

# Stability of Counterfort Retaining Wall using Crusher Dust as Backfill Material (By GEO5 Software)

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**Abstract-** Meerut being the 63<sup>rd</sup> fastest growing urban city in the world and 14<sup>th</sup> fastest developing city in India. But the most important factor which should be analyzed before construction is stability against failure. Stability is itself a huge topic to discuss which may depend on various conditions. In case of retaining wall, this research has considered one of the main factors effecting stability of a retaining wall, that is type of the soil used in backfilling. Study is made reading the profile of soil varying in Meerut and considered in this research. This research is a step towards providing a comparative study of retaining wall construction in the soil available in Meerut at varying backfill conditions. This paper will cover, variation in backfill (magnitude) and measuring the effects on slope stability, considering all other factors as constant. Both the analysis will take place using Geo5 software. Geo5 software is considered as one of the most important learning software as a geotechnical engineer.

## 1) INTRODUCTION

### 1.1 RETAINING WALLS

Retaining walls are the structures which are designed to restrain the soil or any other material, in a position wherever there could be a change in bottom level suddenly. Their construction is usually employed in areas having steep slopes or in areas wherever the landscape must be shaped severely for construction or any relevant engineering projects.

### 1.2 STABILITY ANALYSIS

Geo5 software is considered as one of the most important learning software as a geotechnical engineer. It provides solution for several geotechnical tasks based on traditional analytical method and Finite Element Method. It is a set of individual programs having same user interface and communicating with each other, while each of the program is having definite structure type. Basic geotechnical approaches implemented in the programs are applicable all over the world. GEO5 offers an accurate and easy to use tool for getting solution. However, the output of the software is analyzed by 'Factor of Safety', which is calculated by dividing shear strength to the shear stress. The factor of safety is determined for heights of wall with varying depths of soil and crusher dust as backfill material. If the value of factor of safety is less than 1.5, the wall is considered unstable. Hence for the safe durability of retaining wall, it is important to maintain the factor of safety.

## 2) LITERATURE REVIEW

### 2.1 REVIEW ON STUDIES

[1] Soosan et al. (2001)

Conducted a comparative study on all three wastes "crusher dust, Stone dust, and Ash". Results were found as follows: -

- Crusher dust is founded as a useful geotechnical material, as it possesses high value of Shear Strength
- Stone dust is founded as a material having Pozzolanic content in abundance as compare to other contents.
- Ash is founded to possess finer soil particles as compare to others, and also having solely pozzolanic property.

As done by other researchers in this study also varying proportions of stone dirt was used. Stone wastes were added by dry unit weight of soil as hundred percent and twenty percent. And the mix was tested and observations were taken in comparison with OMC, CBR and MDD.

**[2] A.Sridharan (2005)**

Conducted the experimental studies on soil-quarry dirt mixtures in terms of soil strength. Different mix were made to compare Shear Strength of the soil by varying amount of soil-quarry dirt. He concluded that max. Dry density increases and OMC decreases while increasing the percentage of quarry-dust. Max. dry density could be obtaining for the mixture of quarry dust as compare to using it alone.

**[3] Salman et.al. (2010)**

Founded the Earth Pressure distributed behind the retaining wall. The height of the wall considered was about twenty meters. He uses 2-D Finite Element method, with few modifications on CRISP. The results were assumed to be compare with standard theory of failure like Mohr- Coulumb theory. Observations resulted in oscillations within the earths value. These oscillations were found extended with the increase in load at the upper half of the RE wall and was near the linear distribution at the bottom half of the RE wall. This difference could be because of the reason based on assumption made during coulombs theory.

**[4] Salman et.al (2011)**

Studied the distribution of earth pressure behind the retaining wall subjected to point load. He has calculated the pressure distributed before the retaining wall of considered height of twenty meters by the use of Finite Element Analysis. The results were compared by the standard theory of Earth pressure like Columns theory. By the studies he has found that the base of the wall had most of the pressure. Results were compared to coulumn theory, and differences were noted. Observation said that Lateral Earth Pressure at the base of the wall was about ten to twenty percent as obtained by standard theory i:e Coulumn theory of Earth pressure.

**[5] Sabat (2012)**

In 2012, he has conducted a number of tests on soil sample and observed the effect of adding quarry dust on Index Properties of soil. During test the effect was observed on each property as follows: -

- a. Decrease was resulted on- Plastic Limit( $W_p$ ), Liquid Limit( $W_L$ ), OMC, Cohesion, Physical prop. Index etc.
- b. Increase was observed on- Shrinkage Limit( $W_L$ ), Dry Density( $\gamma_d$ ), Angle of internal friction( $\phi$ ) (in case of expansive soil).

