INVESTIGATION OF CEREMIC WASTE AND RUBBER TIRE WASTE AS A POTENTIAL MATERIAL FOR EMBANKMENT CONSTRUCTION

A

PROJECT REPORT

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

of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

Under the supervision

Of

DR Saurabh Rawat

Assistant Professor

by

ANMOL KATNA (171630)

SHUBHAM THAKUR (171623)

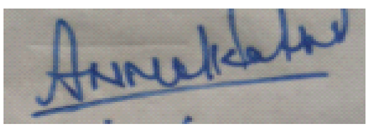
TO

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

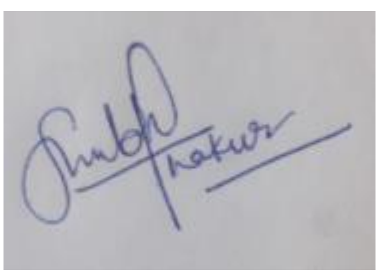
WAKNAGHAT, SOLAN – 173234 HIMACHAL PRADESH, INDIA MAY 2021

<u>STUDENT'S DECLARATION</u>

We hereby declare that the work presented in the Project report entitled "***Use of waste product while construction of embankment***" submitted for partial fulfillment of the requirements for the degree of Bachelor of Technology in Civil Engineering at **Jaypee University of Information Technology, Waknaghat** is an authentic record of our work carried out under the supervision of **DR Saurabh Rawat** . This work has not been submitted elsewhere for the reward of any other degree/diploma. We are fully responsible for the contents of our project report.



Anmol katna (171630)



Shubham Thakur (171623)

Department of Civil Engineering

Jaypee University of Information Technology, Waknaghat, India

16 MAY 2021

CERTIFICATE

This is to certify that the work which is being presented entitled, "***Use of waste product while construction of embankment*"** in fulfillment of the requirements for the award of the degree of Bachelor of Technology and submitted in Civil Engineering Department, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by **Anmol katna (171630) and Shubham Thakur (171623)** during a period from December 2020 under supervision and guidance of **Dr Saurabh Rawat** Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

16MAY 2021

Dr saurabh Rawat
Assistant Professor Professor
department of
Department of civil engeerneering
Juit, waknaghat.

HOD
CE DEPT

Dr. Ashok Kumar Gupta,
professor and head of
civil engeneering
Juit , waknaghat.

AKNOWLEDGEMENT

We extend our deep sense of gratitude and indebtedness to our guide Dr. Saurabh Rawat Department Of Civil Engineering, University of Information Technology, Waknaghat for his kind attitude, invaluable guidance, keen interest, immense help, inspiration and encouragement which helped us in carrying out our present work. We are grateful to our parents who patiently helped us as we went through our work and helped to modify and eliminate some of the irrelevant or un-necessary stuffs. It is a great pleasure for us to acknowledge and express our gratitude to our classmates and friends for their understanding, unstinted support. Lastly, we thank all those who were involved directly or indirectly in completion of the present seminar work.

ABSTRACT

The aim of this analysis is to assess the use in the construction of road embankment of waste ceramic tiles as raw material in the soil. The ceramic tiles may be used instead of disposal in landfill applications in highway engineering so that their possible environmental effect is reduced and the pavement's design thickness can decrease substantially. The mixtures prepared with ceramic waste tiles and low-plasticity clay (CL) soil were subjected to California Bearing ratio (CBR), nonconfined compressive strength (UCS), compaction and swelling tests. Mixtures of ceramic waste were 0%, 5%, 15%, 20% and 30% by dry weight of specimens. The mixtures included wastes. The test results have shown that adding ceramic waste tiles raises the soil's CBR benefit, while adding them decreases its UCS. In addition, in various measurements according to the report we read from the google scholar there has been an improvement in the weight of the dry unit and a reduction in the related water content (w). Moreover, the test results reveal a drop in the vacuum ratio (e) as the volume of waste ceramic tiles increases. similarly we done the same procedure with rubber tire waste also .But here percentage of waste by weight measured was 0, 2, 4, 6, 8% by weight . Some general properties were concluded like c,phi vale void ratio, dry unit weight were concluded when the waste get mixed with thw soil. As the general properties get changed when waste was added.

LIST OF ACRONYMS AND ABBRIVATIONS

KN	KILO NEWTON
KN/m2	Kilo Newton per meter square
KN/m3	Kilo Newton per meter cube
M	Meter
CBR	CALIFORNIA BEARING RATIO
E	Void ratio
C	COHESION VALUE
Phi(φ)	Angle of friction

TABLE OF CONTENTS

1. INTRODUCTION

1.1 GENERAL.

In this report we have covered the basic information on how the ceramic tile waste and rubber tire waste is used as a raw material in the soil of the road embankment and modify its properties and compare it with the normally designed pavement using plaxis 3d software. Different properties like unit weight , void ratio, poisons ratio, angle of internal friction, cohesion value were determined and hence these values were entered in the software and hence the output was being obtained .

Firstly question arises what is road embankment?

A **road**, an **embankment** is a bank of earth that is used to carry the road or railway over an area of low ground ie made of compacted soil to avoid a change in level required by the terrain, the motive is to have an unacceptable change in level or detour to follow a contour.

Now Plaxis 3d is a complete 3D pre-complete geotechnical finite element software for the import and processing of CAD structures in a geotechnical setting.

1.1 Plaxis 3d:-

The PLAXIS 3D is a geotechnical finite element package that includes a complete 3D pre-processor that enables the geotechnical processing and import of CAD artefacts. The programme, including plastic static deformations, advanced soil models, stability analysis, consolidation and protection analysis, is provided as a comprehensive kit.

The PLAXIS 3D features different facets of dynamic geotechnical systems and building procedures. For the simulation of the non-linear, timely and anisotrope behaviour of soils and/or rocks, advanced constitutive models are needed for geotechnical applications.

As the land is a multi-phase substance, it often needs special techniques to treat hydrostatic and non-hydrostatic soil pore pressures. While soil modelling is a significant matter, many projects include structural modelling and the relationship between the structures and the soil.

Finite element modeling was never easy in 3D before this application hot the market. It provides a very wide variety of CAD like drawing tools and operations like extrude, intersect, combine and array operations. It has been equipped with a very user friendly interface which will guide you to efficiently create models with the logical geotechnical workflow. It allows you to import the geometry from CAD files.

1.2 INTRODUCTION TO CERAMIC WASTE

Many developed nations have vast waste supplies, including ash, stone stains, plastic, glass, pneumatic rubber, metal parts, and various types of building materials. The best waste content within construction and demolition waste is the ceramic materials that include ceramic tiles and different ceramic products.

Nowadays disposal of assorted wastes created from completely different Industries could also be an excellent drawback.

This products are not biologically degradable, which creates environmental waste inside the near neck of the wood.

Company waste solutions in several developed and developing countries are being thought about in recent years in construction with a pleasant concern.

The use of these materials in the production of roads depends on technological, economic and environmental factors. The Republic of India opts for an outsized industry network in several parts of the country and a lot is expected for the near future.

In these establishments are produced several million metric tonnes of toxic waste. If these materials are usually used in road building properly, the problems of waste and disposal can also be minimized in part.

The doable use of these materials ought to be developed for the construction of low-volume roads in many components of our country. within the ceramic business, regarding 15%-30% waste generated from the complete production. In road transportation, the road is typically differentiated functionally and structurally.

In some cases, multi-faceted paving is most common because of the flexible flooring, material and constructive value, and this material can be obtained regionally. It is generally simply developed, retained and updated at the constant time. The ceramic waste studies will check whether it can be used in building or not.

Moreover, the valuation of a building will be reduced and the notification of the environment disadvantages caused by the disposal of industrial waste could increase, other than this report.

- **Ameta and Wayal(2013)**

  Both of them attempted to use ceramic waste to stabilize sand dunes. They discovered that as particle size grows, the value of C.B.R of the mix composition increases. The C.B.R value varied depending on the level of tire waste. They also discovered that the rise in C.B.R value occurred more frequently in Unsoaked conditions and less frequently in soaked conditions. In addition, the angle of internal tension varied as the size of ceramic tile waste in the composition became larger.

- ***Babita Singh and Ravi Kumar(2014)***

In a ratio of 63:27:10:9:0.5 they combine the soil with sand, fly ash, tile waste and jute fibres. The highest dry density in the mixture of clay sand fly ash reduces with increasing content of fly ash while the best humidity increases with increasing content of fly ash.

1.3 INTRODUCTION TO RUBBER TIRE WASTE:-

Disposing various waste generated in various industries nowadays is a big issue. This products pollute the surroundings and there are many non-biodegradable in the surrounding area. The traditional usage for road building is clay, stone aggregates, sand, bitumen, cement etc.

The vehicle growth rate is the bedrock of a country's economic development. India is the world's second fast-growing car market.

In the present day, the thrust field is solid waste management. The volume of traffic is also growing on the other hand. This further increases the volume of waste pipes.

