SHEAR STRENGTH & POZZOLAN CONTENT

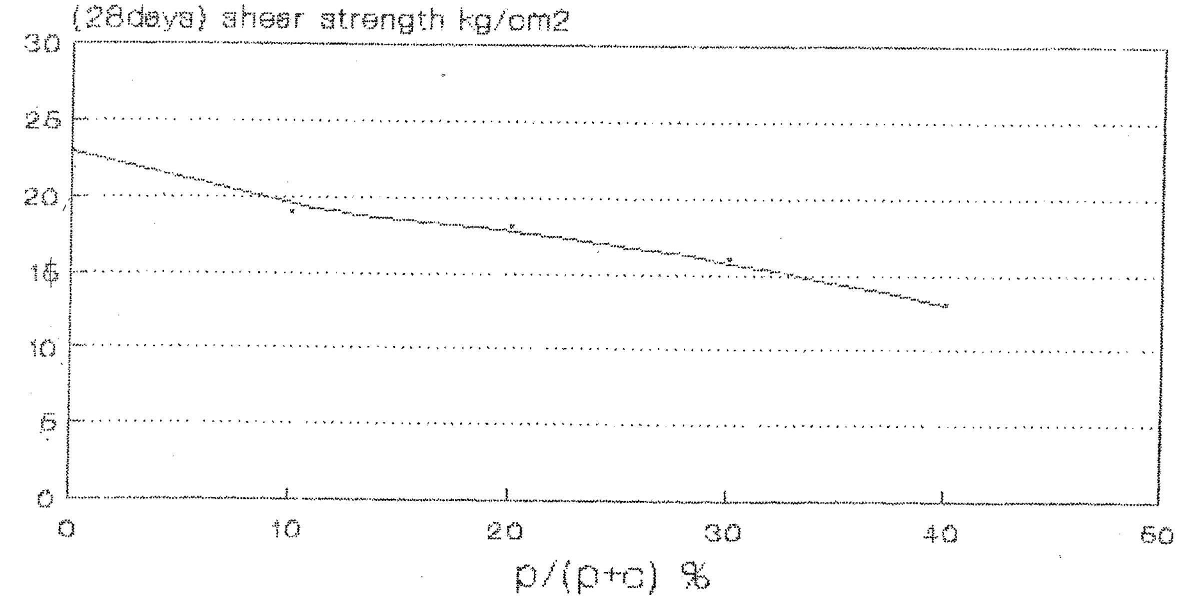

Fig 5.

COMP.STR.(28 & 56 DAYS) & POZZOLAN CONTENT

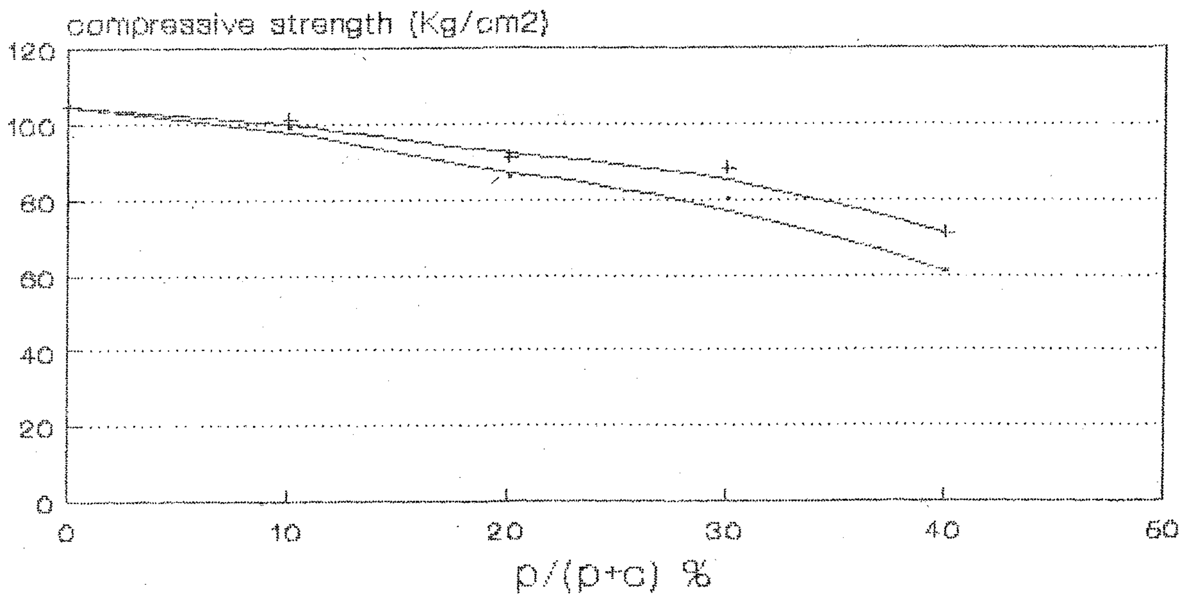

Fig 6.