**P.V.V. Satyanarayana (2013)**

Conducted a study on the performance of crusher dust when used as a filler material in place of sand. Samples of sand and crusher dust were taken and a number of Mix were made by varying the quantity of crusher dust added with sand. All-important properties like OMC, angle of shearing resistant, CBR value etc. have been taken for every mix and noted. As a result, it is found that crusher dust and sand are the two important coarse grained, non-plastic materials. Combination of both could offer additional shear strength and maintains high densities. And hence the mix can be used as used as a decent material for construction as well as a fill material for subgrade.

**3) MATERIAL USED AND METHODOLOGY****3.1 SOIL FROM HASTINAPUR**

Hastinapur soils mostly have a moderate slop to moderately steeper side slope. Hills are generally low approximately five to twenty five percent. Twenty to Two Hundred meters above the mean sea level is the general elevation of the hills. Crusher dust, the second material used in this thesis was collected from a quarry at Ganga Traders, Transport Nagar, Meerut (U.P).

**3.2 METHODOLOGY****STEP 1: Site Reconnaissance**

It is the very first step followed in this thesis. It helps to preplan or decide the procedure and need of future investigations. It also helps to access the need of primary or detailed investigation.

**STEP 2: Collection of Material**

The main materials used in this project are the soil and crusher dust. Polythene bags are used for collecting sample of soils. These samples are then air-dried for obtaining better results. Crusher dust, the second material was collected from a quarry at Ganga Traders, Transport Nagar, Meerut (U.P).

**STEP 3: Identification of the soil and crusher dirt properties**

All-important properties of soil specimen were identified using appropriate methods of determination.

**STEP 4: Retaining Wall Design**

Several possible solutions are obtained technically, during designing, by considering all important aspects, parameters, and requirements of designing.

**STEP 5: Analysis of Stability using the software (GE05)**

This step is the final step to obtain results. Analysis of the wall is done with following procedure-

- a. Height of RE wall is selected with the consideration of economy.
- b. Selected Height is then fixed and suitable backfill mix is selected next.

**4) EXPERIMENTAL RESULTS**

**4.1 PROPERTIES OF SOIL SAMPLE**

Following experimental values are taken for stability analysis-

Sr. No	CHARACTERISTICS	RESULTED VALUE
1.	Percentage Moisture Content (W%)	14.11
2.	Particle Size Distribution- Sand Percentage (%) Clay Percentage (%) Silt Percentage (%)	37.00 55.71 6.91
3.	Max. Density(dry) in g/cc	1.79
4.	OMC (%)	14.02
5.	Limit (plastic) (W <sub>p</sub> )	20.00
6.	Limit (Liquid) (W <sub>L</sub> )	46.00
7.	UCS in KN/m <sup>2</sup>	2.70
8.	CBR	13.00
9.	Cohesion	0.15
10.	pH Value	5.55
11.	IS Classification	CI

Table 4.1: Soil Properties

**4.2 CHARACTERISTICS OF CRUSHER DIRT**

Following experimental values are taken for stability analysis-

Sr. No	CHARACTERISTICS	RESULTED VALUE
1.	Particle Size Distribution- Sand Percentage (%) Gravel Percentage (%) Fines Percentage (%)	91.02 0.18 8.12
2.	Max. Density(dry) in g/cc	1.9
3.	OMC (%)	13
4.	Limit (plastic) (W <sub>p</sub> )	NP
5.	Limit (Liquid) (W <sub>L</sub> )	NP
6.	Angle of internal friction (degree)	44.71
7.	Co-efficient of Uniformity	7.86
8.	Specific Gravity	2.533
9.	10 Co-efficient of curvature	1.003

Table 4.2: Properties of crusher dust

### 4.2 STABILITY ANALYSIS OF COUNTERFORT RETAINING WALL USING GEOS

Three separate cases have been taken for the stability analysis of above designed retaining wall. These cases are most generalized conditions prevailing on retaining wall irrespective of its type and location. Following are the three cases: -

Case A: Stability analysis of Retaining wall of selected height.

Case B: Trial for various depths of backfill using crusher dust.