The increasing use of waste pneumatic has caused many issues, including increased site of waste landfills, environmental contamination and health risks. Around the same time, as a result of heavy road traffic, roads have been expanding.

More than 15 million waste tires are produced per year in India. These pneumatic mounds are not only eyesight’s, but are both environmental and health risks. The small water pools contained by waste pipes provide an excellent breeding ground for mosquitoes.

Apart from the constant molestation, there are other deadly viruses that mosquitoes have transmitted. Tire fires, which pollute the air with large amounts of carbon smoke, hydrocarbons and residues, are equally dangerous. These fires can hardly be extinguished until they have begun.

Currently, burns for electricity generation, concrete processing in cement kilns, pulp and paper mill power and recycling of pneumatic energy plants are the only wide-ranging approaches for waste tires. In 1990, the Agency for Environmental Protection (ESP) reported that 78 percent of tires were either stored, filled in or illegally dumped of the 242 million waste tires produced that year.

Although some countries burn waste pipes this is just a temporary solution due to pipes, it seems to float back up to the surface in many situations. Land waste tyres are often more costly as the waste area has fallen.

2. LITERATURE REVIEW

2.1 General

As per the literature review we studied different literatures or the documents that consists of different cases where ceramic tile waste and rubber tire waste used as a raw material in the embankment construction. So we received different important observations in the various articles we reviewed, in which waste percentage was used from 5 to 30 percent in weight and for tire waste 2 to 8 percent by weight is used. A basic compaction test was conducted following the procedures outlines of ASTM D698 for the water content-dry unit weight relationships between clean CL and CL with separate residual ceramic tile contents. In Figure 4, the water content-dry unit weight ratios of the compacted mixtures are shown. With the increased ceremic waste tile contents from 0 to 30%, the overall unit weight of the measured mixtures ranges from 17 to 18.4 kN/m3.The reason of such increment is due to replacement of waste ceramic tile grains having higher specific gravity with soil grains having relatively low specific gravity. However, the optimum water content values decrease from 17% to 12.7% with increasing waste ceramic tile content from 0% to 30%.

Both vast soil samples were mixed by weight with varying volumes of tiled waste. The mean dry density of the experiments increases by 30% from 15.5kN/m3 to 16.11kN/m3 and decreases by 15.5kN/m3. However, the amount of water is constantly decreasing.

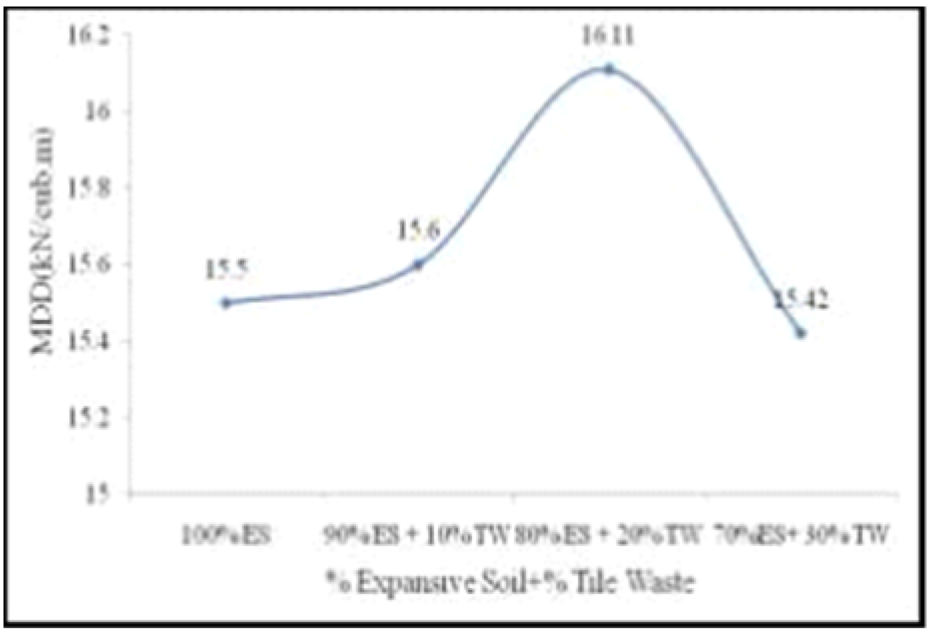
A series of laboratory experiments were carried out to investigate the impact of tile waste on an enormous soil's liquid limit, plastic limit, MDD, OMC, soaked CBR, and swelling strength. The following conclusions are taken from this analysis based on the findings.

• The liquid and plastic limits are diminishing regardless of the percentage of tile waste added.

• At 20% tile waste, the Maximum Dry Density is achieved, and the OMC decreases as the percentage of tile waste increases. • As the percentage of tile waste added increases, so does the soaked CBR. When 30% tile waste is applied, the soaked CBR value increases by 105 percent when compared to untreated dirt.

. • The swelling pressure goes on decreasing with addition of tile waste. There is 48 % decrease in swelling pressure of soil as compared to untreated soil, when 20%tile waste was added. From the above analysis it is found that tile waste up to 20% can be utilized for strengthening the expansive soil of flexible pavement with a substantial save in cost of construction

.



MAXIMUM DRY DENSITY WITH PERCRNTSGE TILE WASTE

2.2 CHANGES IN PROPERTIES DUE TO CERAMIC WASTE

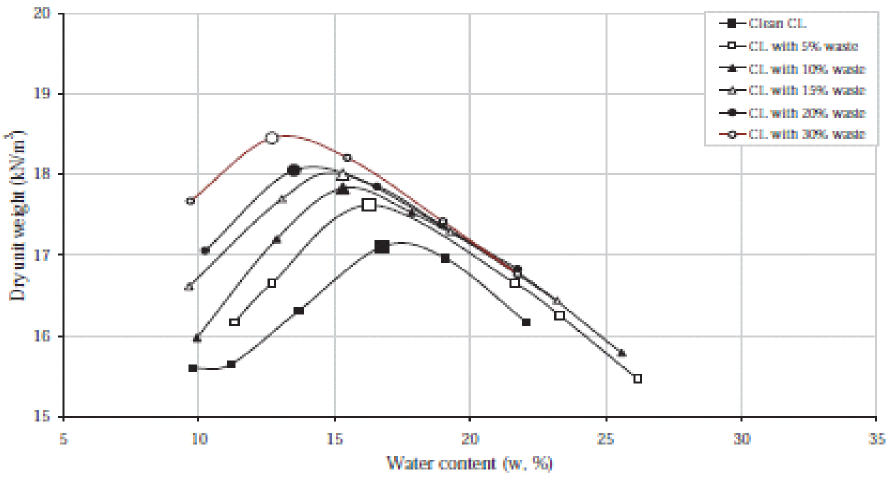


Figure 4. Standard proctor compaction curves of the specimens at different mix ratios.

This graph shows us that when the percentage of waste increases the optimum water content decreases.

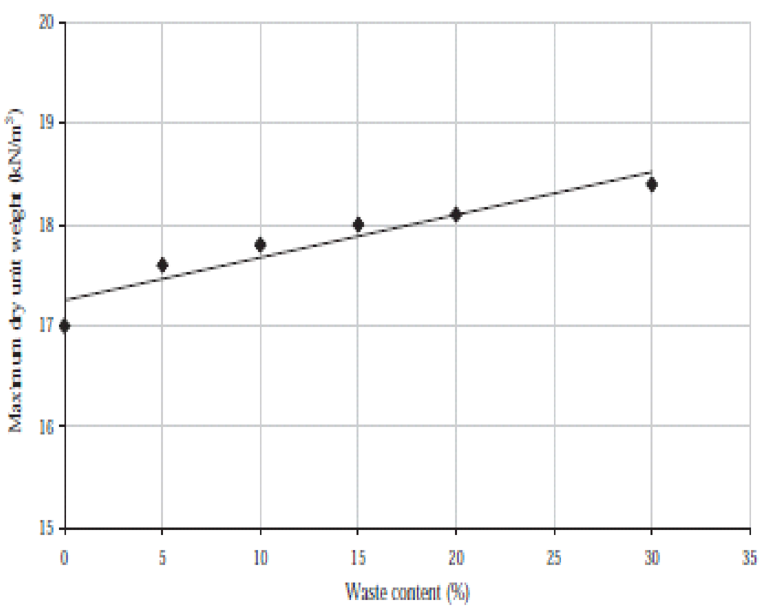


Figure 5. Variation in the maximum dry unit weight and waste ceramic tile grains content.

