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Earth Roads Stabilization using many Additives to increase Rutting Resistance

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Abstract

Earth roads are among the oldest roads widely used by humans in rural or desert areas with low traffic density. These roads are usually weak and unable to resist the heavy loads applied to them. Therefore, this research aims to study the possibility of using soil additives to stabilize these roads and increase their ability to resist repetitive loads, and thus enhance the rutting resistance. A series of laboratory tests is conducted on the soil, including Compaction tests, California Bearing Ratio (CBR) tests, and Wheel Tracking tests, before and after the addition of stabilizing agents. Various amounts of Cutback asphalt, Emulsified asphalt, SBR polymer and Cement are tried. Compaction and CBR tests revealed optimum additive percentages of (4%) for cutback asphalt, (2%) of emulsified asphalt, (2%) of SBR, and (7.5%) of cement, by weight of the dry sample. The obtained bulk CBR-values for the (cutback asphalt, emulsified asphalt, SBR, and cement)-stabilized soil are (4.6, 1.6, 5.7, and 11.2) times that of the natural soil, respectively. Except for cement, the added agents have adverse effects on the original soil behavior upon soaking. Rutting is evaluated via the wheel tracking test, where bulk and soaked samples are tested at temperatures of (40°C) and (60°C). The results showed that using the cutback and emulsified asphalt did not improve the soil rutting resistance. Where (SBR) is used, the treated soil showed high resistance to permanent deformation, with rut depth values of (5 mm) and (3 mm) under (5000 cycles) of load application and at (40°C) and (60°C), respectively. The soaked sample is collapsed during the test. The (7.5%) cement stabilized soil exhibited very high effectiveness in resisting rutting under bulk and soaked conditions, where the rut depth equals (1 mm) at (10000 cycles) of load application for both temperature values.

Keywords: *Earth roads, Rutting, Stabilization, Cement, SBR Polymer*

1. Introduction

The road represents an essential element of transportation; it takes an important role in connecting different regions and make people movement and goods easy [1]. It is divided into many types which differ according to the use, design and its technical characteristics [2].
Earth roads are unpaved roads and represent the simplest and most common type of roads in rural or less densely populated areas, they are built directly on the local soil from the natural materials. Their initial construction costs are low, but this type of roads require continuous maintenance as they are affected by climatic factors such as rain and wind which can cause soil erosion and the formation of potholes [3]. In agricultural and desert areas in many countries, soil roads are used as a substitute for paving, they are suitable for low traffic density in these areas, which makes them a practical and economical solution in environments with limited traffic use [4]. These roads are vital social and economic pathways where there is a need to open new ones. However, constructing new rural roads can sometimes be costly and constrained by geographical limitations. They

are often used in areas where the soil has properties that can be modified and strengthened by adding stabilization materials [5].
Earth roads are significantly affected by moisture exposure, and rainfall is one of the major issues they face. Rainfall causes the disintegration and separation of the particles that make up the road, leading to the loss of surface soil materials. The erosion rate of a compacted earth road surface at a maximum dry density increases with the duration of rainfall [6]. There roads could face many problems after construction and use. One of the most important problems is rutting and what causes it [7].
Rutting is a phenomenon that occurs on roads when permanent holes or grooves form in the road surface due to vehicles repeatedly passing over it. It can occurs when plastic deformation accumulates in the surface of road [8], rutting is also a common and significant problem on the roads that affected by heavy loading conditions or the heavy traffic. It can be defined as a permanent deformation that happen as a result of repeated loads placed on the pavement [9].

There are a number of factors that must be considered, when using soil roads and studying its possibility to resist rutting, such as:

A. **Soil characteristics.** The soil which can be used in constructing the roads, must be carefully selected and must have a high resistance and good stability to withstand the traffic loads, thus resisting excessive deformation [10].
B. **Layer thickness.** Thickness of the soil layer required in the road construction can affect the occurrence of rutting, Increasing the soil layer thickness can help distribute the applied traffic loads, and reduce the chance of soil rutting [11].
C. **Compaction.** It is important to do the compaction of the soil correctly to achieve high density and stability, the good compaction helps to improve the bearing capacity of loading of the soil and will reduce the deformation [12].
D. **Drainage effective.** Water drainage is considered a key factor in soil stabilization and maintain the stability of soil roads, the moisture with long time can weaken the soil structure and leading to rutting [13].
E. **Stabilization Techniques.** The techniques of soil stabilizing in some cases, can be used to enhance the resistance of the soil for rutting, this can be done by adding materials to the soil that improve its strength and stability, such as cement addition, lime or bitumen [14].

Soil stabilization by additives is working to improve the performance of weak or unsuitable subgrade soils in constructing roads. These additives can improve the behavior of soil depending on increasing its ability to retain moisture for periods, and increasing the connecting between soil particles. In addition, stabilization materials act as binding and protective agents that limit water penetration and significantly improve the long-term strength and stability of road layers [15].

In this research four types of soil stabilizers are used: Cutback Asphalt (Medium Curing type), Emulsified Asphalt, Styrene Butadiene Rubber (SBR) polymer and Cement.

- **Cutback Asphalt (Medium Curing type):**
  Davidson (1960) Pointed out that medium curing cutbacks (called MC) is considered suitable type of liquid asphalt for soil stabilization. as it contains solvents that help facilitate mixing with the soil [29]. Based on (AASHTO M82), the bitumen binder is made of diluted bitumen of medium maturity, resulting from dissolving bitumen with a permeability (85-100) with white oil (kerosene), The approximate composition of diluted bitumen is one part kerosene to one and a half parts cement bitumen [27].
  Puzinauskas and Kallas (1962) explain that the main stabilizing effect comes from reducing the soil's sensitivity to moisture and increasing internal cohesion. Stabilizing fine grained soils with medium curing (MC) cutback asphalt works through a combination of mechanical bonding and waterproofing actions [30].
  Cutback asphalt is used in soil stabilization by adding different percentages depending on the type of soil. In a study conducted at the University of Baghdad by (Sarsam et al., 2011), a percentage of 5% MC-30 was used in addition to the water content applied [31]. In a study conducted at the University of Al-Mustansiriya, Iraq, by Ali J. Kadhim (2014), several MC-30 contents were tested based on the dry weight of the soil: 2%, 4%, 6%, 8%, and 10%, the results showing that 6% and 8% provided the most effective improvement in mechanical properties and overall stability of the gypseous soil. This method is considered suitable for subgrade and base layers in low to medium traffic roads [16].
  Based on the research study carried out by (Zainab H.S., 2017), the improvement of gypseous soil using cutback asphalt (MC-30) with different percentages ranging from 3% to 15% based on the dry weight of soil, achieved a distinct improvement in bearing capacity as well as reduction in possible collapse with 9% optimum asphalt content giving the best mechanical strength, The high percentages were successful in resisting the effects of water but this did not cause any additional increase in strength [32].
- **Emulsified Asphalt:**
  The results of the research carried out by Mutter (2019) indicated that bitumen emulsion was an effective technique for soil stabilization. The test results indicated that a 3% emulsion dosage was adequate to attain substantial enhancements in the engineering and chemical properties, this led to a decrease in the potential for erosion as well as an improvement in soil stability [33].
  Based on the study (Stabilization of Sandy Clay Loam with Emulsified Asphalt, 2011), the application of 1.5%, 3%, and 4% of the emulsified asphalt dosage enhances the physical, chemical, and mechanical properties of the soil used in the study [24]. Oluyemi In (2019) carried out a research study to determine the behavior of lateritic soil in the

process of stabilization by the application of asphalt emulsion. The results showed that soils with a high clay content may not be suitable for this type of stabilization due to difficulties in mixing and the long curing period required [34].