**Case A: Stability analysis of Retaining wall of selected height.**

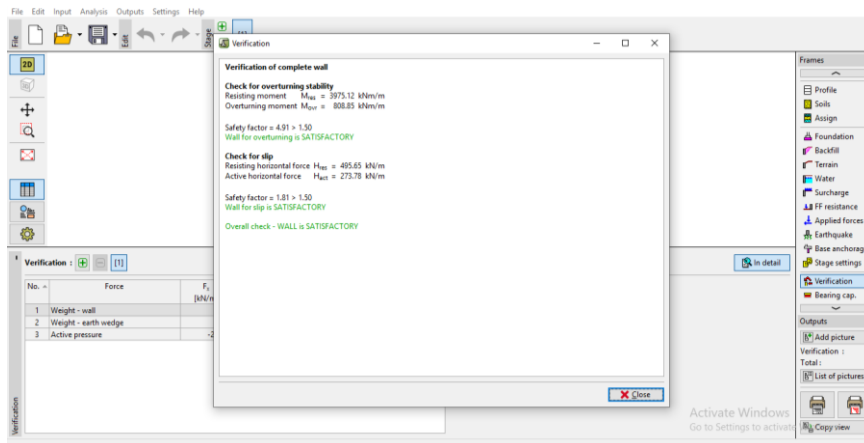


Figure 4.1: Verification frame (b)

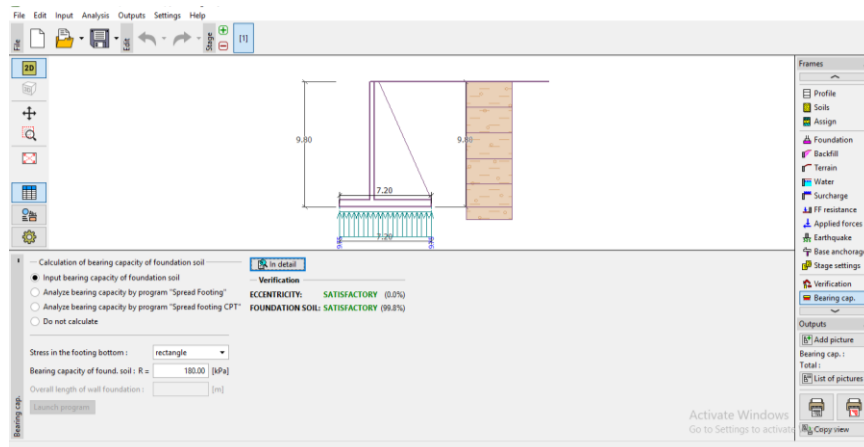


Figure4.2: Bearing capacity frame(a)

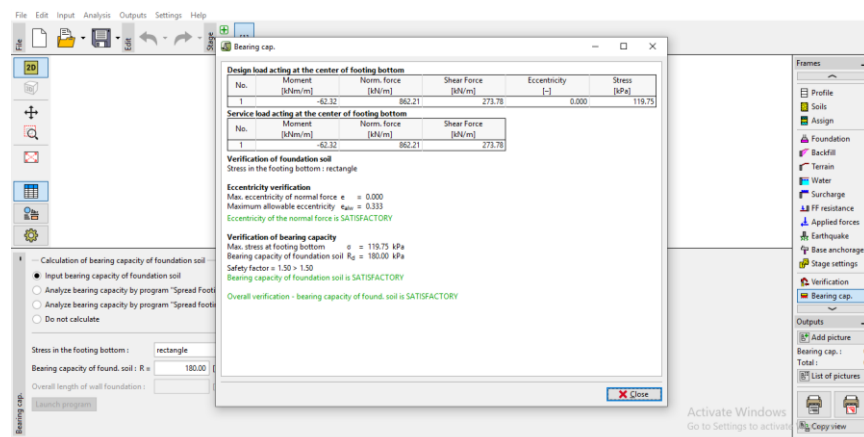


Figure 4.3: Bearing capacity frame(b)

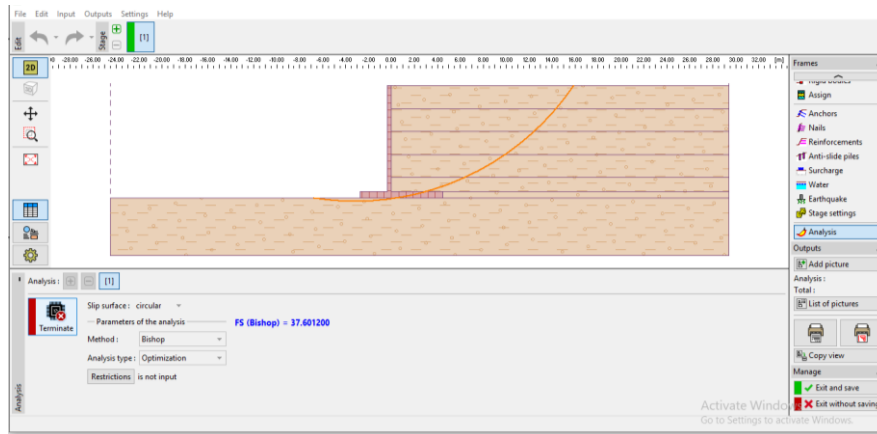


Figure 4.4: Analysis frame(a)

