TECHNICAL REPORT

ON

THE EFFECTS OF ADDING EN-1 ON THE COMPRESSION CHARACTERISTICS AND ON THE STRESS RESISTANCE PROPERTIES OF THE BASE-LAYER'S MATERIALS

PREPARED BY:

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DARS … DAR AL-ISTISHRAT AL-HANDASIYAH
[ENGINEERING CONSULTING FIRM]

JANUARY 2001

The Effect of Adding EN-1 on the Compression Characteristics and on the Stress Resistance Properties of the Base-Layer's Materials

1- INTRODUCTION

The Highways Engineering Consultancy Unit at Ain Shams University [in Cairo – Egypt], at the request of Dars Engineering Consulting Firm, conducted a series of gradation, modified Proctor and CBR experiments on specimen of the base materials used in highway construction such as the lime stones after adding EN-1 material at the rate of 1:300 and 1:500 to the water in order to determine the effect of adding this material on the natural and mechanical properties of the specimen of the base materials.

This report was prepared in order to analyze the results of the limited laboratory experiments which were conducted on the base-layer's materials and reach the results and recommendations in regards to the extent of effect adding EN-1 material would be on the base-layer's materials.

2- LABORATORY EXPERIMENTS

The following experiments were conducted at the Faculty 0f Engineering of Ain Shams University:

1- Gradation experiments on the base layer.

2- Modified Proctor experiments on specimen from the base layer:

- Without addition.
- With adding EN-1 material at the rate of 1:300 in weight of water.
- With adding EN-1 material at the rate of 1:500 in weight of water.

3- CBR experiments on specimen of the base layer.
- Without addition.
- With adding EN-1 material at the rate of 1:300 in weight of water.
- With adding EN-1 material at the rate of 1:500 in weight of water.

Appendix (A) contains the results of the experiments conducted at the laboratory.

3- ANALYSIS OF THE RESULTS:

Table (1) summarizes the results of the modified Proctor and CBR experiments. Figures 1,2,3 and 4 show the effects of adding EN-1 on the natural and mechanical properties of the base layer materials.

3-1 The Effect of Adding EN-1 on Maximum Dry Density:

Figure (1) illustrates the effect of adding EN-1material to the maximum dry density that was obtained from the modified Proctor experiment.

This figure shows that when the density of EN-1 increases, the dry density value increases. For example, the density increased from 1,960 tons/m^3 of the base layer, without any additions to 2,010 tons/m^3 when EN-1 material was added at a density of 1:300.

The experiment leads to the conclusion that under the same pressure adding EN-1 material leads to acquiring higher density for the base layer. In another word, one can get the same dry density of the base layer (without additions) with less stress pressure when EN-1 material is added.

3-2 The Effect of Adding EN-1 on the Optimum Amount of Water:

Figure (2) illustrates the effect of adding EN-1 material on the optimum amount of water needed to achieve maximum dray density in the modified Proctor experiment.
It also shows that adding EN-1 material reduces the amount of water needed to achieve the maximum dry density by a rate of approximately 30% at density of 1:300 and approximately 10% at density of 1:500. It leads us to conclude that adding the concentration of EN-1 by weight in the water reduces the amount of water needed to be added to the base layer to achieve maximum dry density.

3-3 The Effect of adding EN-1 to CBR:

Figure (3) illustrates the effect of adding EN-1 on the rate of CBR after covering the base layers. By reading the CBR from this figure, it shows that it increase by adding

the EN-1 material. Also the solidity increases when the concentration of EN-1 material increases. The solidity of CBR increased from 41 (of the base layer without additions) to 79 at concentration of 1:500, and it increased to 86 at concentration of 1:300.

Figure (4) illustrates the percentage increase of the solidity of the CBR when EN-1 material was added. The ratio of solidity increased from 92.7% when EN-1 was added at concentration of 1:500 and to 109.8% when EN-1 was added at concentration of 1:300.