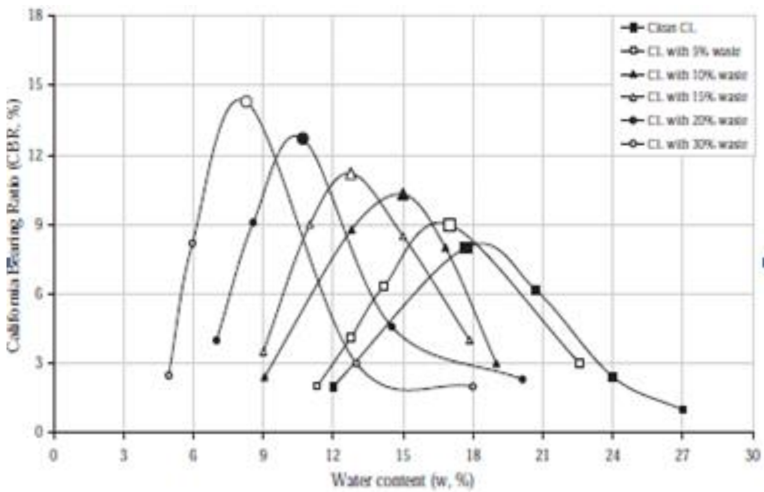
This tells us maximum dry unit weight obtained when the percentage of waste content is 30 % is 18.45(kN/m3).

Maximum dry unit weight-

It is highest density of the soil in the driest state. The maximum dry unit weight is known using laboratory method for the standard proctor test.

Optimum Moisture Content:

Water content at which a soil can be compacted by a certain compactive effort to the maximum dry unit weight. The maximal water content is also named.

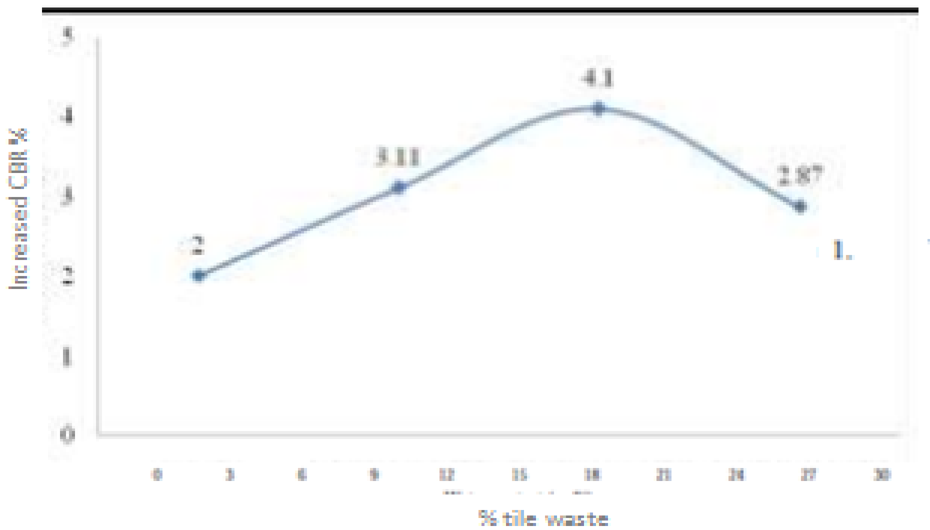


Maximum value of California bearing ratio (CBR) is obtained when the waste percentage used is 20% and the optimum water content is minimum.

California Bearing Ratio-

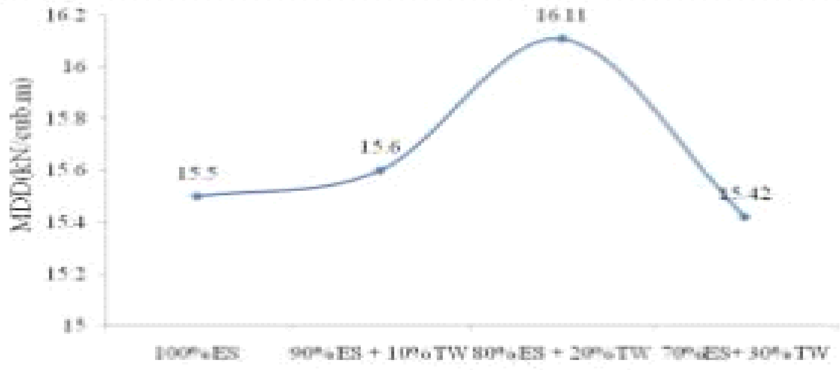
A penetrations measure used to assess the strength of the roads and the pavements in the Californian Bearing Ratio (CBR) test.

Variation of CBR % WITH PERCENTAGE TILE WASTE



The CBR continues to rise with the inclusion of tile waste percentage. Compared to untreated soil there is a 4.1% rise in CBR value by adding 20% tile waste.Then it decreases

VARIATION OF MDD(MAXIMUM DRY DENSITY) WITH% TILE WASTE

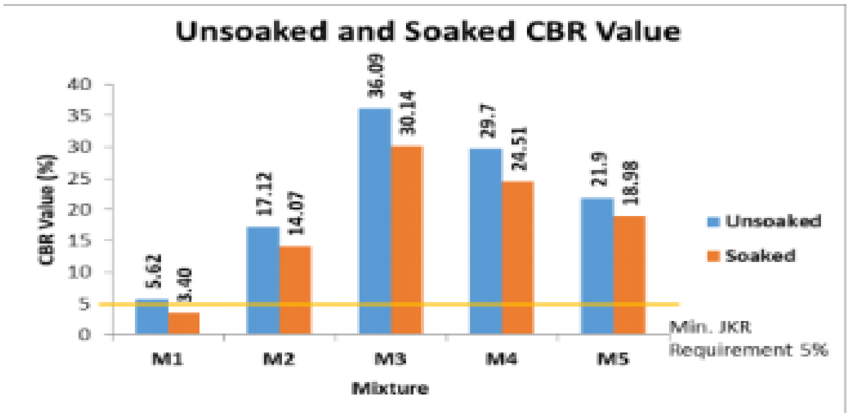


The Maximum Dry Density attained at 20% tile waste and OMC goes on decreasing with increase in percentage of tile waste.

CHANGE IN GENERAL PROPERTIES WHEN TILE WASTE ADDED TO SOIL.

Cohesion value(c)	15KN/m2
Angle of internal friction(phi)	22*
e(void ratio)	0.5
Poisson value	0.35
Specific gravity	2.61

2.3 CHANGES IN PROPERTIES DUE TO RUBBER TIRE WASTE:-



CBR test will be performed for soaked and Unsoaked condition with the load measuring device.

Mixture	Percentage Mixture (%)		Average CBR Value (%)	
	Soil	Crumb Rubber (CR)	Unsoaked	Soaked (4 days)
M1 (control sample)	100	0	5.62	3.40
M2	98	2	17.12	14.07
M3	96	4	36.09	30.14
M4	94	6	29.70	24.51
M5	92	8	21.90	18.98

4% of rubber waste is advisable for soil stabilization according to information. From the obtained findings, it is inferred that the soil strength had been improved by industrial waste of crump rubber. As in the case of an unsoked state we get more CBR percent because we waste dry waste.

Cohesion value(c)	9.5KN/m2
Angle of internal friction(phi)	26*
e(void ratio)	0.5
Poisson value	0.35
Specific gravity	2.66

3. METHODOLOGY

3.1 GENERAL INPUT

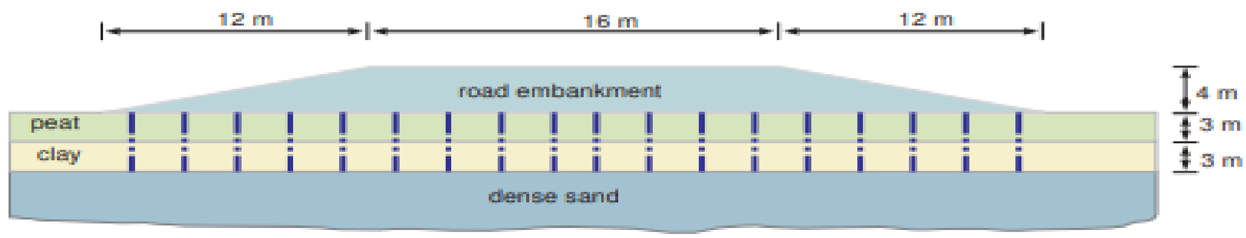
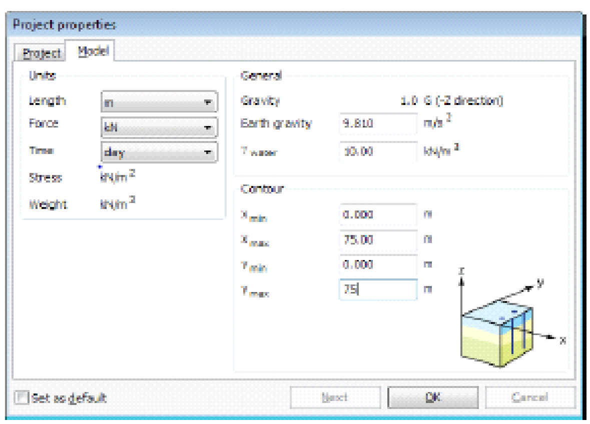


Figure 4.1 Situation of a road embankment on soft soil

The following structure of embankment was taken into account.