- **Styrene Butadiene Rubber (SBR) polymer:**
  Baoshan H. et al., 2010, Mentioned that Styrene butadiene rubber (SBR) latex is a high-polymer dispersion emulsion that may be effectively attached to a variety of materials. It is made up of butadiene, styrene, and water to increase the concrete's tensile, flexural, and compressive strengths, SBR is a thick, white liquid with a water content of 52.7% and a good viscosity [35].
  Generally, (SBR) Addition can affect on Compressive Strength and Water Absorption, Z. A. Siddiqi et al., 2013, showed that the addition of Styrene Butadiene Rubber (SBR) latex as a polymer additive in concrete had positively contributed to the compressive strength of concrete as well as its water absorption [36].
  There have been a number of studies involving the percentage of SBR added to soil, such as in the study of Atemimi (2013), where percentages of 1%, 3%, and 5% were added to clay soil samples to determine its effect on its properties such as its dry density, unconfined compressive strength, and swelling and shrinkage ratio. It was shown that adding SBR had a significant effect on its compressive strength at a 5% ratio [37].
- **Cement:**
  Improving subgrade soil using chemical additives, especially cement, is an effective method for enhancing weak soil properties and increasing its load-bearing capacity [38]. The application of cement additives in study by adding cement rates ranging from 2% to 8% of the dry soil weight, and according to this addition of cement the unconfined compressive strength and California Bearing Ratio values significantly increased with increasing cement content, good strength was achieved in cemented units at (4-6)% cement [39]. In another case, (Farid S. and Balasingam M., 2009) used cement ratio of 2.5%, 5%, 7.5%, 10% of the dry soil weight, which resulted in a significant improvement in soil compaction strength [26].
  Issa and Resa, 2015, proved that adding varying amounts of the cement results in significant improvements in the geotechnical properties of soil. This is attributed to the ability of cement-stabilized soil to withstand greater compressive forces, due to the significant increase in the unconfined compression strength of the soil when using high amounts of cement and with longer curing times [40].

2. Materials and Methods

2.1. Soil

A granular soil from Al-Salman District in Al-Muthanna Governorate, Iraq, is used. This soil can be utilized for road construction purposes after undergoing some modifications. Grain size distribution test showed that the soil is classified as subbase Type (C), according to the Iraqi Standard Specification [20], as illustrated in Table (1) and the particle size distribution shown in Figure (1).

Table 1: Original soil grain size distribution.

Sieve size (mm)	Passing (%)	Specification Limits
25	100	100
9.5	83	50-85
4.75	62	35-65
2.36	49	26-52
0.3	25	14-28
0.75	13	5-15

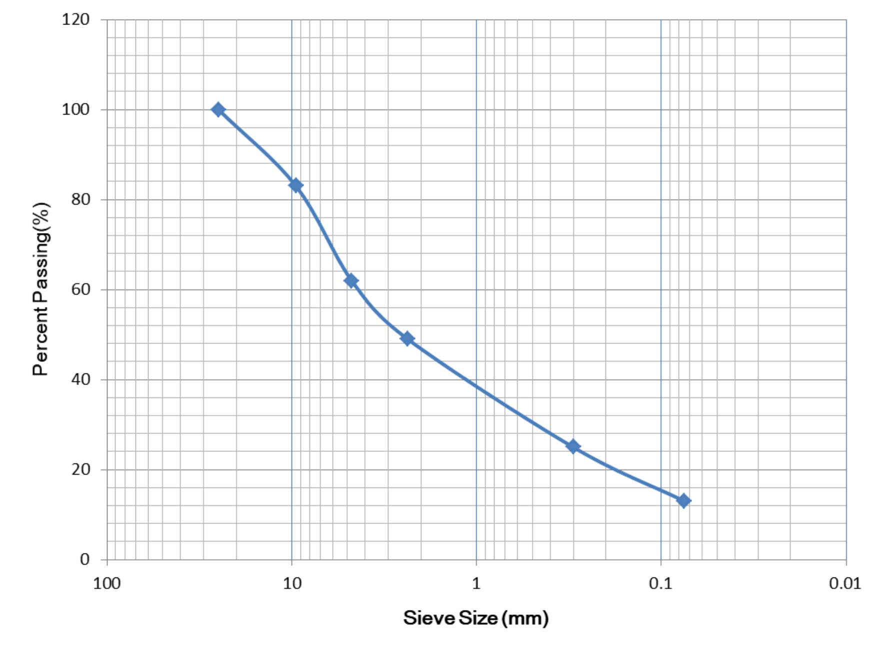

Fig. 1: Particle size distribution curve of the original soil.

2.2. Stabilizing Materials

A. Cutback Asphalt (Medium-Curing type)
The liquid asphalt used in this research is medium curing cutback type purchased from Ahlia Chemicals Company. Medium curing cutback asphalt is used as one of the stabilizing components. It produced by mixing asphalt cement with a petroleum solvent, which reduces asphalt viscosity for easier application [21]. Using MC asphalt to stabilize soil roads is a common technique for improving the road surface and enhancing its durability. The percentage used range is (1% to 5%) of the dry weight of soil [22].

B. Emulsified Asphalt
Cold applied bitumen emulsion from Al-Yaqota Company was used. It is another stabilizing agent that product from mixing asphalt, water and dispersions [23]. Emulsified asphalt is generally a type of asphalt that contain from (40% to 75%) bitumen, (0.1% to 2.5%) emulsifier, (25% to 60%) water plus some minor components. The advantages of asphalt emulsion compared to hot asphalt and cut back binders are related to the low application temperature and compatibility with other water-based binders [17].

C. Styrene Butadiene Rubber (SBR) Polymer
It is One of the additives that improving cohesion and adhesion forces. This polymer acts as a binder between soil particles. The polymer percentage used usually ranges from (1%) to (3%) of the dry soil weight [18]. Cempatch SBR100 is used.
It is a synthetic polymer used in road construction projects as a supporting agent to stabilize soil and improve its geotechnical properties by increasing strength and cohesion and reducing permeability [18].

D. Cement
Portland cement is used as a stabilizing material, especially for improving soil strength and stiffness [25]. It used in different quantities, starting from (2.5% to 12.5%) of the soil dry weight [26].
The use of cement stabilized soil is becoming more common in pavement applications, It provides savings in both cost and time and also improve the strength and durability of roads by increasing cohesion and compressive strength [19].

