of freedom are calculated. The results revealed that $\chi 2(2) = 3.221$ with a p value of 0.047. A significance level (p-value) less than or equal to 0.05 indicates the acceptance of Hypothesis 2.

6.5.3 Workers Level Ranking:

Table 11 –Ranking of Workers Level

Worker Ranking			
Code	**Attributes**	**Mean Rank**	**Rank**
W1	Lack of usage of PPEs	3.66	**2**
W2	Unsafe acts of Workers	3.44	**6**
W3	Poor Work Methodology	3.59	**3**
W4	Carelessness of Workers	3.84	**1**
W5	Communication Gap Between Workers and Supervisors	3.47	**5**
W6	Conflicts between Workers	3.51	**4**

Fig. 11 – Ranking of Workers Level Chart

FRIEDMAN TEST FOR WORKERS LEVEL

Table 11 – Friedman Test for Workers Level

Test Statistics, c	
N	104
Chi-Square	3.199
df	5
Asymp. Sig.	0.049
c. Friedman Test	

The above table shows the Friedman test for T (contributing factor 3) and P (Major Issue 1), where the $\chi2$ values relative to the degrees of freedom are calculated. The results revealed that $\chi2(2) = 3.199$ with a p value of 0.049. A significance level (p-value) less than or equal to 0.05 indicates the acceptance of Hypothesis 3.

7. RESULTS AND INFERENCE

From the recorded observations, the top ranked factor for Top Management Level is "Lack of importance towards safety measures from management". The top ranked factor for the Supervisor level is "Lack of Safety Inspection/Supervision at Construction Site". The top ranked factor for the Workers level is "Carelessness of Workers".

It is also concluded that the hypothesis assumed that the Top Management Level, Supervisor Level and Workers Level is proven to be true towards the Major Issue, i.e. Barriers to Implementation of Safety Practices.