- **Project properties :**



Enter the title of the project and settlement of the foundations in the comment box.

In the unit box, maintain the default units. In the box of the contour group, define the boundaries of soil: xmin=0, Xmax =75; ymin=0 and Ymax =75. The framework is provided below.

2.*<u>Soil mode:</u>*

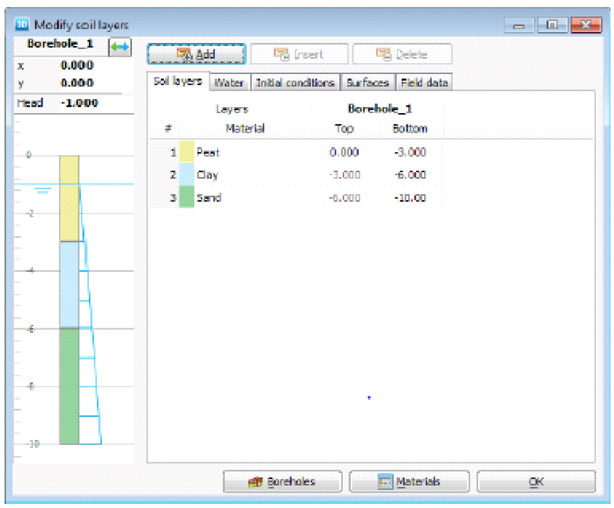
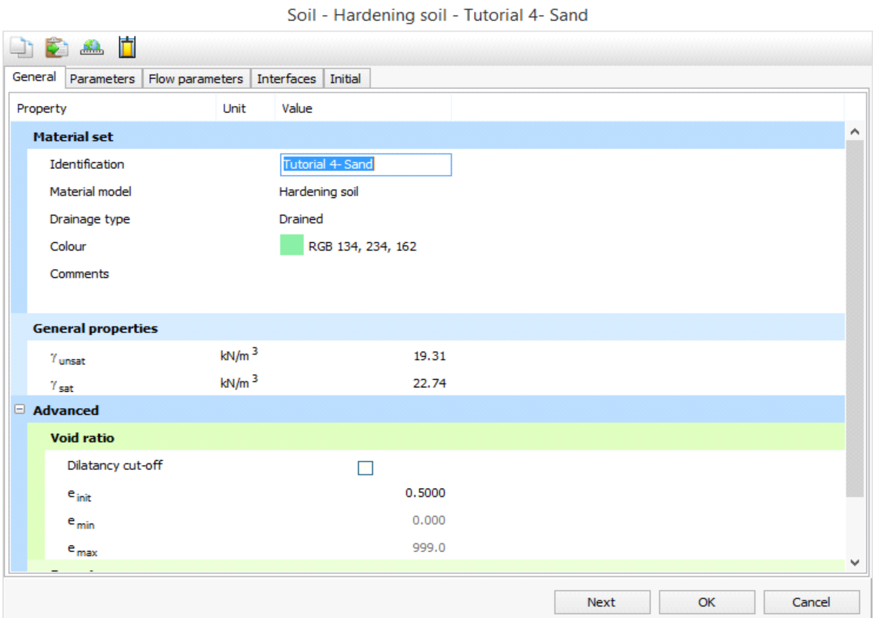


Figure 4.2 Soil layer distribution

Soil material data was set and the data was assigned in the corresponding layers in the bore holes. Before proceeding further set the general properties and certain parameters according to the project. As the general properties changes as compare to the default properties set by the plaxis 3D software because the properties set were according to the ceramic waste properties, when tile waste id added in the soil. For eg there is increase in the unit weight, and chnge in many other properties like c-phi value, angle of internal friction, void ratio and poission's value. As given the fig.



Structure mode:

In the structure mode, the embankment and drains are described.

All the time the model is reorientated and the front view is displayed for proper understanding. At the points (0 0 0), (0 0 4), (8 0 4) and (20 0 0) a surface is created, also a line passing through the points (0 0 2) and (14 0 2) in the embankment layers is drawn , hence the object is excluded and at the y component 2 value is assigned of the extrusion vector as showing in the figure below.

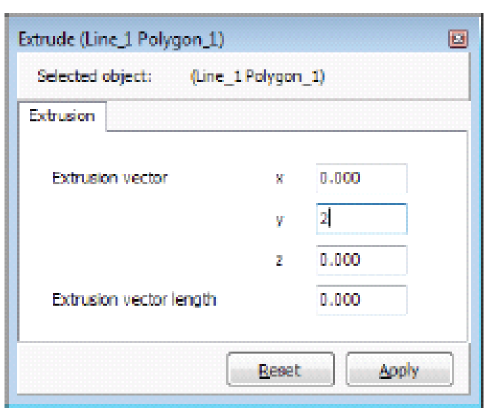
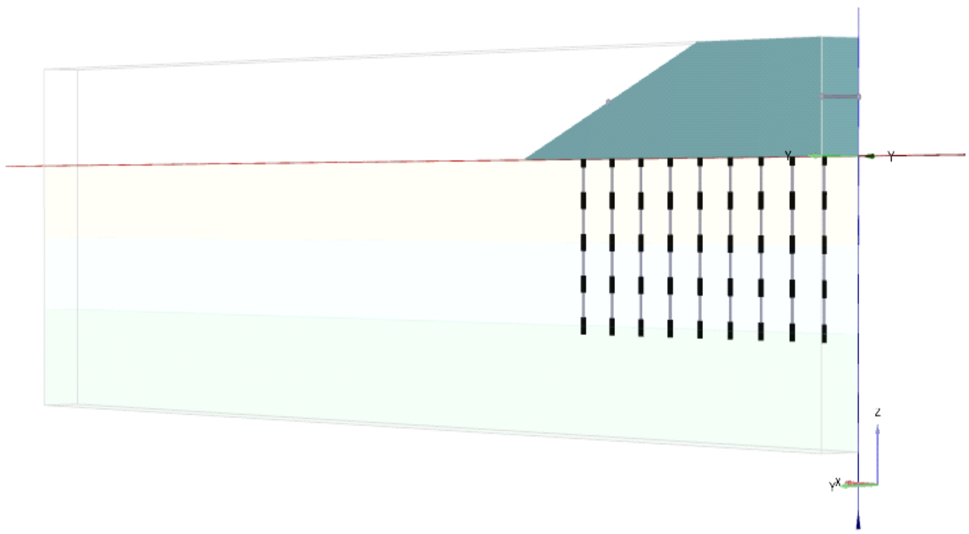


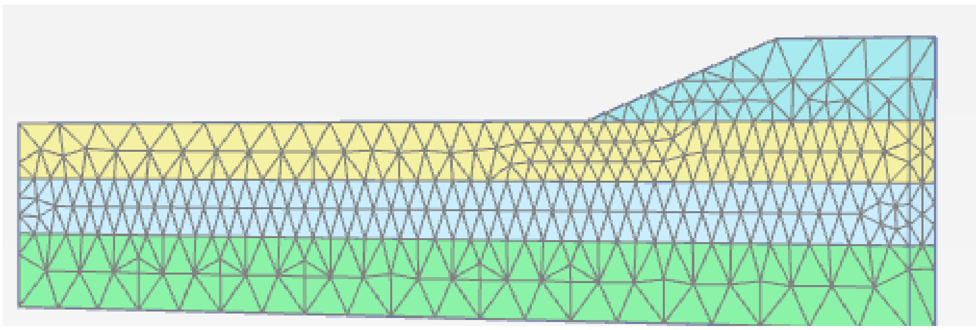
Figure 4.3 *Extrusion* window

Crate the hydraulic conditions from the side toolbar and line drains from the menu and define the line drains between the points (1 1 0) and (1 1 -6) and finnaly the create the drain pattern from the create array button. Hence the following image appears on the input screen.



Mesh generation:

In the mesh generation we set the element distribution to coarse. As after proceeding to the mesh mode the generate mesh button was clicked and hence the mesh generation take place. As the the output of generated mesh is obtained as given in the figure below.

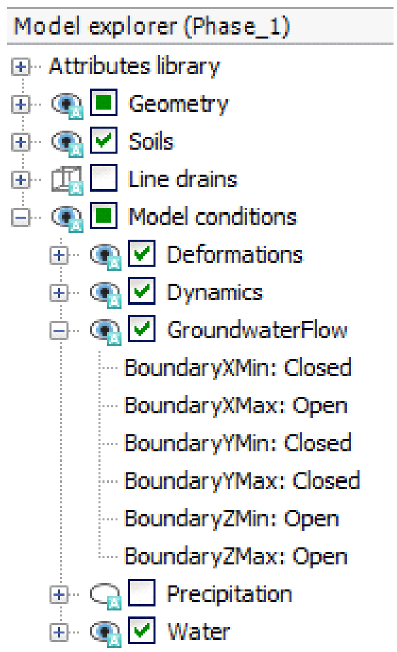


Calculation Process:-

The embankment construction process will considered twice. In the first calculations we will not considered drains.