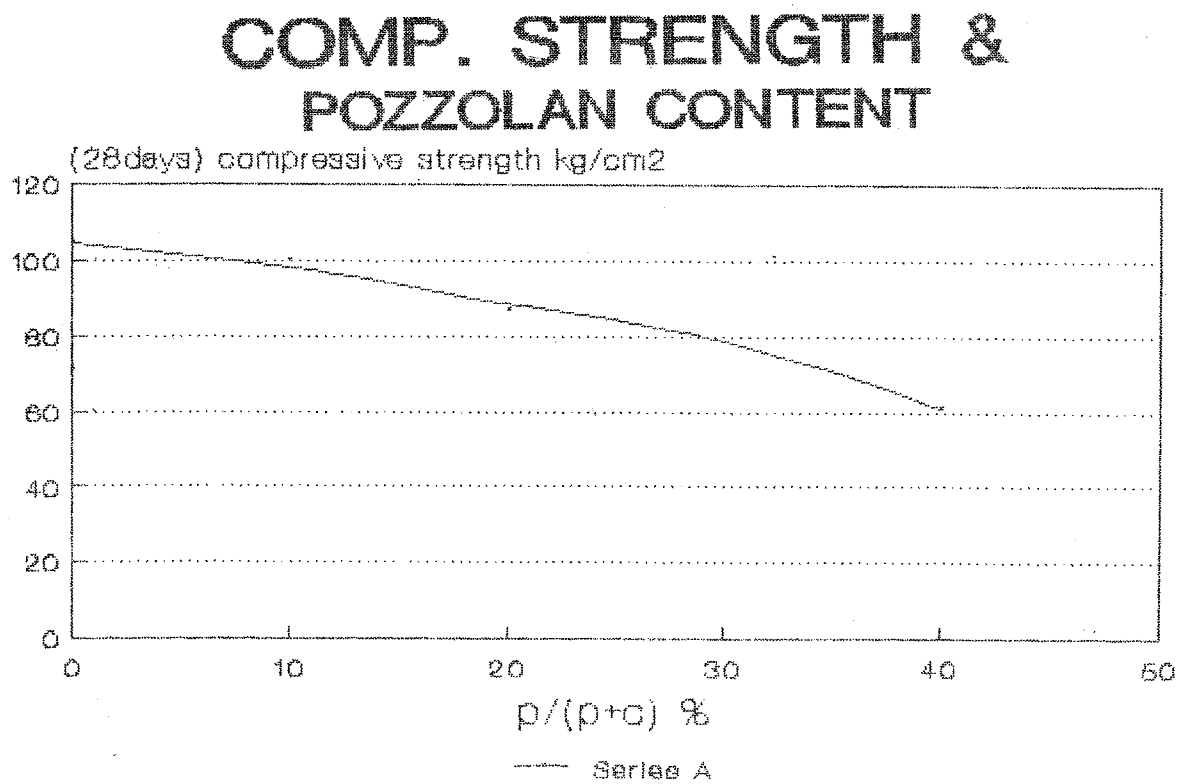
COMP. STRENGTH &
POZZOLAN CONTENT
(28days) compressive strength kg/cm2
120
100
80
60
40
20
0
0
10
20
30
40
50
p/(p+c) %
Series A

Fig 3.