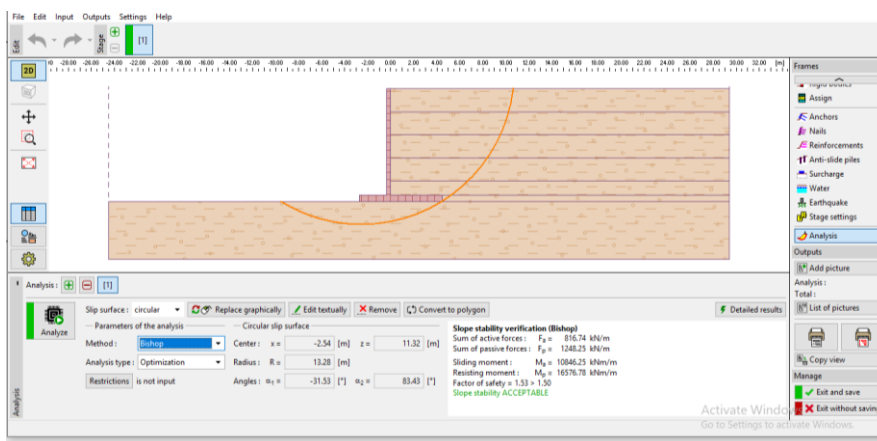


Figure 4.5: Analysis frame(b)

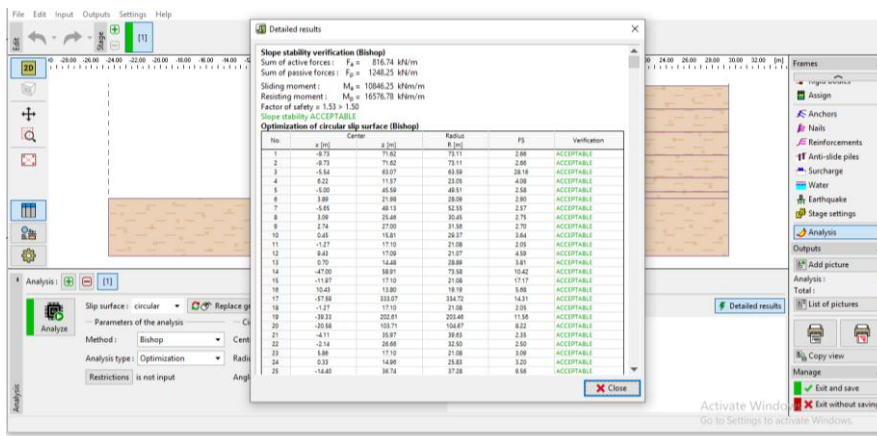


Fig 4.6: Stability frame

**Results of Analysis**

The results are shown below-

Overturning:30.50%; SATISFACTORY, Slip:82.90 % ; SATISFACTORY,Eccentricity:0.0%; SATISFACTORY, Foundation soil:99.80 %; SATISFACTORY, Factor of Safety:1.53 > 1.5; SATISFACTORY.

Result: Hence the overall safety of the retaining wall is satisfactory.

Case B: Trial for various backfill depths of crusher dust and backfill material

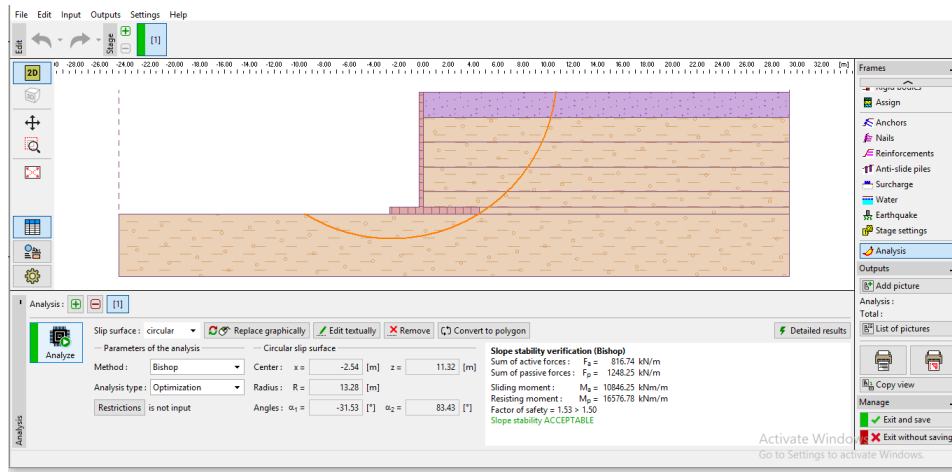


Figure 4.7: Analysis frame

FOS = 1.53 > 1.50

- Backfill = crusher dust upto height (h1) equals to 6m from the top and remaining is filled with Gravelly clay loam.