- ## **Initial phase:-**

  Initially the embankment is not present. Hent there is no soil volume in the initial phase. there is fully hydrostatic initial water pressure and based on the general pheratic level defined by head value assigned to the boreholes. Finally the boundary conditions can be applied in the model condition subtree in the model explorer.



- ## **Consolidation analysis :-**

Here the dimension of time period is introduced for the analysis of the consolidation in the calculation. In order for the consolidation to be properly performed the proper time step must be selected. The plaxis software allows the proper time stepping procedure in the consolidation option which takes the critical time step into the account5.

No drain consolidation process

As the rear building is divided into two stages. The first building has a consolidation period of 30 days, allowing the excess pore pressure to be drained. Following the second phase of development, a new period of consolidation is entered for determining the final saturation. There would then be four steps of estimation.

Phase 1:-

The first is added from the add phase option. The loading type is set by default to the staged construction. In the pheratic option is automatically selected and the global water level for the calculation phase can e defined in the water sub tree available under the water condition in the model explorer. The 2 days value is specified in the time interval. Hence the first part of the embankment is activated by in the staged construction mode .

Phase 2:-

It is also a consolidation analysis. As no changes in the geometry are made but the only thing is that the ultimate time is required for the consolidation analysis. As 30 days time interval was being kept and rest the value of other parameters were kept by default.

Phase 3:- In this phase the 1 day value to the time interval was being specified and the other parameter were kept by default as set the software. The second part of the embankment is activated in staged construction mode.

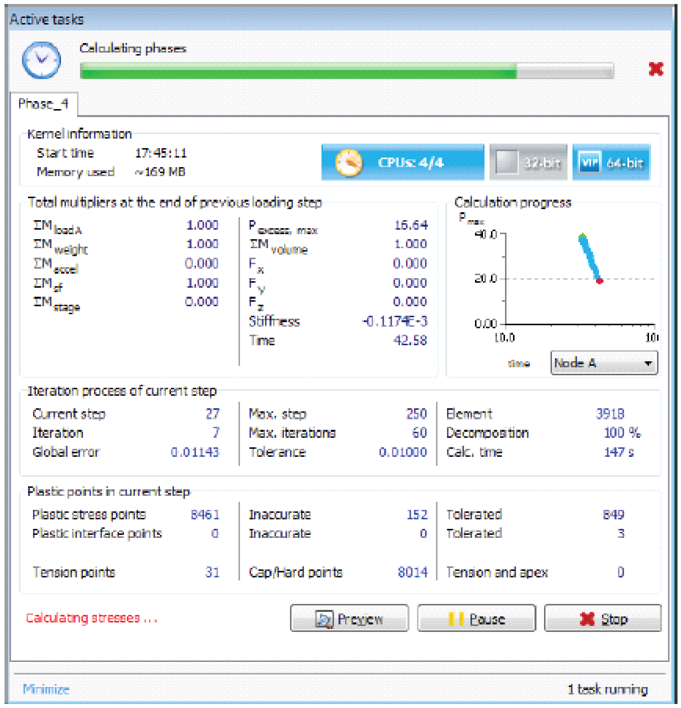
Phase 4:-

This phase is just to minimise the pore pressure by selecting the minimum pore pressure option in the loading type drop-down menu. The default values were kept to mentain the minimum pressure and the calculation phase gets completed.

Calculation process:

The window given below in the calculation window the calucates all the parameters inserted in different phases and hence provides the output of the input material. The value Pmax indicates the current maximum pore pressure.

This parameter is of the interest in case of minimum pore pressure consolidation analysis.



safety analysis:-

It is necessary not only to remember the final stability, but also the stability during the construction when designing an embankment. After a certain construction process the fallible structure still begins to form.

At this stage of the issue and even in other building phases it is often necessary to determine the global safety element. The security factor is essentially defined as the operating load ratio to the collapse load.

For embankments, much soil weight is responsible for loading and soil weight increases may not generally cause a failure. The safety factor is theoretically

safety factor = S maximum available/S needed for equilibrium

"S" represents the shear strength.

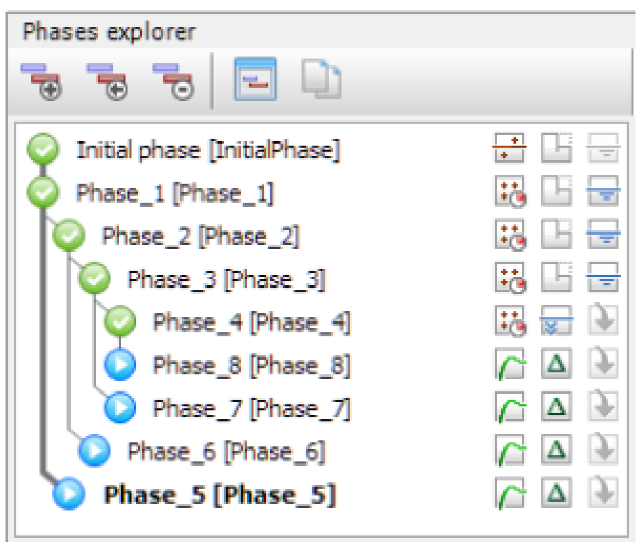
Ratio of the true strength to the computed minimum strength required for the equilibrium is the safety factor that is conventionally used.

$$\text{Safety factor} = \frac{c - \sigma_n \tan\varphi}{c_r - \sigma_n \tan\varphi_r}$$

Where c and φ are the input parameters and σ_n is the actual stress component where as c_r - and φ_r are the reduced strength parameters that are just large enough to mentain equlibrium.

As mentioned above, the fundamental safety analysis used in PLAXIS is the global safety factor calculation.

The reduction of strength parameter is controlled by total multipier i.e. ΣMsf . This parameter increases in step by step procedure until faliure occour. The safety factor is defined as the value of ΣMsf at faliure.

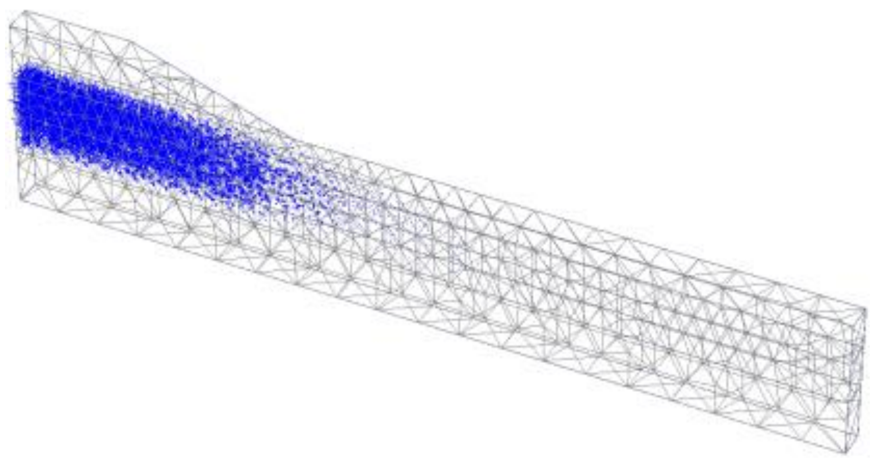


safety explorer displaying the safety calculation phases.

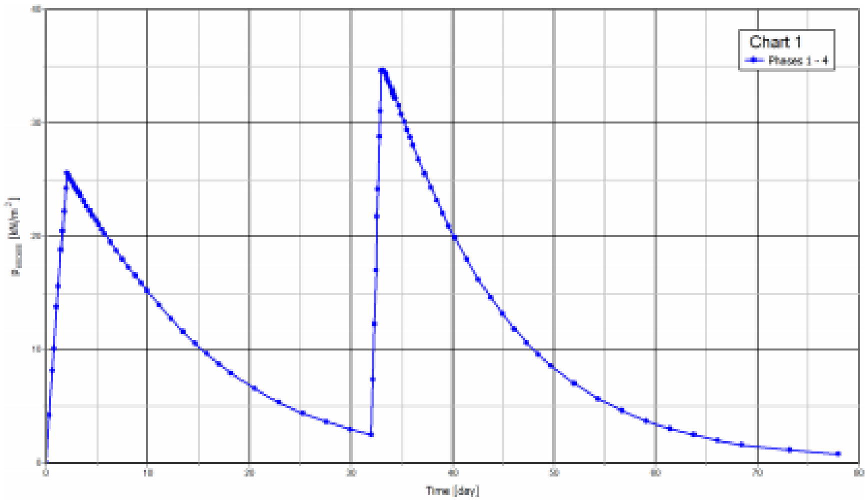
The safety factor can be obtained from the calculation info option from the project menu. The value of ΣMsf represents the safety factor.