2.3. Strategy of the Experimental Work

Several tests are conducted in this study, including:

1. **Compaction test:** Compaction is the application of mechanical energy to the soil, to rearrange the particles and reduce the void ratio, usually by driving out air, thus increasing the dry density of the soil. At any given water content, compacting the soil improves its engineering properties. This test was conducted using the Modified Proctor method according to (AASHTO T180).
2. **California Bearing Ratio (CBR):** The CBR test is performed by measuring the pressure required to penetrate a soil sample with a plunger of standard area during a specific time. This test based on (BS 1377-4:1990), According to this specification, one mold is used for each test for soils in which the percentage retained on the (20 mm) sieve does not exceed (25%) and the penetration speed is set to 1 mm per minute. Specimens will prepare and test at optimum moisture content condition.

3. **Rutting Test (Wheel Tracking Test):** The rutting test is one of the most important laboratory tests used to evaluate the resistance of paving materials or stabilized soils to permanent deformation resulting from repeated traffic loads. This test is conducted according to the (AASHTO T324).

2.4. Samples Preparation

In the Figure (2) shows the process of preparing the stabilized soil with cutback asphalt, as an example of adding soil stabilizing agents, whereas the molds prepared for rutting test are shown in Figure (3). The sample is prepared according to the following steps:

1. Prepare and dry the soil sample.
2. Divide the sample into several parts and adding the required percentage of water to each part, Then after that mix until homogeneous.
3. Add the additive to the sample and mix it well to ensure its distribution throughout the sample.
4. Place the soil in the mold in layers and compact it using the testing hammer.

Fig. 2: Process of adding cutback asphalt into the soil.

Fig. 3: Wheel tracking test molds.

2.5. Specimen Curing Methods

When stabilization materials are used and mixed with the soil, they require a curing period to properly integrate or react with the soil.
In bulk soil CBR-testing, the sample is left for three days before conducting the test. While in case of soaked tests, the sample is left for three days, then submerged in water for four days before the test is performed.
For the rutting tests, the prepared molds are put in the oven, at the required temperature, for one day before conducting the tests. In the soaked condition the specimen is cured after mixing for three days and then submerged in water for four days before conducting the test. Figures (4) and (5) show the soaking process.

Fig. 4: CBR test molds soaking process.

Fig. 5: Rutting test molds soaking process.

3. Results and Discussion

This section presents the results obtained from the experimental program which is utilized to investigate the effectiveness of stabilizing the soil by various types of additives in mitigating the rutting problem affecting unpaved roads. These results are achieved by preparing and curing samples of natural soil and soil treated with additives, followed by subjecting them to a series of compaction, (CBR), and wheel tracking laboratory tests.

3.1. Compaction Tests

The compaction curves of modified Proctor tests are shown in Figures (6) to (10). It can be realized that, the addition of stabilizing agents increased slightly and almost uniformly the maximum soil dry density Compared to natural soil, this indicates that the additives helped improve particle arrangement and reduce air voids within the soil. The optimum moisture content (OMC) decreases when using bituminous materials (cutback and emulsified asphalt) and SBR, because these materials act as binders and reduce the need for a large amount of water to achieve optimal compaction. Conversely, the optimum moisture content increases when cement is added, due to the cement requiring sufficient water to complete the hydration reactions and form cementitious bonds.

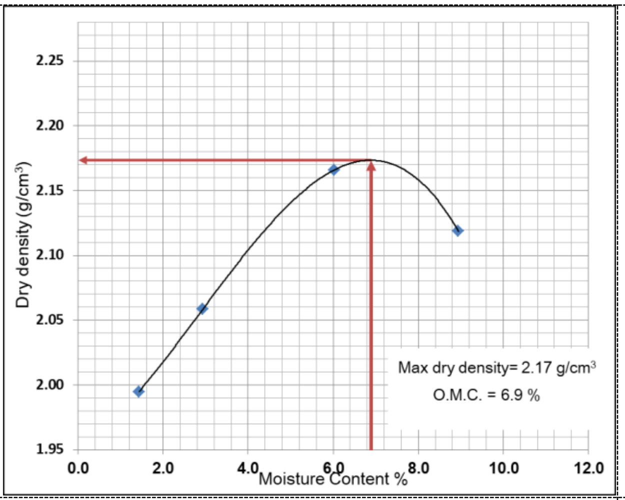

Fig. 6: Compaction curve for the natural soil.

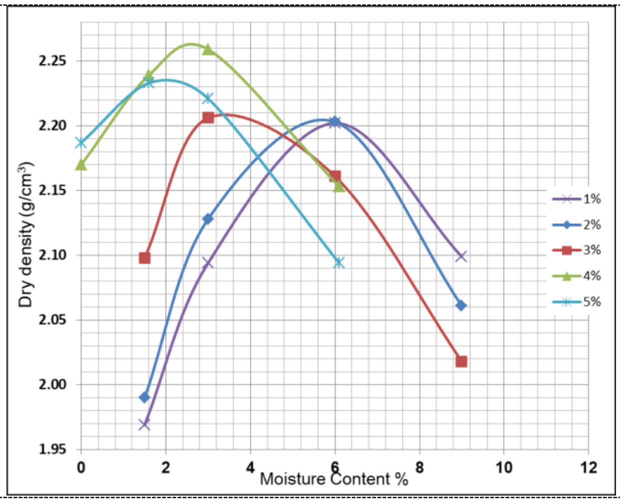

Fig. 7: Compaction curves for the cutback asphalt stabilized soil.

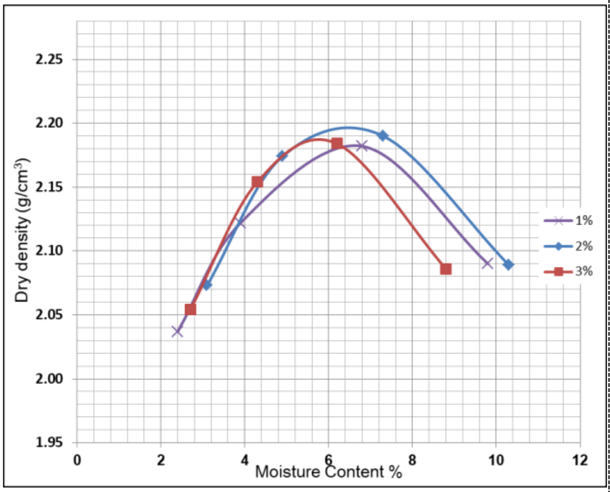

Fig. 8: Compaction curves for the emulsified asphalt stabilized soil.