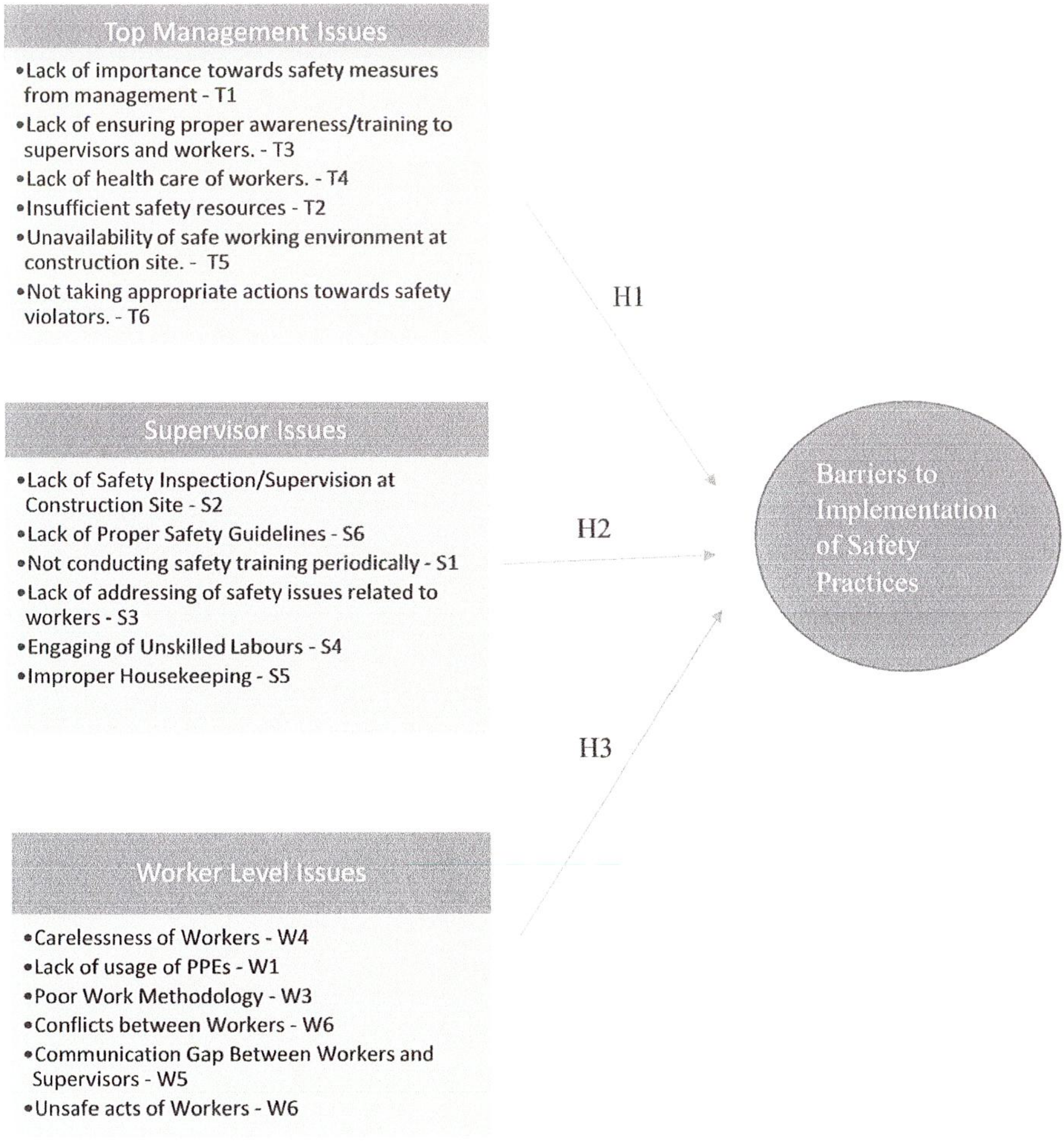

Fig. 12 - Model representing the relation between contributing factors and the major issue conducted by this study.

8. CONCLUSION AND RECOMMENDATIONS

Through a literature review and focused interview, this study identified the various factors that serve as a barrier to the implementation of safety practices. A total of 18 attributes grouped under 3 categories were identified. The three factors identified at the top rank in each category are "Lack of importance towards safety measures from management, "Lack of Safety Inspection/Supervision at Construction Site", "Carelessness of Workers".

The Management Personnel of any company can look into these factors and identify the issues in the implementation of safety practices. Furthermore, this study is separately conducted for each category of workers in the construction industry.

REFERENCE

1. Zhao Ying, (2004) "Effective Safety Management in Construction" – National University of Singapore
2. Wahyu Rachmayanti, Putri Arumsari, (2010) "Implementation of Safety Management through Review of Construction" - IOP Conf. Series: Earth and Environmental Science 794012010, doi:10.1088/1755-1315/794/1/012010
3. Saurav Dixit, Amit Kumar Pandey, Satya N Mandal, Sanjeev Bansal, (2017) "Saftey Practices in Ralway Civil Engineering Construction Projects" - International Journal of Civil Engineering and Technology (IJCIET), Volume 8, Issue 6, June 2017
4. Serdar Durdyev, M. Reza Hosseini, (2018) "Implementation of Safety Management System for Improving Construction Safety Performance: A Structural Equation Modelling Approach" - International Journal of Managing Projects in Business, DOI: 10.1108/IJMPB-09-2018-0178
5. Mbuyamba Mbala Jean Paul, Clinton Aigbavboa, John Aliu, (2019) "Barriers to safety program implementation in the construction industry"

QUESTIONNAIRE SURVEY FORM

QUESTIONNAIRE SURVEY

Dear respondent Respondent no:

The following statements corresponds the factors that serve as a barrier for implementation of Safety practices.

S.No	QUESTIONS	Highly Disagree	Disagree	Neither Agree nor Disagree	Agree	Highly Agree
		1	2	3	4	5
	Management level					
1	Lack of importance towards safety measures from management					
2	Insufficient safety resources					
3	Lack of ensuring proper awareness/training to supervisors and workers.					
4	Lack of health care of workers.					
5	Unavailability of safe working environment at construction site.					
6	Not taking appropriate actions towards safety violators.					
	Supervisor level					
7	Not conducting safety training periodically					
8	Lack of Saftey Inspection/Supervision at Construction Site					
9	Lack of addressing of safety issues related to workers					
10	Engaging of Unskilled Labours					
11	Improper Housekeeping.					
12	Lack of Proper Saftey Guidelines					
	Workers level					
13	Lack of usage of PPEs					
14	Unsafe acts of Workers					
15	Poor Work Methodology					
16	Carelessness of Workers					
17	Communication Gap Between Workers and Supervisors					
18	Conflicts between Workers					

PERSONAL INFORMATON

Organisation:	
Name of the respondent:	
Designation:	
Age (in years):	18–30 31–40 41–50 More than 51
Work experience:	Less than 5 / 6-10 / 11-15 / 16-20 / More than 21
Employee level:	Management level Supervisor level Worker level