4 - Summery and Recommendations

Based on the experiments, which were conducted on the base layer without addition and after addition of EN-1 material at different rates of concentration, one can conclude the following preliminary results:

a- The results of the modified Proctor experiments show that the addition of the EN-1 to the base layer materials results in greater dry density than is possible without the use of EN-1, and also to reach higher degree of compression.

b- The results of the modified Proctor experiments also showed that an increase in the EN-1 concentration increases the achievable maximum dry density. It means, that under the same power of compression we can reach high density by increasing the concentration of EN-1 material in the water added to the base layer.

c- The results of the modified Proctor experiments showed that the more the concentration of the EN-1 material increased, the less amount of water is needed to achieve the maximum dry density. It is less by a ratio of 10% (at concentration of 1:500) to 30% (at concentration of 1:300).

d- In general, when we add EN-1 material to the base layer, less water is needed and we acquire high dry density in compared to a base layer without additions.

e- The results of the modified Proctor experiments show that by increasing the concentration of the EN-1 material the solidity of the CBR of the base layer increases by a ratio of 90.00% (at concentration of 1:500) to 109.00% (at concentration of 1:300).

Signed by: Dr. Ihab HussAin Fahmi, and dated: January 13, 2001

Appendix A

Experiments Conducted on Specimen of Base Layer Materials

Highway Engineering Consultancy Unit
Faculty of Engineering – Ain Shams University
Tel: 287--- Fax: 2858618 Al-Abbasiyah – Cairo

Date: December 19, 2000 Ref. Serial No. S888 Page 1/2
Client: Dar Al-Istisharat Al-Handasiyah, Dr. Mustafa Qarashi
Contractor: Dar Al-Istisharat Al-Handasiyah, Dr. Mustafa Qarashi
Site:
Specimen: Limestone specimen
==========

Several specimen of limestone from different geological strata were received. Based on the client's letter of assignment, the specimen were classified in the following order:

Size of Gradation tray	Rate of movement
2”	100
1.5”	93.0
1”	88.0
3/4"	82.0
1/2"	78.0
3/8”	73.0
Number 4	67.0
Number 10	54.9
Number 40	50.3
Number 100	30.2
Number 200	15.4

The results of the modified Proctor and CBR tests were as follows:

a) Maximum density using the modified Proctor test is 1.96 Gr./Cm³
   Optimum water ratio is 10.6%
b) CBR ratio after cover is 41%

Signed by:

Lab Engineer	Lab Supervisor	Unit Manager
[Illegible signature]	Dr. Hamdi El-Sayed	Dr. Saeed Fahmi

Square stamp: Highway Engineering Consultancy Unit
Faculty of Engineering – Ain Shams University
Outgoing document number: 546
Date: December 20, 2000
Number of Attachments: 2
Round stamp: Faculty of Engineering
Ain Shams University
Signature
Rectangular stamp: Highway Engineering Consultancy Unit
HECU
Faculty of Engineering – Ain Shams University

Highway Engineering Consultancy Unit
Faculty of Engineering – Ain Shams University
Tel: 287--- Fax: 2858618 Al-Abbasiyah – Cairo

Date: December 19, 2000 Ref. Serial No. S888
Client: Dar Al-Istisharat Al-Handasiyah, Dr. Mustafa Qarashi
Contractor: Dar Al-Istisharat Al-Handasiyah, Dr. Mustafa Qarashi
Site:
Specimen: The specimen after adding to it the material (ROADBOND EN1)
==========

The results of the tests conducted on the received specimen: -

1- <u>In case of concentration level of 1/300</u>
   a) Maximum density using the modified Proctor test is 2.045 Gr./Cm³
      Optimum water ratio is 7.6%
   b) CBR ratio after cover is 86%

1- <u>In case of concentration level of 1/500</u>
   a) Maximum density using the modified Proctor test is 2.01 Gr./Cm³
      Optimum water ratio is 9.5%
   b) CBR ratio after cover is 79%

Signed by:

Lab Engineer	Lab Supervisor	Unit Manager
[Illegible signature]	Dr. Hamdi El-Sayed	Dr. Saeed Fahmi

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Faculty of Engineering – Ain Shams University
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HECU
Faculty of Engineering – Ain Shams University

Arab Consultants
Othman Ahmad Othman Co.
Highway Department

A Study about the Effects of the EN1 Material On the Base Layer using the CBR test

Introduction

Dr. Alaa El-Din Eid presented to us samples of a liquid material under the name EN1, in 75 containers. He explained that the EN1 material has been used in the United States of America to improve the strength of the soil as measured by the CBR tests, and also to reduce the softness by reducing or completely stopping the seeping of water into the materials used in road construction. He added that, in general, this material could be used with the same efficiency in the Arab Republic of Egypt.