<u>3.2 General Result output:-</u> **(with standard properties in plaxis)**

****Figures and graphs obtained***



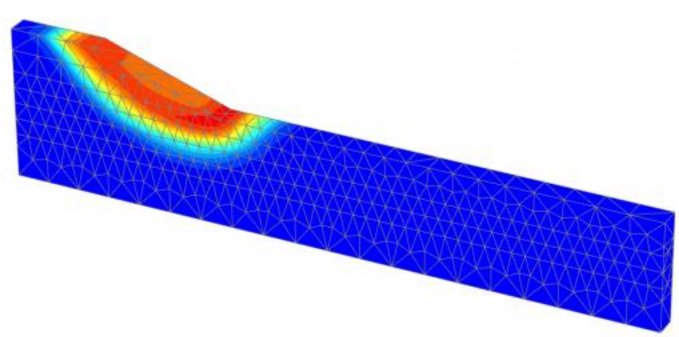
Here we can see the under the embankment or under the load there is excess pore pressure. This blue portion indicates the max and minimum value of excess pore pressure and as the pressure is applied downwards for the consolidation so Pexcess is considered negative.



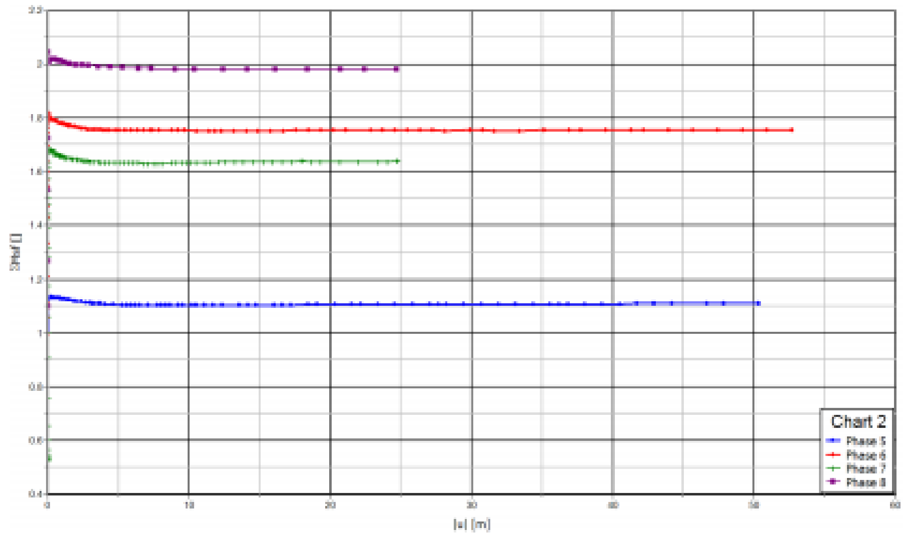
development of excess pore pressure under the embankment

As from this curve we can conclude that the excess pore pressure has been increases for 2 days and then we let it to consolidate for some about some days shown in the graph. Then again the excess pore pressure starts increasing and we let it to consolidate until the Pexcess ie excess pore pressure reaches to 1 or unity.

safety factor:-



This general plot gives a good impression of the failure mechanisms. The magnitude of the increment displacement is not relevant.



In the above graph it is clear that when the phase gets fully consolidated the safety factor is very large. As according to the general graph phase 8 is fully consolidated, so the chances of failure is very less and safety factor is more as compare to all the phases.

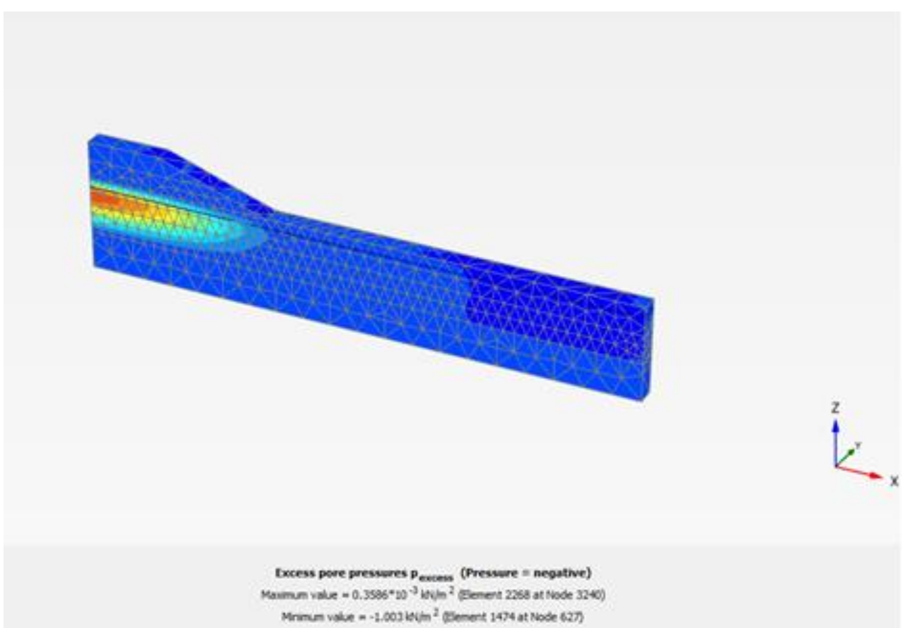
4. DISSCUSSION AND RESULTS

As according to the information studied earlier we concluded that we are constructing the road embankment using 2 different kind of waste ie ceramic tile waste and tire waste. As the soil properties in two different cases naturally were different from each and also different from the default properties there in the software. The properties like c-phi value, e, dry unit weight, specific gravity were taken into the account. Hence after applying these properties in the software we concluded the differences in 2 different cases in the form of consolidation analysis, excess pore pressure, safety analysis. These change in the properties come in the the theoretical differences concluded from the research papers. As some differences like CBR%, dry unit weight, dry density were concluded.

*__Given below is the output we obtained using in 2 difference cases.__

4.1 ***<u>For ceramic tile waste</u>***

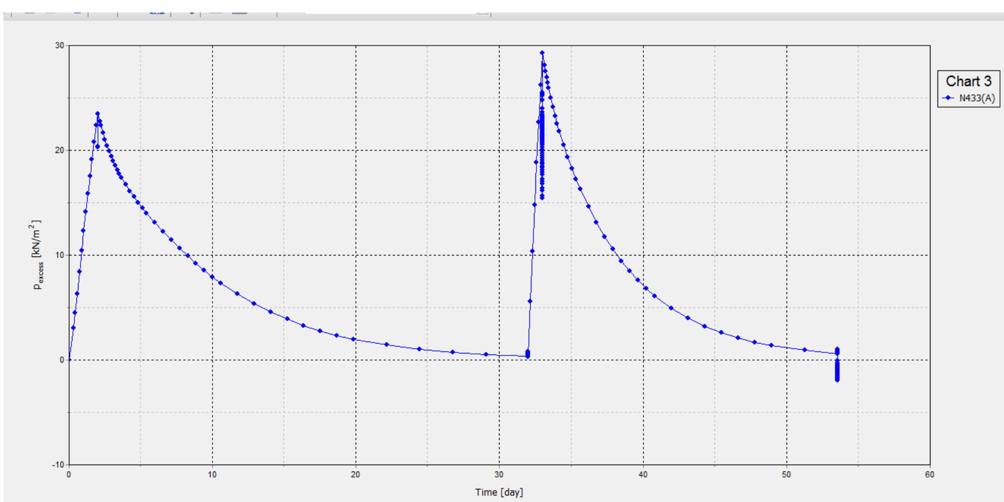
<u>Consolidation analysis :-</u>



As this above figure shows the minimum and maximum excess pore pressure which is totally related to the consolidation analysis that is for **phase 4 i.e. fully consolidated phase**. As we can see that under the embankment or under the load the excess pore pressure exists. As it is to be noted that with the soil getting more consolidated the excess pore pressure gets decreases and when the phase gets fully consolidated we get the minimum excess pore pressure value. Minimum Pressure = negative doesn't means that pore pressure in negative, as when load is applied and keeps on increasing under the consolidation analysis value of pore pressure comes down in the graph which is drawn vs time as given below. Also consolidation analysis means decay of excess pore pressure with time. Hence we can say pressure = negative with the statement written above. As in the given figure for the current phase i.e. phase 4 maximum value of excess pore pressure.