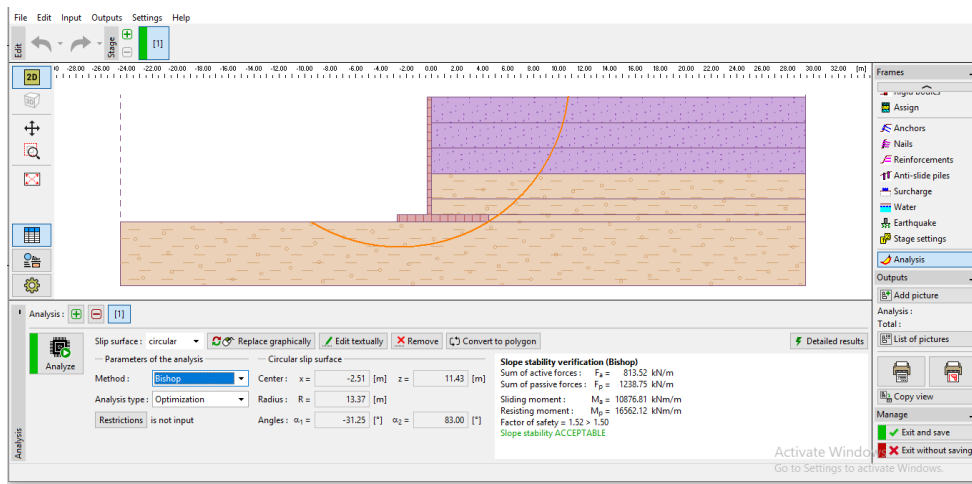


Figure 4.8: Stability frame

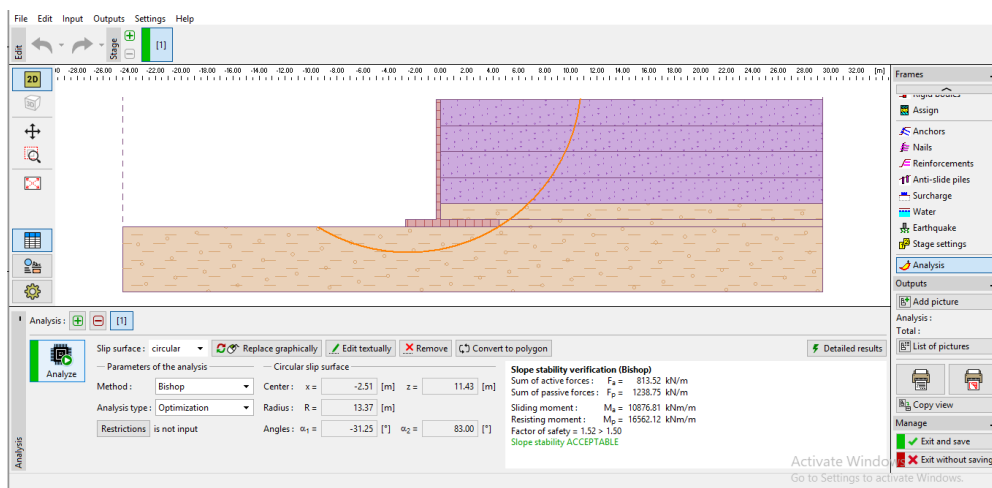


Figure 4.9: Stability frame

Factor of Safety = 1.52 > 1.50

Case	Backfill criteria	Factor of Safety (should be > 1.5)
1	0m crusher dust + 9.8m soil	1.53
2	2m crusher dust + 7.8m soil	1.52
3	6m crusher dust + 3.8m soil	1.52
4	8m crusher dust + 1.8m soil	1.55

Table 4.3: Variations in Factor of safety

## 5) CONCLUSIONS

By adding crusher dust, the stability of the backfill is improved. The value of phi for crusher dust which is 44.710 is much more than that of soil at Hastinapur, Meerut which is just 250. A decrease in OMC along with an increase in MDD is observed due to the addition of crusher dust. Due to an increase in Factor of Safety there is an increase in the stability of the structure. As per analysis carried out in this thesis using GEO5 software it can be concluded that the stability of the structure increases with the increasing depth of crusher dust backfill.

## REFERENCES

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