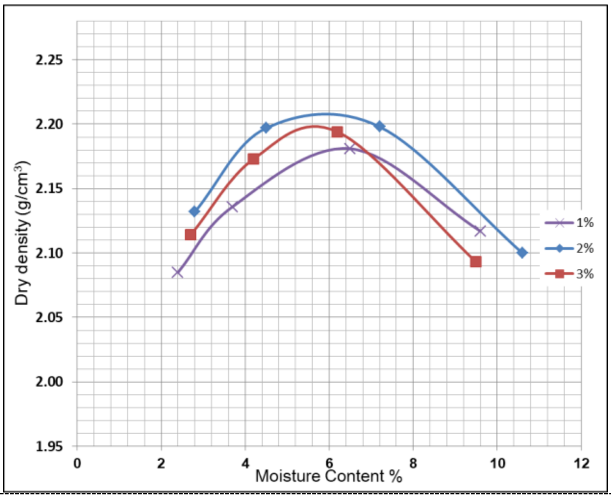

Fig. 9: Compaction curves for the SBR-stabilized soil.

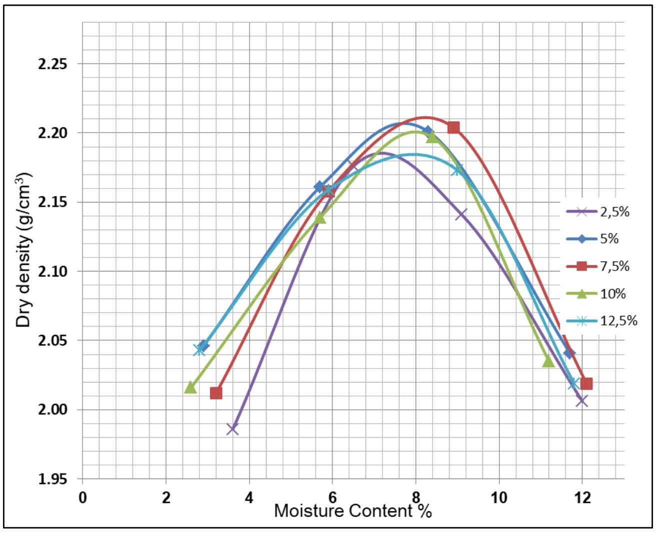

Fig. 10: Compaction curves for the cement stabilized soil.

Table (2) presented the optimum percentages of additives associated to the maximum dry densities .

Table 2: Optimum percentage values of additives based on the maximum dry density.

Additive type	Optimum addition (%)	Maximum dry density (g/cm³)	Optimum moisture content (%)
Cutback Asphalt	4.0	2.260	2.7
Emulsified Asphalt	2.0	2.197	6.5
SBR	2.0	2.210	6.0
Cement	7.5	2.211	8.3

3.2. California Bearing Ratio (CBR) Tests

CBR-tests performed on bulk samples, prepared at the maximum dry densities and optimum moisture contents, for various percentages of additives. The penetration-stress relations are illustrated in Figures (11) to (15).

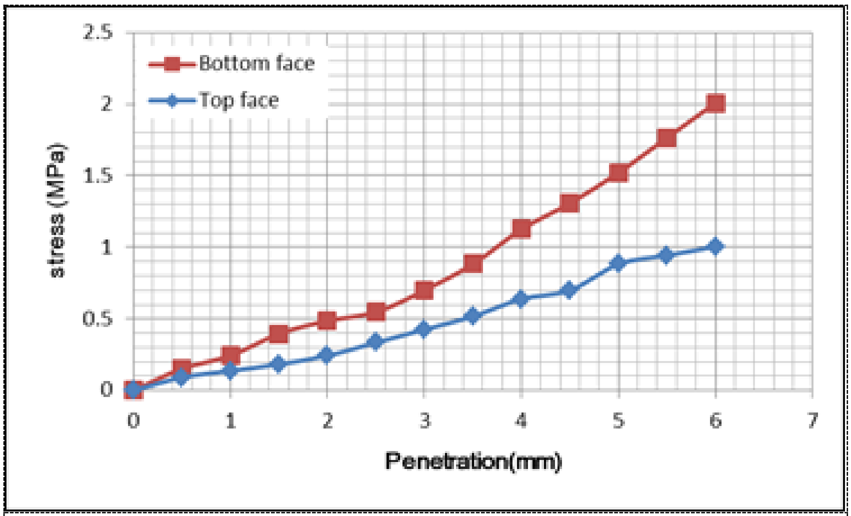

Fig. 11: CBR-curves for the bulk natural soil.