Based on the above the following experiments were conducted:

1- A specimen was identified to compare all the results with it.

This specimen was taken in two stages: The first contains 50% fine and 50% coarse.

The second contains 40% fine and 60% coarse.

2- CBR test was conducted in both stages.

3- CBR test was conducted in both stages adding 2% of cement dust.

4- CBR test was conducted in both stages adding 0.5% of regular Portland cement.

5- CBR test was conducted on all above samples (2,3,4) adding the EN! Material with concentration level of 1/500 and 1/300.

The acquired results showed that it increased the CBR by using this material EN1 reaching approximately 193.73% in the optimum case of comparison with the original specimen. Dr. Eid stated and presented supporting information that this material was approved by the American G.S.A. organization, which is specialized in measuring and checking the compliance of materials with American government's specifications. He presented also the results of the experiments, which were conducted at the laboratories of the Egyptian Department of Roads and Bridges, which support the above results as well as the results of the central laboratories of the Department of Roads. The following are the results of these experiments: -

Work Schedule: -

1- We obtained a container of EN1 material.

2- We reduced this material's concentration to 1/500 and 1/300.

3- We conducted experiments on the limestone, which has low resistance (Los Angeles 55%) by adding 2% of the cement dust, 0.5% of cement.

4- Test was conducted on the above specimens.

a. Limestone only: 1. 50% fine
2. 40% fine

EN1 concentration 1/500 and 1/300 was added.

b. EN1 concentration 1/500 and 1/300 was added to the Limestone with the above ratios of fineness plus 2% cement dust.

c. EN1 concentration 1/500 and 1/300 was added to the Limestone with the above ratios of fineness plus 0.5% cement.

5- The CBR was set in each case as indicated above.

EN1 Material

Dr. Alaa El-Din Eid arranged for the delivery of a container of EN1 material weighed (75) lb., which we reduced its concentration to 1/500 and 1/300 to be used in the experiments.

Results

Rocky Soil (SN6)

First:

50% Fine 50% Coarse

Specimen - Number	Description	Modified Proctor Max Dry – Density	Original - Water %	CBR%	Expansion
1	SN 6 without additions	1.84	4.8%	39.9	-0-
2	SN 6 + 2% Cement Dust	1.89	4.5%	56.7	-0-
3	SN 6 + 0.5% Cement	1.89	4.5%	95	-0-
4	SN 6 + 1/500 EN1	--	--	66.5	-0-
5	SN 6 + 1/300 EN1	--	--	77.3	-0-
6	SN 6 + 2% Cement Dust + 1/500 EN1	--	--	100	-0-
7	SN 6 + 2% Cement Dust + 1/300 EN1	--	--	77	-0-
8	SN 6 + 0.5% Cement + 1/500 EN1	--	--	103.7	-0-
9	SN 6 + 0.5% Cement + 1/300 EN1	--	--	147.6	-0-

Comment:-

The above results indicate the high level of CBR expressed as the soil strength.

For SN 6 only to approximately 166.67 of equivalence at concentration rate of 1/500 of EN1
to approximately 193.73 of equivalence at concentration rate of 1/300 of EN1
For SN 6+2% cement dust to approximately 176.37 of equivalence at concentration rate of 1/500 of EN1
For SN 6+2% cement dust to approximately 135.8 of equivalence at concentration rate of 1/300 of EN1
For SN 6+0.5 cement to approximately 109.16 of equivalence at concentration rate of 1/500 of EN1
For SN 6+0.5 cement to approximately 155.37 of equivalence at concentration rate of 1/300 of EN1

Second:-

40% Fine 60% Coarse

Specimen - Number	Description	Modified Proctor Max Dry – Density	Original - Water %	CBR%	Expansion
1	SN 6 without additions	1.86	4.7%	78.1	-0-
2	SN 6 + 2% Cement Dust	1.86	5.1%	76.8	-0-
3	SN 6 + 0.5% Cement	1.86	5.1%	84.2	-0-
4	SN 6 + 1/500 EN1	--	--	104.6	-0-
5	SN 6 + 1/300 EN1	--	--	134.9	-0-
6	SN 6 + 2% Cement Dust + 1/500 EN1	--	--	90.5	-0-
7	SN 6 + 2% Cement Dust + 1/300 EN1	--	--	80.4	-0-
8	SN 6 + 0.5% Cement + 1/500 EN1	--	--	101.7	-0-
9	SN 6 + 0.5% Cement + 1/300 EN1	--	--	120.3	-0-

Comment:-

The above results indicate the high level of CBR expressed as the soil strength.