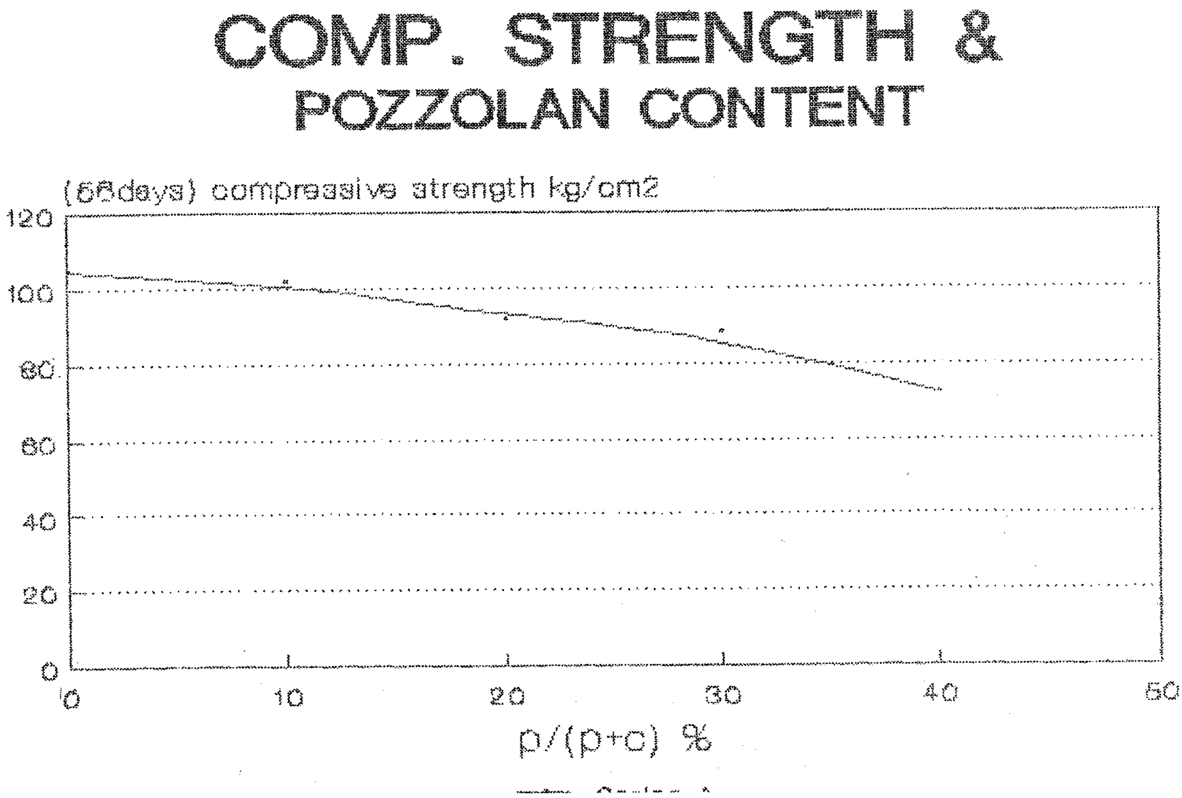
COMP. STRENGTH &
POZZOLAN CONTENT
(68days) compressive strength kg/cm2
120
100
80
60
40
20
0
0
10
20
30
40
50
p/(p+c) %

Fig 4.