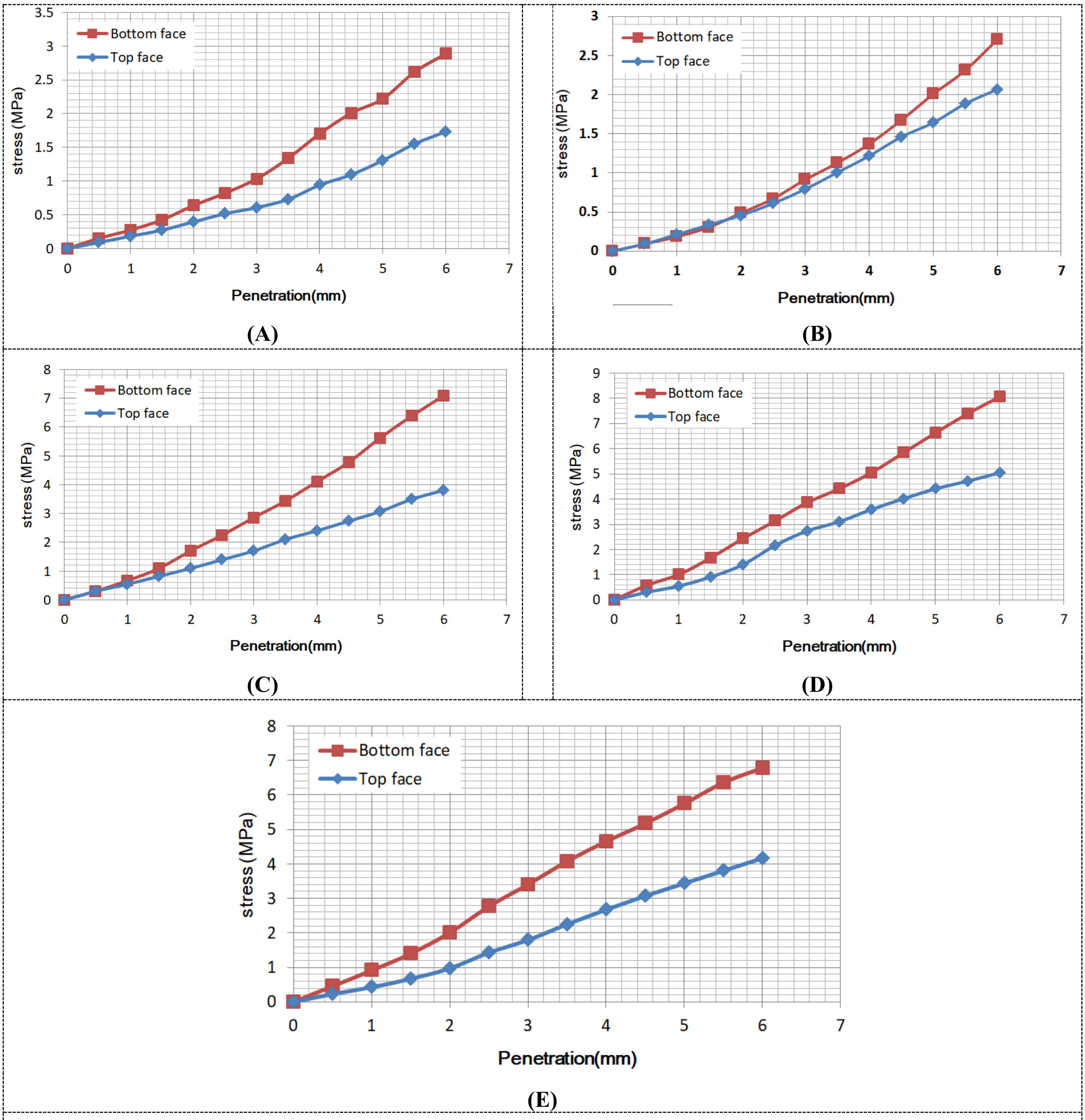

Fig. 12: CBR-curves for cutback asphalt bulk stabilized soil: (A) 1%; (B) 2%; (C) 3%; (D) 4%; (E) 5%.

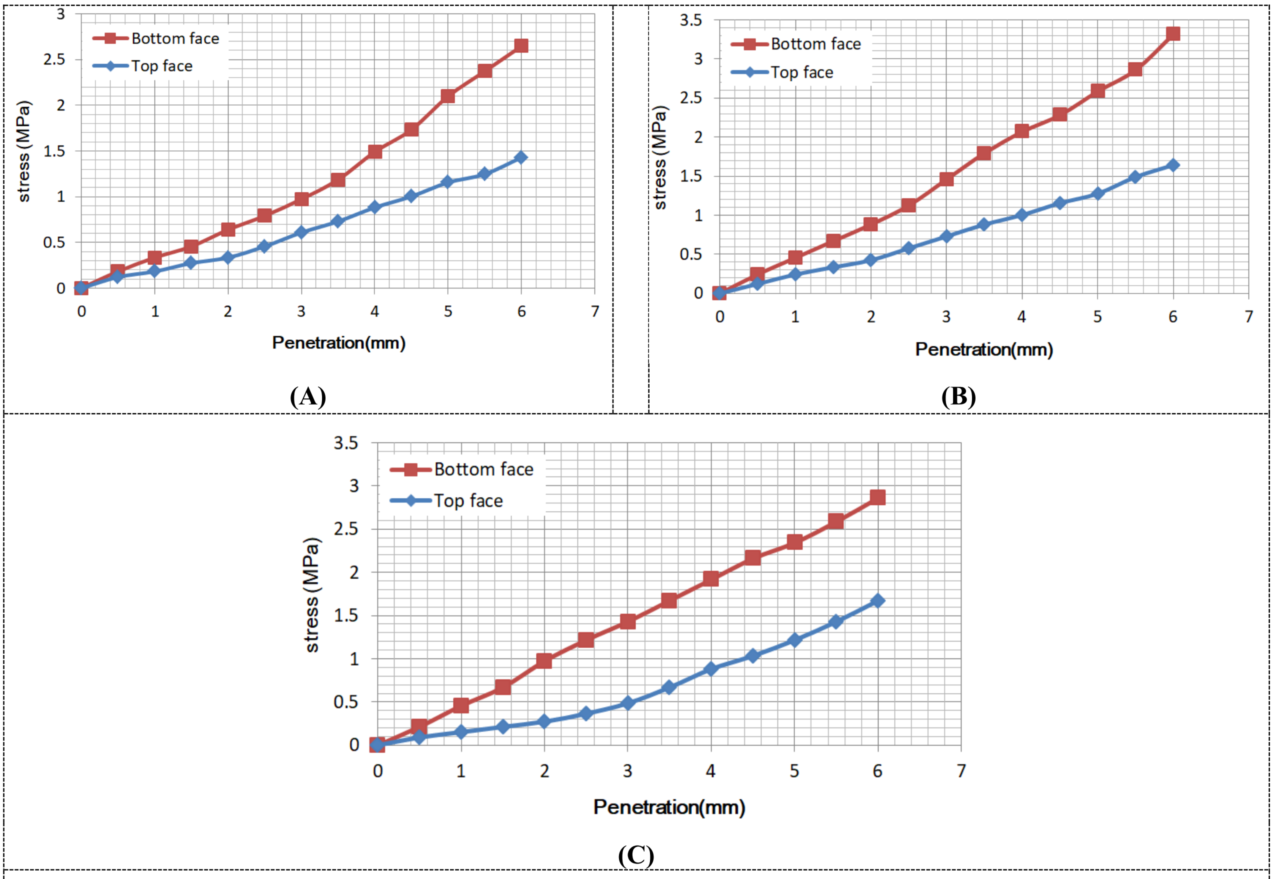

Fig. 13: CBR-curves for emulsified asphalt bulk stabilized soil: (A) 1%; (B) 2%; (C) 3%.