For SN 6 only to approximately 133.93 of equivalence at concentration rate of 1/500 of EN1
to approximately 172.73 of equivalence at concentration rate of 1/300 of EN1
For SN 6+2% cement dust to approximately 117.84 of equivalence at concentration rate of 1/500 of EN1
For SN 6+2% cement dust to approximately 104.69 of equivalence at concentration rate of 1/300 of EN1
For SN 6+0.5 cement to approximately 120.78 of equivalence at concentration rate of 1/500 of EN1
For SN 6+0.5 cement to approximately 142.87 of equivalence at concentration rate of 1/300 of EN1

Summary of the Results of Experiments on the Effect of EN1 Material On the Strength of Resistance of CBR on the Base Ground Layer

Fine: Coarse
50 : 50

Results	Without EN1			With EN1					
				Concentration 1/500			Concentration 1/300		
	SN6 only	Add 2% Cement-Dust	Add 0.5%	SN6 only	Add 2% Cement-Dust	Add 0.5% Cement-	SN6 only	Add 2% Cement-Dust	Add 0.5% Cement
CBR 1”	39.9	56.7	95	66.5	100	103.7	77.3	77	147.6
% Increase from original specimen		142.11	238.10	166.67	176.37	109.17	193.73	135.80	155.37

Fine: Coarse
40 : 60

Results	Without EN1			With EN1					
				Concentration 1/500			Concentration 1/300		
	SN6 only	Add 2% Cement-Dust	Add 0.5%	SN6 only	Add 2% Cement-Dust	Add 0.5% Cement-	SN6 only	Add 2% Cement-Dust	Add 0.5% Cement
CBR 1”	78.1	76.8	84.2	104.6	90.5	101.7	134.9	80.4	120.3
% Increase from original specimen		95.34	107.81	133.93	117.84	120.78	172.73	104.69	142.87

MINISTRY OF TRANSPORTATION
DEPARTMENT OF ROADS, BRIDGES AND LAND TRANSPORTATION
HEADQUARTERS OF CENTRAL LABORATORIES

EXPERIMENTAL STUDY ON THE EFFECTS OF EN1 MATERIAL ON THE CHARACTERISTICS OF THE BASE LAYER AND MUD SOIL MATERIALS

First: (Rocky Soil SN6)

Explaining the specimens:

Specimen number 702 SN consists of white limestone.

Experiments Conducted:
1- Gradation Analysis.
2- Erosion by Los Angeles Equipment.
3- Specific gravities, absorption and dilution in water.
4- Modified Proctor (without adding the material and with adding it at different ratios).
5- CBR ratio (without adding the material and with adding it at different ratios).

Ministry of Transportation
Department of Roads, Bridges and Land Transportation
Headquarters of Central Laboratories

Name of Project	Specimens Regarding EN1 Material
Contractor Company	Dr. Alaa El-Din Eid Company

RESULTS

Size of Gradation Tray	Rate of movement	Specifications of the base layer (B)
First: Gradation		
2”	100	100
1.5”	91	70/100
1”	70	55/85
3/4"	60	50/80
3/8”	43	40/70
Number 4	35	30/60
Number 10	29	20/50
Number 40	23	10/30
Number 200	18	5/15
Second: Los Angeles		
Los Angeles after 500 Round	54	50
Third:		
Specific gravity	2.12	
Specific gravity Saturated	2.3	
Specific gravity Apparent	2.56	
Absorption	8.1	
Erosion	3.4	