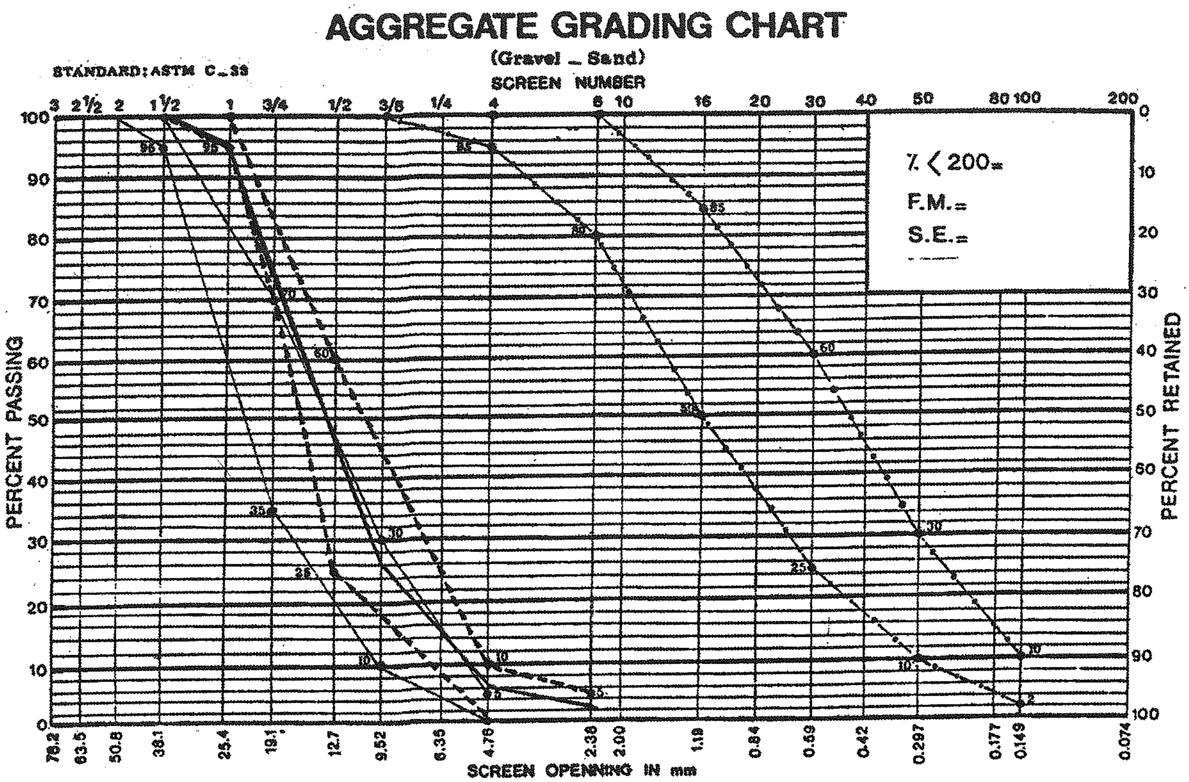

Fig 1.

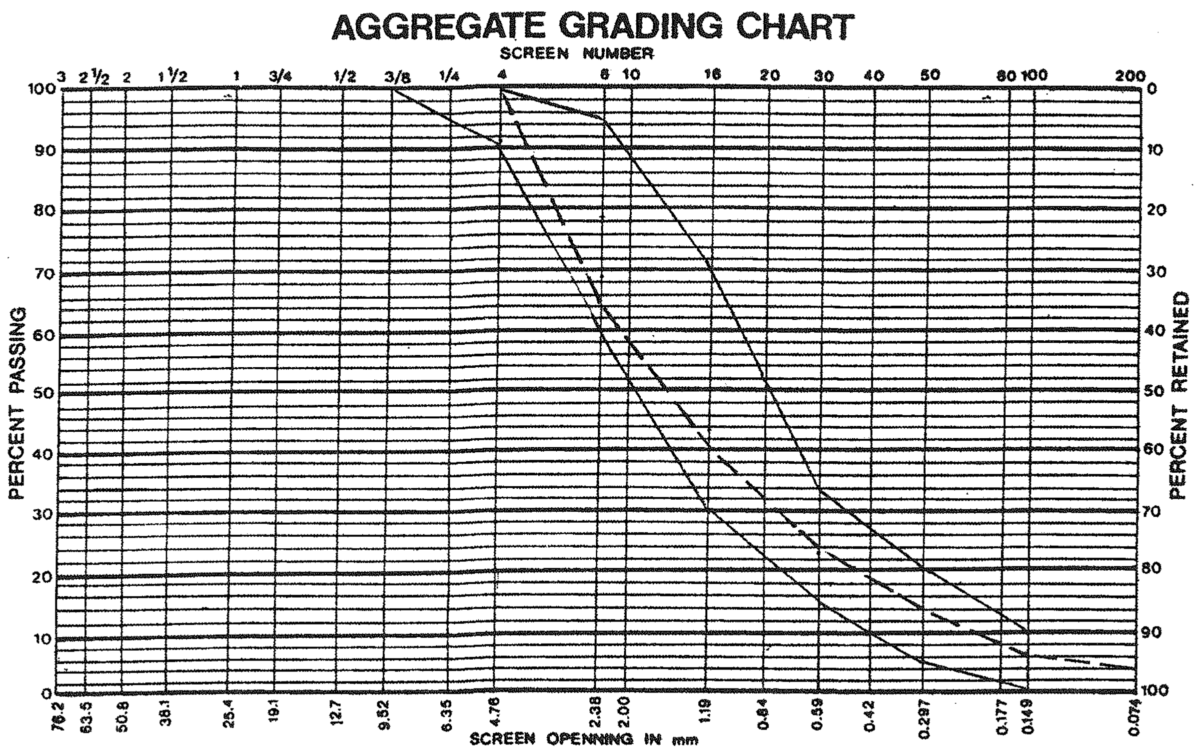

Fig 2. Gradation Curve of fine **aggregates**

Results:

Laboratory compressive strength tests on RCC specimens indicated that the strength decreases with an dicreased trass-cement ratio which follows traditional concrete theory for fully compacted concrete. Fig (3) is a plot showing 28-day unconfined compressive strength versus trass-cement ratio for specimens compacted at the mantioned selected energy level. Fig. (4) represents 56-day unconfined compressive strength versus trass-cement ratio for a similar compaction conditions. with regard to the fact that at the present time four methods for achieving bond between layers of RCC being utilized: a) time-temperature (maturity) restrictions, b) bedding concrete on treated or untreated surface, c) mortar layer on treated surface, d) high paste concrete on treated or untreated surface, the first method was adapted. This method is unristricted placement of RCC within specified time-temperature guidlines for the joint as determined by degree-hours, ie the average hourly temperature multiplied by the number of hours the lift is exposed. The maturity limit has been reported (Crow et al 1984) to vary from 120 °C-hour to 460 °C hour. This concept was used in the present investigation and a maturity of 144 °C -hour was maintained which is close to the lower reported limit. Bond strength testing of such construction joints consisted of direct shear tests by means of a shear box. The results of break bond testing for various trass contents are given in Table 3. There is a significant decrease in shear strength with increasing trass-cement ratio. Fig. (5) is a plot showing 28-day strength versus trass-cement ratio for specimens compacted under similar conditions. A comparison between 28-day and 56-day compressive strength of the RCC containing trass is shown in Fig. (6)

Conclusions:

In accordance to the test results of the present study, it may be concluded that Damavand trass may be safely used as a pozzolanic material in RCC mixes with certain limitations which are common for many pozzolans. Introducing trass into the RCC mix instead of cement would inversely affect the compressive strength and bond strength and the higher the trass-cement ratio, the lower would be the compressive strength. However, a somewhat improvement in the results obtainable from RCC specimens containing trass may be expected in a long-time terms. An optimum trass content for any given project should b e defined on the basis of a laboratory testing programme.

References:

[1]. ACI Standard Recommended practice for Evaluation of Strength Test results of concrete (ACI 214-77), Detroit, Michigan, 1983.

[2]. Benson, S.A., W.M. Verigin and M. J. Carney, "Cedar Falls RCC Dam" Proceedings of the 2nd RCC Conference, San Diago, California, 1988, pp 39-50.

[3]. Casias, T. J., V. D. Goldsmith, A. A. Benavidez, "soil Laboratory Compaction Methods applied to RCC", Proceedings of the 2nd RCC", Proceedings of the 2nd RCC Conference, San Diago California, 1988, pp 107-122.

[4]. Crow, R. D., T. P. Dolen, J. E. Oliverson, C. D. Prusia, "Mix Design Investigation RCC Construction, Upper Stillwater Dam", USBR, Denver, Colorado, 1984.

[5]. Lowe J. III, "Roller Compacted Concrete Dams-An Overview", Proceedings of the 2nd RCC Conference, San Diago, California, 1988, pp 2-20.

[6]. Naderi, R. "Construction Joints Shear Strength of RCC", MSc Dissertation Presented to the Civil Enging. Dept. Tehran Polytecnhnics, 1992.

Table 2. Laboratory mix proportion

	Coarse aggregate kg/m^3	Fine aggregate kg/m^3	Cement kg/m^3	Trass kg/m^3	Water lit/m^3	$\frac{tr}{C+tr}$ %
Mix I	992	992	150	0	160	0
Mix II	992	992	135	15	160	10
Mix III	992	992	120	30	160	20
Mix IV	992	992	105	45	160	30
Mix V	992	992	90	60	160	40

Table 3. Laboratory RCC strenth summery (containing trass as pozzlan)

Speciment	Age days	$\frac{tr}{C+tr}$ %	Compressiv eStrength kg/cm^2	bond Strength kg/cm^2
OC1	28	0	104	-
OC2	28	0	103	-
OC3	28	0	107	23.1
1C1	28	10	103	19.3
1C2	28	10	100	20.0
1C3	28	10	98	-
2C1	28	20	86	18.3
2C2	28	20	84	-
2C3	28	20	89	17.8
3C1	28	30	81	14.9
3C2	28	30	88	16.7
3C3	28	30	84	14.9
4C1	28	40	65	14.9
4C2	28	40	62	11.1
4C3	28	40	60	-
0PC1	56	0	105	24.0
1PC1	56	10	102	19.5
2PC1	56	20	91	19.1
3PC1	56	30	89	16.9
4PC1	56	40	72	15.3