Maximum value of excess pore pressure = 0.3586 * 10^-3 KN/m2

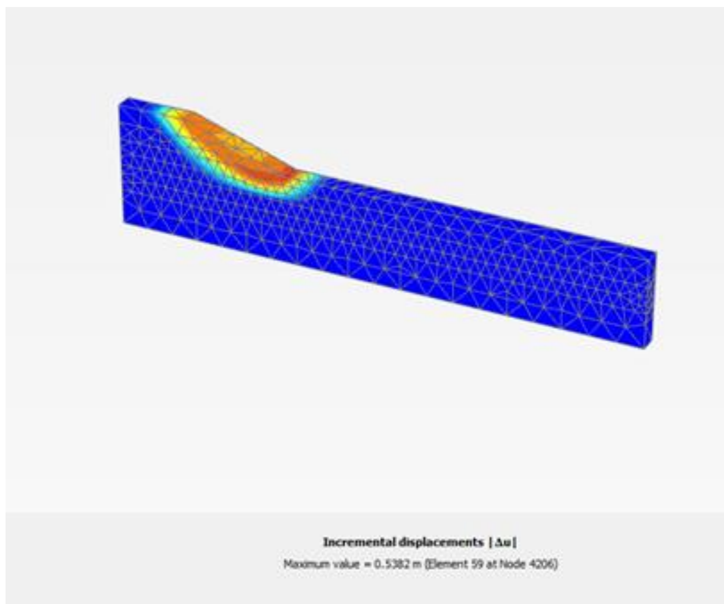
Minimum value of excess pore pressure = -1.003 KN/m2 (negative)



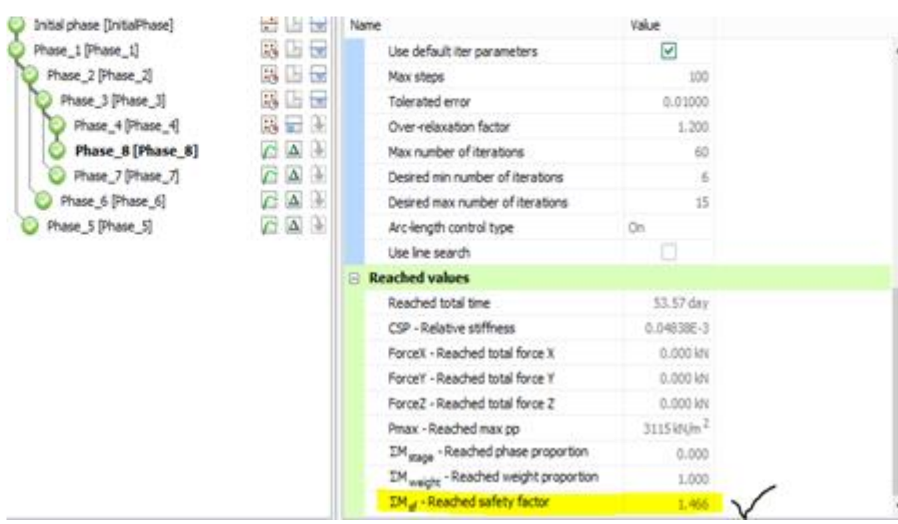
Here from the curve we can predict why pressure = negative is written .The curve above shows the consolidation analysis of all the phases in the construction of emankment. In the 1st phase for the first 2 days the excess pore pressure increases upto 23.504 Kg/m2 band after that we let it to consolidate for 30 days and then again the excess pore pressure increases upto 29.289 KN\m2.

After that we let to consolidate until the Pexcess reaches near 1 or below 0. nearly it took nearly about 54 days to consolidate (53.571 days)

safety factor:-



This resultant plot gives a good impression of the failure mechanisms. As the total increamental displacement is equal to 0.5382m.



As we concluded the safety factor with the ΣMsf multiplier factor. As this multiplier factor helps us to calculate the reduced strength parameter that are large enough to mention the equilibrium condition.

safety factor (when ΣMsf multiplier reaches failure) = 1.466

As after calculation reducing strength parameters are equal to:-

c_r and φ_r is calculated using formula

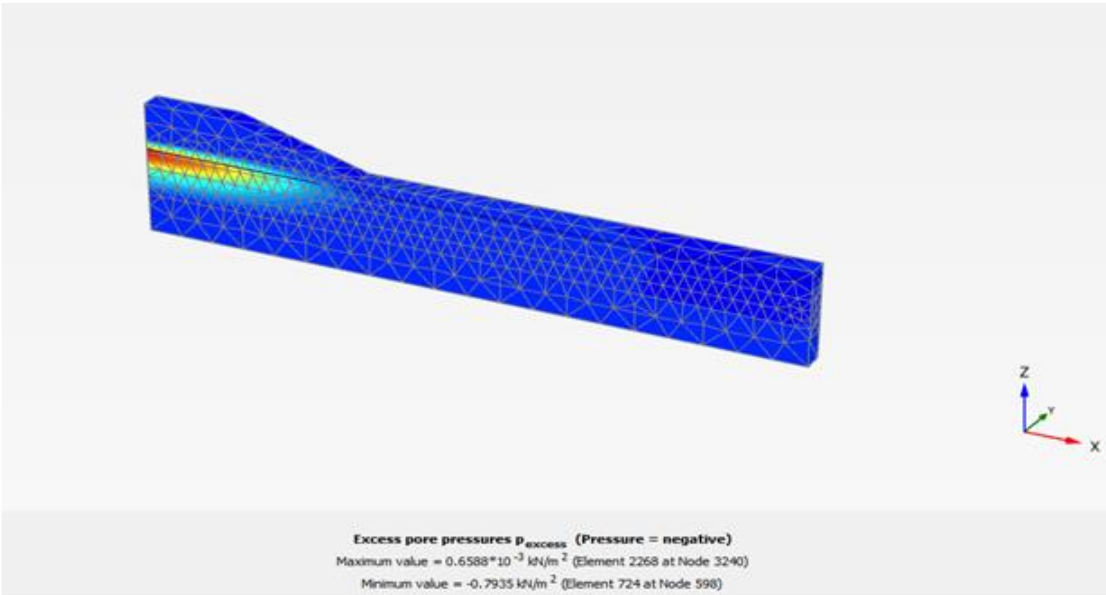
$$\frac{c}{c_r} = \frac{\tan\varphi}{\tan\varphi_r} = \Sigma Msf$$

Hence

c_r and φ_r = 10.232 KN/m2 and 15.40*

4.2 **Rubber tire waste:-**

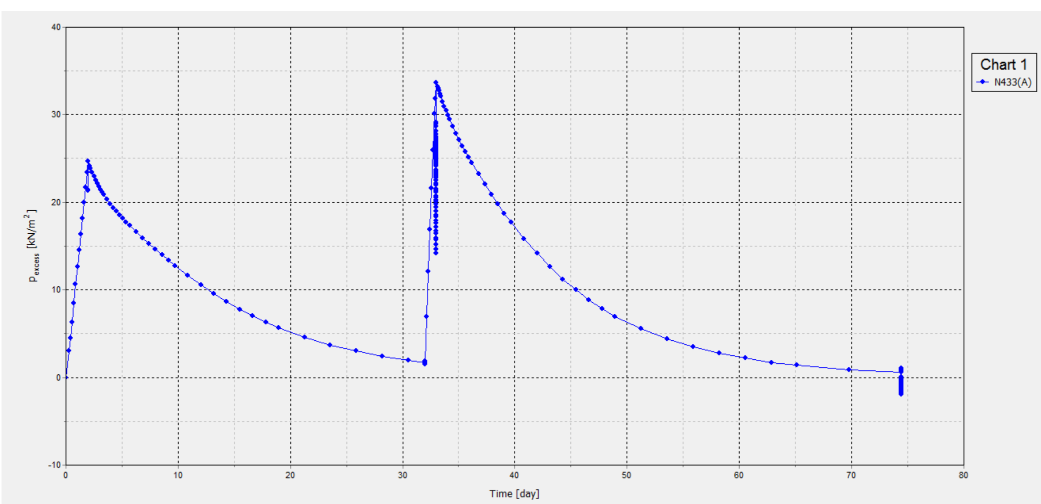
Consolidation analysis:-



As in the given figure for the current phase i.e. phase 4 maximum and minimum value of excess pore pressure. Is