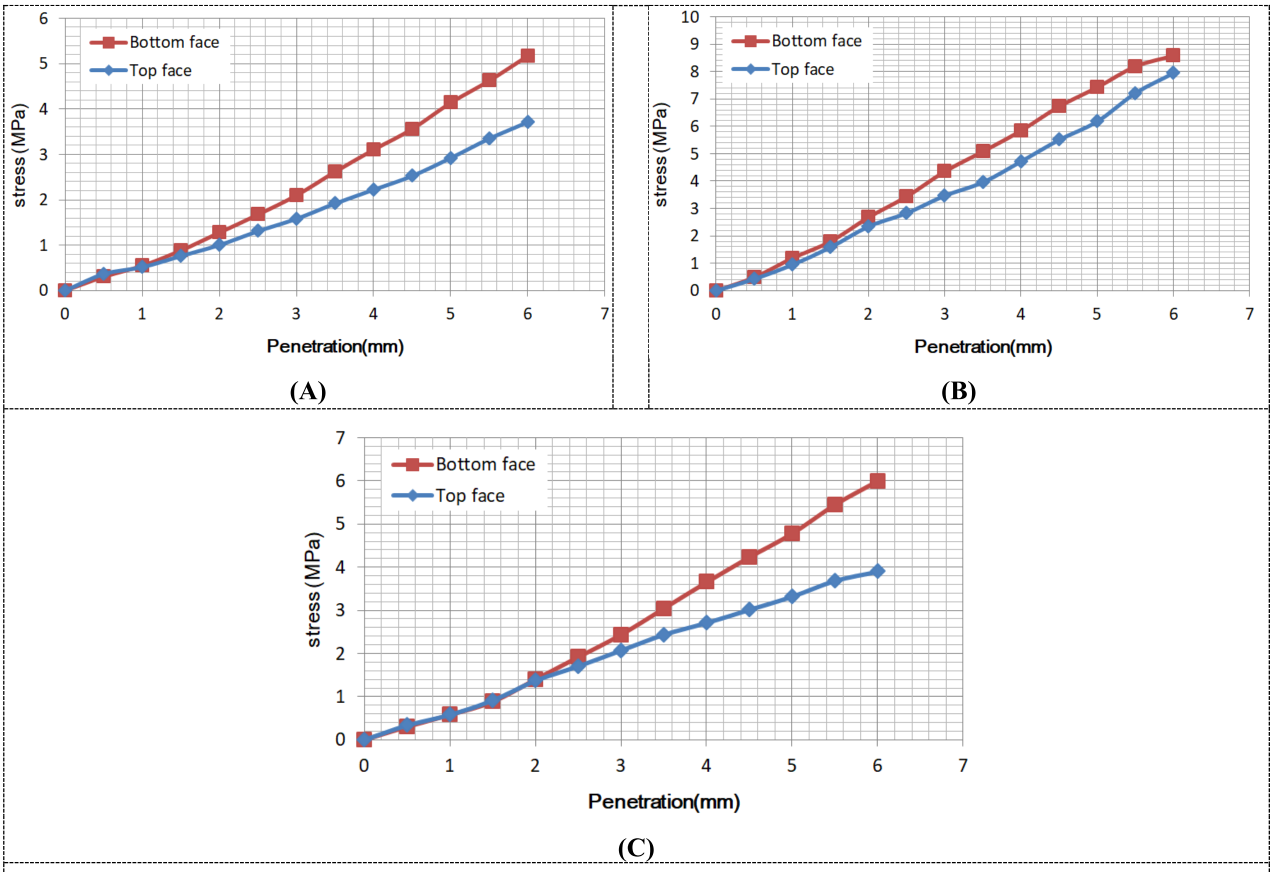

Fig. 14: CBR-curves for SBR-bulk stabilized soil: (A) 1%; (B) 2%; (C) 3%.

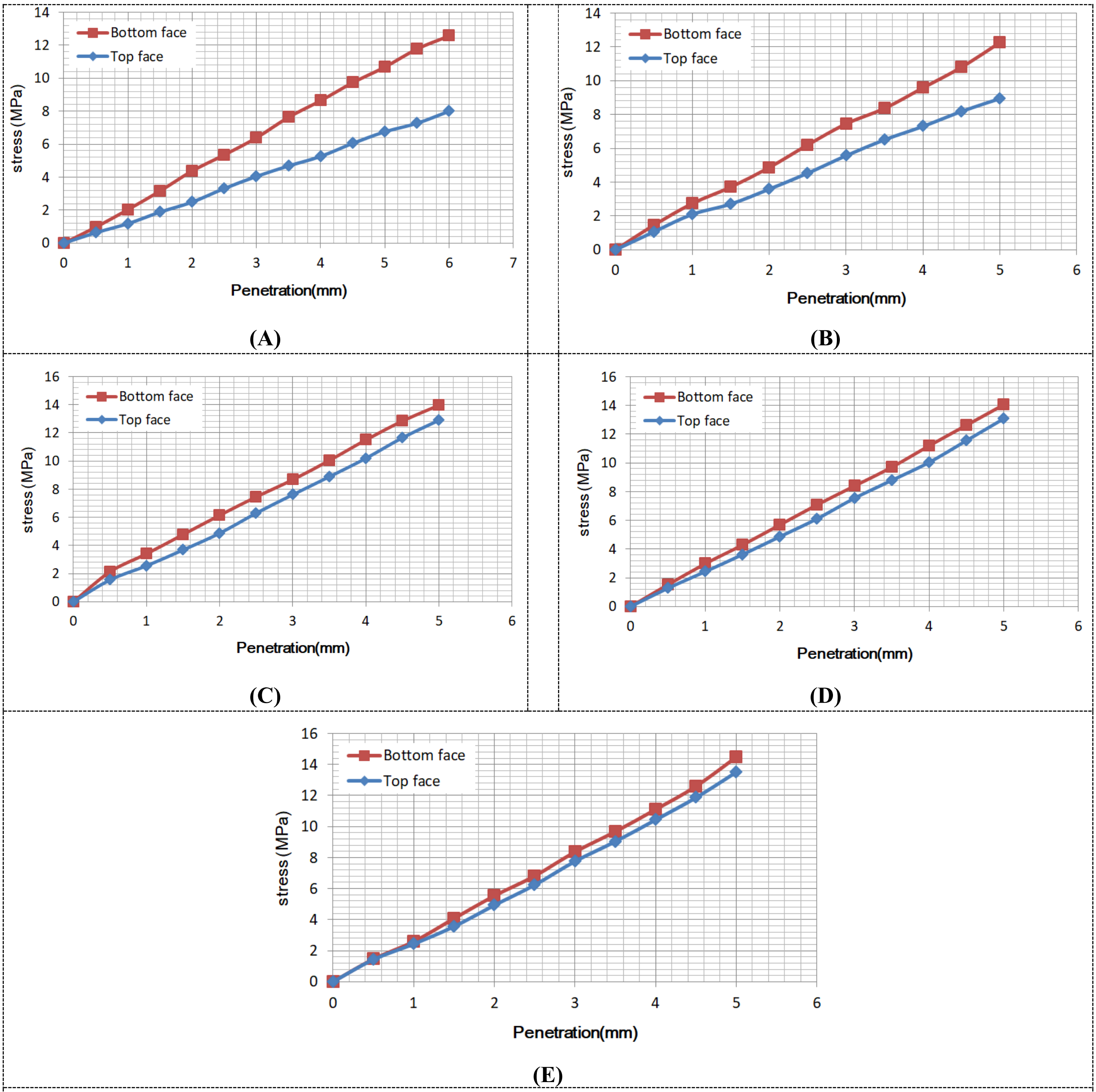

Fig. 15: CBR-curves for cement bulk stabilized soil: (A) 2.5%; (B) 5.0%; (C) 7.5%; (D) 10.0%; (E) 12.5%.

The penetration-stress relations for soaked samples prepared at addition ratios giving the highest bulk CBR-values are illustrated in Figures (16) to (20).

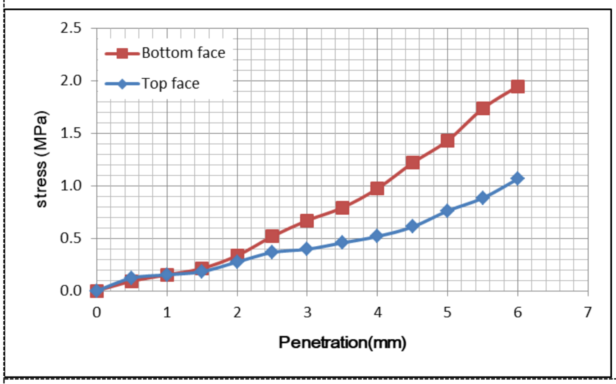

Fig. 16: CBR-curves for the soaked natural soil.