First: Rocky Soil SN6

Specimen - Number	Description	Modified Proctor Max Dry – Density	Original - Water %	CBR%	Expansion
702	SN 6 without additions	1.946	10	73	-0-
(a)	N 6 + 4% Cement Portland - Regular	1.979	11	165	-0-
(b)	SN 6 + 1/300 EN1	1.970	9.5	122	-0-
(c)	SN 6 + 2% Cement + 1/500 EN1	1.942	10.5	227	-0-
(d)	SN 6 + 1/500 EN1	1.990	8.5	91	-0-
(e)	SN 6 + 1/500 EN1 after bAing treated for a week at room temperature	1.990	8.5	113	-0-

Remarks

Studying the above results we conclude the following:

1- The increase in the CBR for a weak soil, where it exceeds the limits of specifications. In Los Angeles (54), it increases from 73 to 122, i.e. at a ratio of 67% when EN1 is added at the rate of 1:300 in weight.

2- The increase in the CBR from 73 to 91, i.e. at a ratio of 25% when EN1 is added at the rate of 1:500 in weight.

3- The increase in the CBR from 73 to 113, i.e. at a ratio of 55% when EN1 is added at the rate of 1:500 in weight and after bAing treated for a week at room temperature.

4- Other experiments were conducted with adding different percentages of cement. The results were a substantial increase in CBR, as indicated above.

Second: Gravel Soil

Specimens' description:

Specimen number 703 gravel soil reddish in color.

Conducted Experiments:

1- Curved Analysis.

2- Liquidity and pliability.

3- Modified Proctor tests with and without adding EN1, in different percentages.

4- CBR tests with and without adding EN1, in different percentages.

RESULTS

Size of Gradation Tray	Rate of movement	Specifications of the base layer (B)
First: Gradation		
2”	100	100
1.5”	91	70/100
1”	70	55/85
3/4"	60	50/80
3/8”	43	40/70
Number 4	35	30/60
Number 10	29	20/50
Number 40	23	10/30
Number 200	18	5/15
Second: Liquidity and pliability		
Liquidity level	33	Not to exceed 30
Pliability range	17	Not to exceed 10

Specimen - Number	Description	Modified Proctor Max Dry – Density	Original - Water %	CBR%	Expansion
703	Gravel soil without addition	2.18	6.8	27	0.3
(a)	Gravel soil + 1:500 EN1	2.180	6.8	85	-0-
(b)	Graver soil + 1:500 after bAing treated for a week at room temperature.	2.180	6.8	81	-0-

Remarks

Studying the above results we conclude the following:

1- The increase in the CBR for a gravel soil with high pliability is from 27 to 85, i.e. at a ratio of 215% when EN1 is added at the rate of 1:500.
2- The increase in the CBR for a gravel soil with high pliability is from 27 to 81, i.e. at a ratio of 200% when EN1 is added at the rate of 1:500, after bAing treated for a week at room temperature.

Third: Mud Soil

Specimens' description:

Specimen of mud weak soil CBR level 4%.

Conducted Experiments:
Compression and CBR experiments were conducted on the specimen. Humidity was measured before and after cover to know the effect of this material on the seeping through the soil.

Results

		Proctor		CBR%	Humidity	
		Max Dry – Density	Humidity %		Before Cover	After Cover
-	Regular soil	1.622	1.98	4	19.75	18.87
-	Soil with EN1, immediately covered	1.596	19.2	6.4	19.18	20.14
-	Soil with EN1, covered after 24 hrs.	1.596	19.2	5.5	19.19	17.05

Remarks

Studying the above results we conclude the following:

1- The increase in the CBR from 4 to 6.4, that is at a ratio of 60%. That is after adding EN1 and covering immediately.
2- The increase in the CBR from 4 to 5.5, that is at a ratio of 38%. That is after adding EN1 and covering after 24 hours.
3- The ratio of humidity in the case of covering immediately after compression increases by 5% from it before covering. As in the case of the cover after leaving the container for 24 hours in the open air after compression, the percentage of humidity decreases by 11% from it before covering. It means that the EN1 material prevent the water from seeping through the specimen. Thus the amount of humidity is not affected because of the existing water or the surface or under ground.

Comment

Studying the results of the above experiments which were conducted on different materials, such as weak limestone, gravel soil high in pliability and the weak mud soil, we conclude that EN1 material helps to improve the weak mud soil, enhances their characteristics, prevent water seepage and helps to secure the soil.