common method of mix design (Lawe III 1988) an appropriate total cementitious content (Portland cement plus trass) of 150 Kg/m^3 was selected. The trass content of different mixes varied from 0 to 40 percent of the total cementitious materials. Table 1 presents chemical composition of the Damavand trass and Abyek portland cement used in the present study. The total required water was determined by a compaction test on the selected aggregates, with the gradation test results shown in Fig. (1) and Fig. (2), as RCC is generally placed at the optimum moisture content for compaction or somewhat dry of optimum in order to have a degree of saturation of its voids less than ninty percent (Lawe III 1988). Furthermore, because of the similarity of RCC construction to compacted earthfill, usually the standard ASTM soil moisture-density tests should be performed to determine the RCC water content (Benson et al 1988). The water, being Tehran's potable water, was added in stages until the RCC was judged to be of the correct consistancy. The constituents of the RCC were thoroughly mixed in a one hundred lit. drum mixer. A summary of five mix proportions are presented in Table 2. Laboratory test cubes (200 x 200 x 200 mm) were cast by placing RCC in the mold in two equal layers and compacting with a standard proctor rammer of 4.5 kg weight, dropped from a height of 457 mm. The compactive efford selected for testing had to be low enough to minimize aggregate breakdown yet high enough to provide adequate compaction. Based on USBR test results (Casias et al 1988) a compaction effort of 1100 kJ/m^3 (50 blows/lift) proved to provide the most consistent test specimens by impact compaction. Specimens were kept in molds for 48 hours, then taken to a curing chamber at a moisture of 90 percent and temperature of 30 °C for three days. Afterwards, Specimens were kept in the ambient conditions in the laboratory. The bond strength tests were carried out using a specially designed and manufactured direct shear box (Naderi 1992). Compressive strength measurements were performed by means of an universal testing machine.

Table 1. Chemical composition of Damavand trass & Abyek Portland cement

Abyek Portand Cement		Damavand trass	
test	percentage	test	percentage
SiO_2	22.4	SiO_2	76.8
Al_2O_3	5.2	Al_2O_3	12.87
Fe_2O_3	3.2	Fe_2O_3	1.11
CaO	61.3	CaO	2.63
MgO	3.2	MgO	1.32
SO_3	1.9	SO_3	-
Free CaO	2.02	K_2O	2.03
NaO+0.66K_2O	1.0	Na_2O	0.96
C_3S	33.1	TiO_2	0.11
C_2S	39.2	Ignition loss	2.0
C_3A	8.9		
C_4AF	9.7		
Ignition loss	1.02		

Suitability of Damavand Trass for RCC

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Abstract:

To evaluate suitability of Damavand trass as a pozzolanic material for making roller compacted concrete (RCC), in Partial replacement of cement, a testing programme including compressive strength and joint shear strength tests were performed on RCC, specimens containing different amount of trass. Experiments indicate that although trass - a natural volcanic sediment-can be safely used as a pozzolanic material in making RCC, a decrease in compressive strength and bond strength should be expected with increasing trass-cement ratio. However, a somewhat improvement in the results may be seen in a long-time terms.

Introduction

Roller compacted concrete dams (RCC) have gained acceptance throughout the world and many countries now have at least one dam constructed of RCC and many are in varios stages of development. RCC is a relatively new material for construction of gravity dams which incorporates soil and concrete technologies. RCC has brought about two primary design methodologies in engineering practice; one based on soil compaction and control techniques and the other based on classical concrete design. It is a zero-slump concrete that is compacted using heavy vibratory rollers. Therefore, in placement, RCC must be dry enough to support the weight of the vibratory rollers but wet enough to permit adequate distribution of the paste binder throughout the concrete mass during mixing and copaction processes.

Generally, RCC is placed in lifts of 0.3 to 0.9m in thickness and often successive lifts have been placed within six hours of placement of the lower lift. However, due to some constraints such as work schedules, weather conditions, required volume, or equipment maintenance, the interval between placement of two successive lifts may exceed one day. Hence making joint bonding questionable and necessitates some degree of joint treament.

An investingation was carried out in the Civil Engineering Department of the Amirkabir University of Technology to evaluate the suitability of a pozzolanic additive known as Damavand trass, which is a natural volcanic sediment, in making RCC and to assess its effects upon charactristics of RCC. The study was disgned to further ivestigate the effective bonding between lifts and to make comparisons between the permeability of the specimens with and without damavand trass.

Experimentation

In designing RCC mixes, several methods have been used as generally described in the American Concrete Institute Manual (ACI 1983). Based on data from previous investigations (Crow et al 1984) and a more