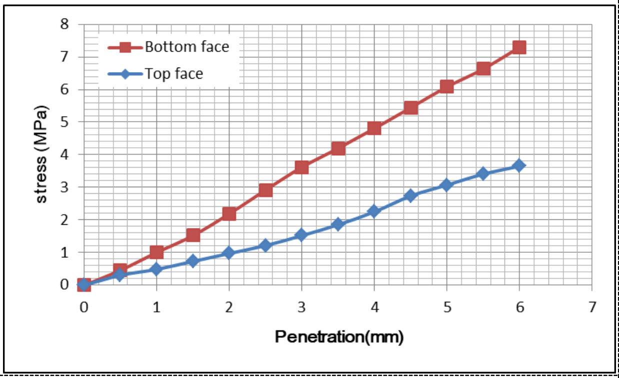

Fig. 17: CBR-curves for the (4%) cutback asphalt soaked stabilized soil.

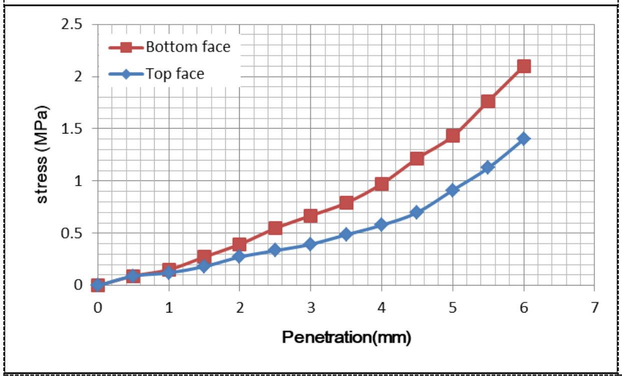

Fig. 18: CBR-curves for the (2%) emulsified asphalt soaked stabilized soil.

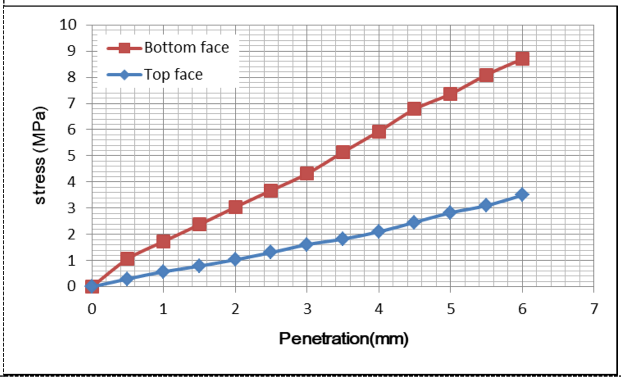

Fig. 19: CBR-curves for the (2%) SBR- soaked stabilized soil.

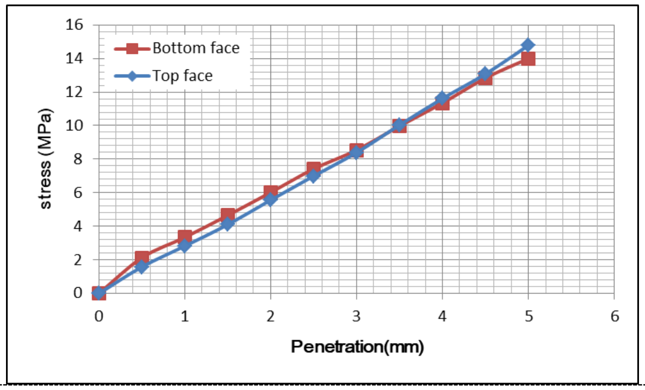

Fig. 20: CBR-curves for the (7.5%) cement soaked stabilized soil.

It is clear that, the CBR-values for the bottom faces are always higher than their counterparts for the top ones. For cement stabilized samples, the two values approaches each other as the cement content increases.

Table (3) shows the results for the optimal ratios of additives (except cement) that give the highest CBR-values for bulk and soaked samples, which will be used in preparing samples for evaluating the permanent deformations (rutting).

Table 3: Optimum percentage values of additives based on the (CBR) values.

Additive type	Optimum Addition (%)	Bulk (CBR) (%)	Soaked (CBR) (%)	(Soaked CBR / Bulk CBR) x 100 (%)
Natural soil	0	11.67	10.63	91.09
Cutback Asphalt	4	53.60	44.45	82.93
Emulsified Asphalt	2	18.75	11.37	60.64
SBR	2	66.01	49.47	74.94
Cement	7.5	130.39	139.69	107.13

The CBR test results under bulk conditions show a clear improvement in bearing capacity after the addition of stabilizing agents compared to the natural soil. The CBR value increased from 11.67% for the original soil to 53.60% with the addition of 4% cutback asphalt, 18.75% with 2% emulsified asphalt, and 66.01% with 2% SBR. The highest value, 130.39%, was recorded when using 7.5% cement. This improvement is attributed to increased cohesion between soil particles and improved internal structure. Bituminous and polymeric materials coat the particles and enhance surface bonding, while cement forms strong cementitious bonds that significantly increase stiffness and resistance.
However, under soaked conditions, the results showed different behavior. The CBR value of natural soil decreased to 10.63% due to the effect of water in reducing friction and cohesion between particles. CBR values for bituminous materials and SBR

also decreased to varying degrees, with Cutback Asphalt registering a decrease of 44.45%, Emulsified Asphalt 11.37%, and SBR 49.47%. This is attributed to their poor moisture resistance and loss of some bonding when exposed to water.
In contrast, cement exhibited exceptional behavior under soaking conditions, with its CBR value increasing to 139.69%, higher than its natural state. This is due to the continued hydration reactions and the development of cementitious bonds in the presence of water, leading to increased hardness and penetration resistance.

3.3. Rutting (Wheel Tracking) Tests

After determining the optimum percentage of the stabilizing additives based on the compaction and the CBR-tests, the wheel tracking tests are conducted on the specimens to evaluate their resistance to permanent deformations (rutting) under repeated loading.
The test was conducted under three different methods for each soil type. In the first method, the compacted sample was placed in an oven at a temperature of 40°C for 24 hours, while in the second method the sample was conditioned at 60°C after compaction and also for 24 hours. In the third method, the compacted specimen was soaked in water for four days.

A. Rutting evaluation of the natural soil

The rutting resistance of natural soil is very low, as shown in Figure (21), which presents the relationship between the number of loading cycles and the resulting rut depth. The results indicate that the rut depth at (1000) loading cycles is (53 mm) at a temperature of (40 °C) and (41 mm) at (60 °C), while under soaked conditions the specimen experienced failure and recorded a rut depth of (59 mm) at only (35) loading cycles, (Figure 22).