… the EN1 material had been approved in the past by GSA Organization, which is specialized in measuring and checking the compliance of materials with American government's specifications.

Initialed by two signatures.
Signed by the General Manager of the Central Laboratories
Ms. Siham Abdul-Salam, Engineer

MINISTRY OF TRANSPORTATION
DEPARTMENT OF ROADS, BRIDGES AND LAND TRANSPORTATION
HEADQUARTERS OF CENTRAL LABORATORIES

A STUDY ON THE EFFECTS OF EN1 MATERIAL ON THE CHARACTERISTICS OF THE BASE LAYER AND MUD SOIL MATERIALS

** Limestone (Specimen number 702)

A quantity of limestone was delivered, white color, graded according to the enclosed. They are weak stones (remnants of quarries, high in progressive erosion, Los Angeles 45). The following statement indicates the quality of this specimen.

Gradation Tray	Rate of movement	Specifications of the base layer (B)
First: Gradation		
2”	100	100
1.5”	91	70/100
1”	70	55/85
3/4"	60	50/80
3/8”	43	40/70
Number 4	35	30/60
Number 10	29	20/50
Number 40	23	10/30
Number 200	18	5/15
Second: Los Angeles		
Los Angeles after 500 Round	54 less than	50
Third:		
Specific gravity	2.12	
Specific gravity saturated	2.3	
Specific gravity Apparent	2.56	
Absorption	8.1 less than	10%
Fritter by water	3.4 less than	5%

** Gravel Soil

Sufficient quantity of gravel soil was delivered, high in pliability, graded according to the enclosed, with the results of experiments.

Gradation Tray	Rate of movement	Specifications of the base layer (B)
First: Gradation		
2”	96	100
1.5”	88	70/100
1”	82	55/85
3/4"	75	50/80
3/8”	62	40/70
Number 4	49	30/60
Number 10	35	20/50
Number 40	21	10/30
Number 200	9	5/15
Second: Liquidity and pliability		
Liquidity level	33	Not to exceed 30
Pliability range	17	Not to exceed 10

** Limestone Powder

Sufficient quantity of limestone powder was delivered, with coarse grading, and was used in the experiments. The results of these experiments are enclosed.

Gradation Tray	Rate of Movement %
Number 4	100
Number 10	95
Number 40	68
Number 200	49

The Cement

A specimen of the regular Portland cement was delivered. It was tested for suitability and was found to meet the specifications of the regular Portland cement stipulated by the Egyptian Department for Uniformity in Measurements ISO.

Conducted Experiments:

Several experiments were conducted on the above-mentioned materials with and without adding the EN1, in various proportions. The results of these experiments were the following:

First: Rocky Soil SN6

Results

Specimen - Number	Description	Modified Proctor Max Dry – Density	Original - Water %	CBR%	Expansion
702	SN 6 without additions	1.946	10	73	-0-
(a)	N 6 + 4% Cement Portland - Regular	1.979	11	165	-0-
(b)	SN 6 + 1/300 EN1	1.970	9.5	122	-0-
(c)	SN 6 + 2% Cement + 1/500 EN1	1.942	10.5	227	-0-
(d)	SN 6 + 1/500 EN1	1.990	8.5	91	-0-
(e)	SN 6 + 1/500 EN1 after bAing treated for a week at room temperature	1.990	8.5	113	-0-

Comments

It is clear from the results of the specimen the increase in the amount of CBR, which refers to the strength of the soil to 125%, after adding the ratio 1:500. It increased also to 167% after adding EN1 at the ratio of 1:300 in weight. That happens after making molds of C.B.R and covers them with water.
Experiments were made on the specimens adding EN1 1:500, keeping the container open for a week at the room conditions. That was in accordance with the recommendations for the use of the EN1, which resulted in an increase in its CBR to 154%.
Other experiments were conducted with adding different percentages of cement and the EN1. The results were substantial increases as indicated above.

Gravel Soil

It is important to use the gravel soil as supporting base layers and foundation in certain places where it is difficult to supply with soil and stones. The gravel soil in certain areas of the country is weak or beyond the specifications of the government. Thus, several experiments were conducted on the gravel soil with and without EN1.