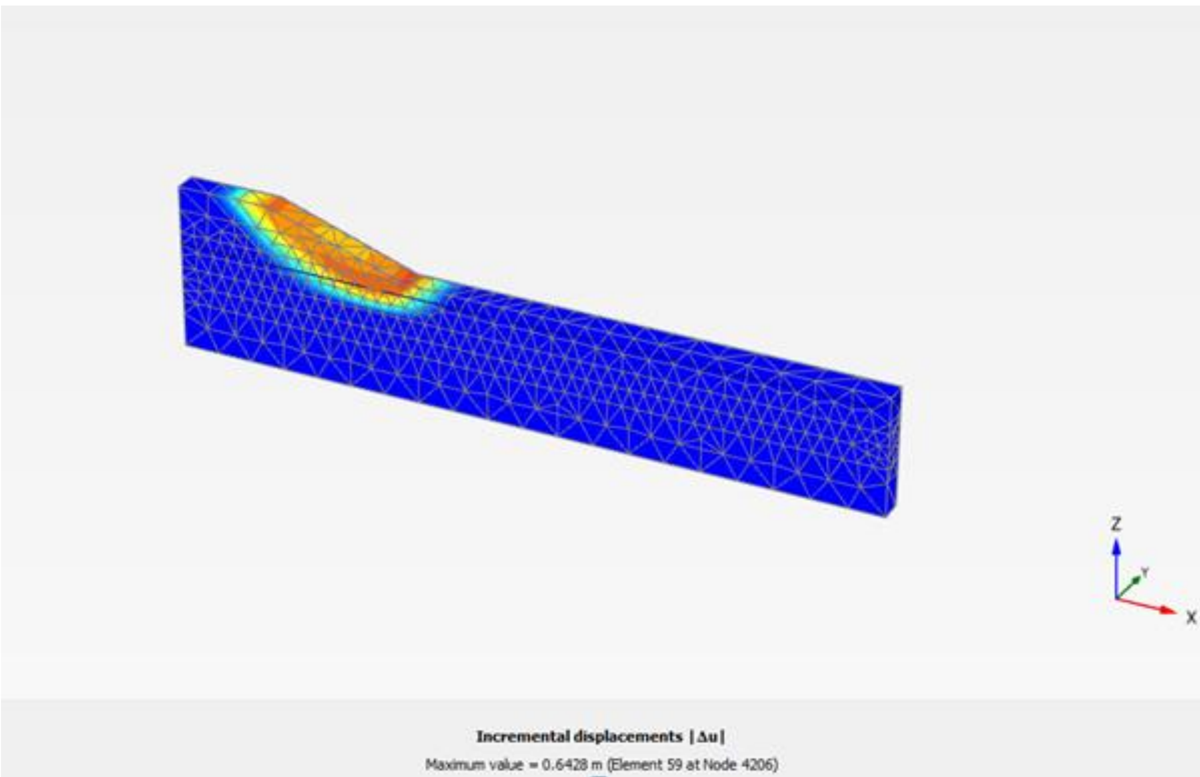
maximum value of excess pore pressure = 0.6588*10^-3 KN/m2

minimum value of excess pore pressure = - 0.7935 KN/m2 (negative)

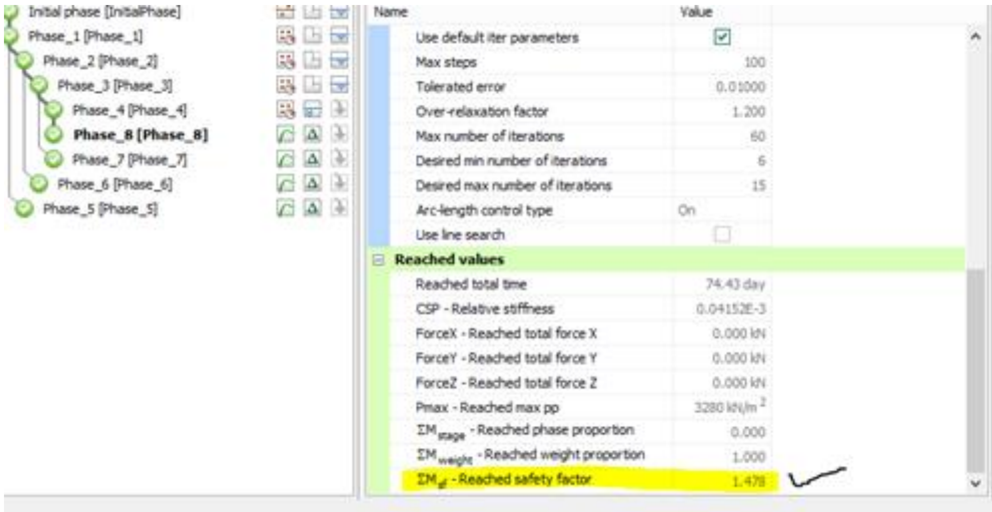


In the 1st phase for the first 2 days the excess pore pressure increases upto 24.667 KN\m2 and after that we let it to consolidate for 30 days and then again the excess pore pressure increases upto 33.645 KN\m2. After that we let to consolidate until the Pexcess reaches near 1 or less than 1 (can be negative). Nearly it took nearly about 75 days to consolidate (74.426 days).

SAFETY FACTOR:-



As the figure above looks completely similar to the resultant plot shown in the case of tile waste. Although it also gives a good impression of the failure mechanisms. As the total increamental displacement is equal to 0.6428m.



safety factor (when ΣMsf multiplier reaches failure = 1.478

As after calculation of safety factor these reducing strength parameter are equal to

c_r and φ_r is calculated using formula

$$\frac{c}{c_r} = \frac{\tan\varphi}{\tan\varphi_r} = \Sigma Msf$$

Hence

c_r and φ_r = 6.43 KN/m2 and 18.26*

5. Conclusion

This final chapter as a conclusion concludes the difference in the output we obtained in ***PLAXIS 3D 2013,*** when we calculated consolidation analysis, maximum and minimum excess pore pressure and the safety factor during the construction of the road embankment. So two different kind of wastes were used in two different cases i.e ceramic tile waste and rubber tire waste. Some of the already determined differences were also notice after reading the research paper that differences are also written below i.e. from the literature review and other from the software.

5.1 DIFFERENCES FROM LITERATURE REVIEW:-

Property	***For tile waste***	***For rubber tire waste***
Cohesion (c)	15KN/m2	9.5KN/m2
Angle of friction (phi)	22*	26*
Maximum CBR value with percentage waste.	14.6% value with 20% waste used	36.09% value with 4% waste used
Specific gravity	2.61	2.66

5.2 DIFFERENCES AFTER CALCULATIONS FROM SOFTWARE:-

Output	**For ceramic tile waste**	**For rubber tire waste**
Minimum excess pore pressure	-1.003 KN/m2	-0.7935 KN/m2
maximum excess pore pressure	0.3586*10^-3 KN/m2	0.6588*10^-3 KN/m2
Total consolidation period after all the phases.	53.571 days (54 days approx)	74.426 days (75 days approx)
Safety factor calculated (when ΣMsf reaches failure)	1.466	1.478
Reduced strength parameter (Cr)	10.232 KN/m2	6.43 KN/m2
Reduced parameter(phi r)	15.40*	18.26*
Incremental displacement (m)	0.5382 m	0.6428 m

REFERENCE

1] Cosentino, P. (2014). "Ground tire rubber as a stabilizer for subgrade soils." Florida Institute of Technology, pp. 1-159

2] To cite this article: A. F. Cabalar, D. I. Hassan & M. D. Abdulnafaa (2016): Use of waste ceramic tiles for road pavement subgrade, Road Materials and Pavement Design To link to this article: http://dx.doi.org/10.1080/14680629.2016.1194884

3] Cabalar, A. F., & Mustafa, W. S. (2015). Behaviors of sand-clay mixtures for road pavement sugared. International Journal of Pavement Engineering. doi:10.1080/10298436.2015.1121782.

4] Munnoli P. M., Sheikh S., Mir T., Kesavan V. and Jha R. 2013 Utilization of rubber tyre waste in sub grade soil 330-333

5] Volume 849, 4th International Conference on Construction and Building Engineering & 12th Regional Conference in Civil Engineering (ICONBUILD & RCCE 2019) 20-22 August 2019, Langkawi, Malaysia

4] IOP Conference Series: Materials Science and Engineering, Volume 849, 4th International Conference on Construction and Building Engineering & 12th Regional Conference in Civil Engineering (ICONBUILD & RCCE 2019) 20-22 August 2019, Langkawi, Malaysia

5] Munnoli P. M., Sheikh S., Mir T., Kesavan V. and Jha R. 2013 Utilization of rubber tyre waste in subgrade soil 330-333

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

PLAGIARISM VERIFICATION REPORT

Date:16 May 2021

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

Name: Shubham Thakur,Anmol Katna **Department: CIVIL Enrolment No 171623,171630**

Contact No. 7018296679,7018025269 **E-mail-171623@juitsolan.in, 171630@juitsolan.in**

Name of the Supervisor: Dr Saurabh Rawat

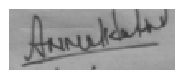
Title of the Thesis/Dissertation/Project Report/Paper (In Capitalletters): "INVESTIGATION OF CEREMIC WASTE AND RUBBER TIRE WASTE AS A POTENTIAL MATERIAL FOR EMBANKMENT CONSTRUCTION"

UNDERTAKING

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

Complete Thesis/Report Pages Detail:

- Total No. of Pages =51
- Total No. of Preliminary pages =46
- Total No. of pages accommodate bibliography/references =5



(Signature of Stud

FOR DEPARTMENT USE

We have checked the thesis/report as per norms and found **Similarity Index** at **17(%).** 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**

HOD
CE DEPT

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)	
16 May 2021	• All Preliminary Pages • Bibliography/Images/Quotes • 14 Words String	17	Word Counts	5785
Report Generated on			Character Counts	30313
16 May 2021		**Submission ID**	Total Pages Scanned	51
		1586644489	File Size	1.98MB

Checked by

Name & Signature Librarian**Please se**

your complete thesis/report in (PDF) with Title Page, Abstract and Chapters in (Word File) through t

supervisor at plagcheck.juit@gmail.com