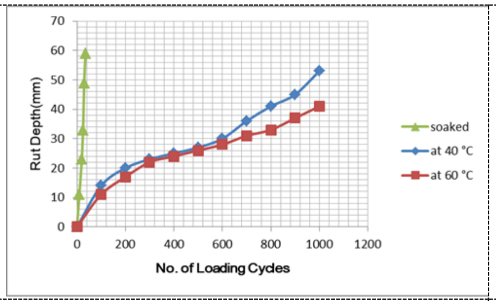

Fig. 21: Wheel tracking test results of the natural soil.

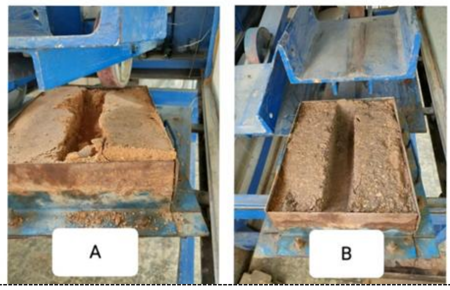

Fig. 22: Rut shape of the natural soil: (A) at a temperature of (40 °C); (B) under soaking conditions

B. Rutting evaluation of the cutback asphalt-stabilized soil

The results show early rutting occurrence after starting the test, where after (100) wheel passes the rut depth reached (14 mm) at (40°C) and (15 mm) at (60°C), as shown in Figure (23). Under the soaked conditions, the sample collapsed after (6 cycles) of device operation, (Figure 24).

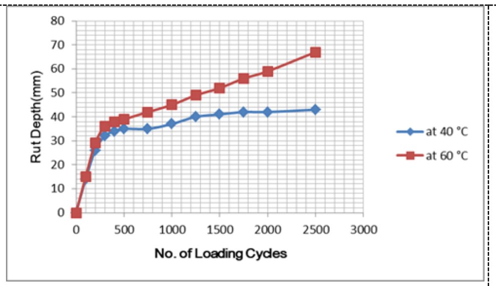

Fig. 23: Wheel tracking test results of the (4%) cutback asphalt-stabilized soil.

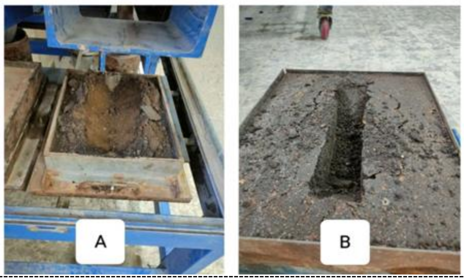

Fig. 24: Rut shape of the (4%) cutback asphalt-stabilized soil: (A) At a temperature of (40 °C); (B) under soaking conditions.

C. Rutting evaluation of the emulsified asphalt-stabilized Soil

The results revealed insignificant improvement in the rutting resistance due to the addition of this agent, as shown in Figure (25). When the test is conducted on a soaked sample, collapse is recorded during loading, (Figure 26).

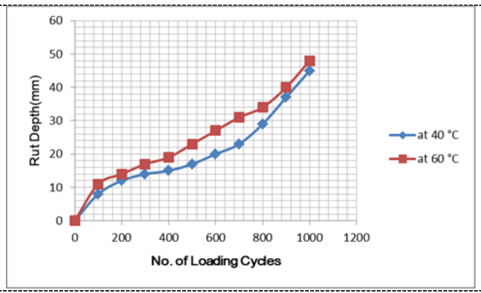

Fig. 25: Wheel tracking test results of the (2%) emulsified asphalt-stabilized soil.

Fig. 26: Rut shape of the (2%) emulsified asphalt-stabilized soil: (A) At a temperature of (40 °C); (B) under soaking conditions.

D. Rutting evaluation of the SBR-stabilized soil

The test results produced permanent deformation depths of (5 mm) at (40°C) and (3 mm) at (60°C) at (5000 cycle), (Figure 27). In soaking conditions, the rut depth reached (33 mm) at (150) loading cycles, (Figure 28).

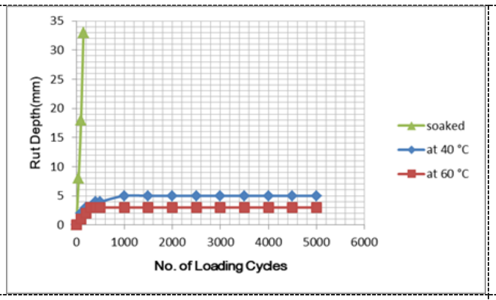

Fig. 27: Wheel tracking test results of the (2%) SBR- asphalt stabilized soil.

Fig. 28: Rut shape of the (2%) SBR-asphalt stabilized soil: (A) At a temperature of (40 °C); (B) At (60°C); (C) under soaking conditions.

E. Rutting evaluation of the cement-stabilized soil

Results showed that, using (7.5%) cement in stabilizing the natural soil is an effective method to resist permanent deformation, where a total rut depth of (1 mm) is recorded for all tested samples (at 40°C, at 60°C, and soaked) under a continuous loading of (10,000 cycles).

Fig. 29: Rut shape of the (7.5%) cement-stabilized soil.

The addition of cutback asphalt, emulsified asphalt, and even SBR stabilization did not result in a significant increase in rutting resistance because these materials primarily coat the soil particles with a sticky layer that only increases surface cohesion, without forming a robust, solid structure capable of withstanding repeated loads. At high temperatures or exposure to moisture, the viscosity of bituminous materials decreases, and they lose some of their rigidity, allowing for permanent deformation under load.

On the other hand, Cement reacts chemically with water and soil, forming strong cementitious bonds within the soil structure. This results in a highly rigid, rock-like structure that is resistant to repeated deformation and moisture. Therefore, the rutting resistance of cement-stabilized soils was significantly higher compared to bituminous and polymer-based materials.

The effect of temperature does not exhibit a regular trend, and is vanished for the cement stabilized soil.

4. Conclusion

An experimental investigation of the effects of using additives in enhancing the rutting resistance of stabilized earth roads is conducted. The main conclusions of the study can be stated as follows:

1. Stabilizing soil with (7.5%) of cement achieves the best overall performance regarding high resistance to rutting in both bulk and submerged conditions. It has an effective ability to improve soil structure and resistance to permanent deformations under various environmental conditions.
2. The addition of (SBR) leads to a clear improvement in rutting resistance under dry conditions, where it exhibited low rutting depth values, but it failed under wet conditions, where rutting resistance decreased significantly.
3. The cutback asphalt and emulsified asphalt additives showed a clear weakness in rutting resistance, as the samples failed at a low number of loading cycles, indicating an inability to resist repeated loads.
4. Although all materials improved CBR-values, this improvement was not necessarily a direct indicator of improved rutting resistance, confirming that permanent deformation resistance requires additional mechanical properties beyond static penetration resistance.
5. The results show that the choice of stabilizing material should not be based only on improved CBR-values or compaction characteristics, but should be based on a comprehensive assessment of soil performance under repeated loads and in various moisture conditions.
6. CBR-values for soaked stabilized soils decrease significantly, except for cement-stabilized soils, where they increase.

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