RESULTS for the Mixed Materials (Gravel Soil)

Specimen - Number	Description	Modified Proctor Max Dry – Density	Original - Water %	CBR%	Expansion
703	Gravel soil without addition	2.18	6.8	27	0.3
(a)	Gravel soil + 1:500 EN1	2.180	6.8	85	-0-
(b)	Graver soil + 1:500 after bAing treated for a week at room temperature.	2.180	6.8	81	-0-

Comment

The CBR experiments were conducted on the pliable gravel soil and the results were an increase in the CBR to 300% after treatment for 24 hours and 315% directly after cover.

Mud Materials

Compression and CBR experiments were conducted on the specimen. Humidity was measured before and after cover to know the effect of this material on the seeping through the soil.

		Proctor		CBR%	Humidity	
		Max Dry – Density	Humidity %		Before Cover	After Cover
-	Regular soil	1.622	1.98	4	19.75	18.87
-	Soil with EN1, immediately covered	1.596	19.2	6.4	19.18	20.14
-	Soil with EN1, covered after 24 hrs.	1.596	19.2	5.5	19.19	17.05

Comment

Study in the use of the EN1 in CBR test resulted in an improvement of 160% over the original figures, in the event of covering with water, immediately after compression. It reached only 138% when the specimen was left at room temperature for 24 hours before covering with water.

Humidity Ratio

The ratio of humidity in the case of covering immediately after compression increases by 5% from it before covering. In case of covering with water after leaving the container for 24 hours in the open air after compression, the percentage of humidity decreases by 11% . It means that the EN1 material prevent the water from seeping through the specimen. Thus the amount of humidity is not affected because of the existing water on the surface or under ground.

Signed by the General Manager of the Central Laboratories
Ms. Siham Abdul-Salam, Engineer

Highway Engineering Consultancy Unit
Faculty of Engineering – Ain Shams University
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Date: December 19, 2000 Ref. Serial No. S888 Page 1/2
Client: Dar Al-Istisharat Al-Handasiyah, Dr. Mustafa Qarashi
Contractor: Dar Al-Istisharat Al-Handasiyah, Dr. Mustafa Qarashi
Site:
Specimen: Limestone specimen
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Several specimen of limestone from different geological strata were received. Based on the client's letter of assignment, the specimen were classified in the following order:

Size of Gradation tray	Rate of movement
2”	100
1.5”	93.0
1”	88.0
3/4"	82.0
1/2"	78.0
3/8”	73.0
Number 4	67.0
Number 10	54.9
Number 40	50.3
Number 100	30.2
Number 200	15.4

The results of the modified Proctor and CBR tests were as follows:

a) Maximum density using the modified Proctor test is 1.96 Gr./Cm³
Optimum water ratio is 10.6%
b) CBR ratio after cover is 41%

Signed by:

Lab Engineer	Lab Supervisor	Unit Manager
[illegible signature]	Dr. Hamdi El-Sayed	Dr. Saeed Fahmi

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Highway Engineering Consultancy Unit
Faculty of Engineering – Ain Shams University
Tel: 287--- Fax: 2858618 Al-Abbasiyah – Cairo

Date: December 19, 2000 Ref. Serial No. S888
Client: Dar Al-Istisharat Al-Handasiyah, Dr. Mustafa Qarashi
Contractor: Dar Al-Istisharat Al-Handasiyah, Dr. Mustafa Qarashi
Site:
Specimen: The specimen after adding to it the material (ROADBOND EN1)
==========

The results of the tests conducted on the received specimen:-

1- <u>In case of concentration level of 1/300</u>

a)	Maximum density using the modified Proctor test is	2.045 Gr./Cm³
	Optimum water ratio is	7.6%
b)	CBR ratio after cover is	86%

1- <u>In case of concentration level of 1/500</u>

a)	Maximum density using the modified Proctor test is	2.01 Gr./Cm³
	Optimum water ratio is	9.5%
b)	CBR ratio after cover is	79%

Signed by:

Lab Engineer	Lab Supervisor	Unit Manager
[Illegible signature]	Dr. Hamdi El-Sayed	Dr. Saeed Fahmi

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