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Transportation problem: A special case for linear programing problems in mining engineering

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ABSTRACT

In real world applications the supply, the demand and the transportation cost per unit of the quantities in a transportation problem are hardly specified precisely because of the changing economic and environmental conditions. It is also important that the time required for transportation should be minimum. In this paper a method has been proposed for the minimization of transportation costs. Supply and transportation costs per unit of the quantities are also determined. The present study was carried out to evaluate the quality of gravel to know its suitability for aggregate (raw material for concrete and road). The samples of gravel were analyzed for petrographic, physical, mechanical and chemical properties. Samples were categorized as quartzite group and carbonate group according to ASTM standard 295. Among these, samples of quartzite group were found dominant. The petrography examination of gravels which was carried out constituted of opal, tridymite, chalcedony, crystobalite and alkali carbonates rocks. Those minerals react with alkalis in cement leading to expansion and cracking of concrete. Other components such as sulfides, sulfates, halites, iron oxides, clay minerals and anhydrites are examined, which might be present as coating and impurities. The present study indicated that all samples are suitable for concrete making and obtain the optimum solution for transporting these materials from quarries to cities with minimum cost according to Egyptian Code.

1. Introduction

Transportation problem one of the most important and successful applications of quantities analysis to solve business problems has been in the physical distribution of products, commonly referred to as transportation problems. Basically, the purpose is to minimize the cost of shipping goods from one location to another so that the needs of each arrival area are met and every sipping location operates within its capacity. Although the transportation problem can be solved using the regular simplex methods, its specials structure offers a more convenient procedure for solving this type of problem. This procedure is based on the same theory as that of the simplex method, but it makes use of some short cuts which yield a simpler computational scheme as discussed in Gass [1].

In the case of rapid increasing population or development growth such as the Sohag governorate in Egypt, new infrastructures are necessary to meet the increasing of requirements. Construction materials in general and aggregate in particular are important components of infrastructure. Construction materials resources in Sohag retain to quaternary sediments as discussed in Omara [2]. Gravels are considered the most important raw materials in all building construction in this study area. Gravels are accumulations which exist in terraces occupying the area between the old cultivated and the foot slopes of Eocene. Quaternary sediments are mainly repeated by siliceous or calcareous associated with washed deposits such as clay. Sources of the gravel may be from the neighboring middle Eocene. To select the type of aggregate suitable for different purposes, the physical and chemical properties are determined. The study area lies along Sohag governorate on both sides of River Nile [3,4].

2. Materials and methods

Samples were obtained from gravel deposits at Sohag governorate in Egypt. A total of 242 samples from these deposits were subjected to index property, physical and chemical properties were determined by members of the faculty at Al Azhar University and Assiut University in Egypt. The applicable and relevant standards for these tests were employed in all cases. Characteristics of the deposits included information about physical, mineralogical, and chemical properties as well as information that are relevant to aggregate quality or suitability. Particle size, shapes and composition are among the properties that affect the suitability of an aggregate deposit for a specific commercial uses. Maximum

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particles size is important to select the suitable crushing equipments studied by Mansour [5].

2.1. Classification of particle size

In addition to gravel samples obtained from quarries, for previous studies such as Beheiry and Abdel-Rahman, samples were obtained from gravel deposits at Sohag [6,7]. A total of 242 gravel samples from these deposits were subjected to index property. Table 1 shows this classification according to type of materials and its size according to Fred [8]. Screen size analyses for all samples were carried out using vibrating screens, and are given in the following figure. Fig. 1 illustrates the size distribution between upper and lower limits according to Egyptian Code.

2.2. Physical and chemical properties

The physical properties such as density and water adsorption; and chemical properties such as sulfate, Cl and pH were determined. Acceptable limits according to the Egyptian code are given in Table 2.

2.3. Microscopic thin section

Thin sections of gravel from the studied area were examined microscopically. The mineral compositions of sedimentary rocks were investigated using polarizing microscope and X-ray diffractions (XRD). The petrography examinations of the gravel were carried out according to ASTM stander 295 to identify the constitution of the minerals and to identify the alkali–silica reactive ingredient such as opal, tridymite, chalcedony, crystobalite and reactivity for alkali carbonates. These minerals react with cement alkalis, leading to expansion and cracking of concrete. Figs. 2 and 3 show the microscopic for locations no. 1 and no. 2. Other materials such as sulfides, sulfate, halite, iron oxide, clay minerals and anhydrite were also examined, which might be present as coating and impurities, which lead to the prevention of the development of a good bond between gravels and cement as discussed in Dassargues [9]. Fig. 4 illustrates the XRD for the gravel from location no.1. This rock is essentially composed mainly ($MgCaCO_3$, (68.96%), quartz (SiO_2, 22.06%).

Table 1
Particle size classification of soil.

Type of material		Size (mm)
Boulders		Over 200
Cobbles		60–200
Gravel	Coarse	20–60
	Medium	6–20
	Fine	2–6
Sand	Coarse	0.6–2
	Medium	0.2–0.6
	Fine	0.06–0.2
Silt	Coarse	0.02–0.06
	Medium	0.006–0.02
	Fine	0.002–0.006
Clay		Less than 0.002

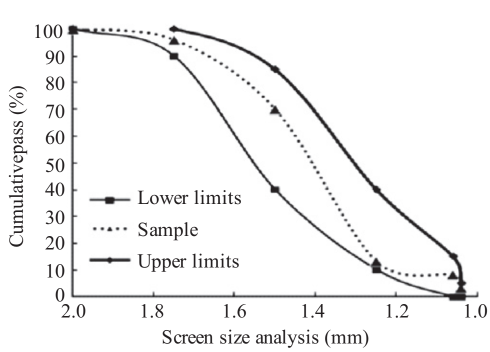

Fig. 1. Screen size analysis for gravel no. 1.

Table 2
Chemical and physical analysis for all locations.

Quarries No.	Property				
	CL	Sulfate	Adsorption (%)	PH	Density
Q1	0.003	0.0014	2.4	7.4	2.61
Q2	0.0025	0.0013	2.15	7.5	2.58
Q3	0.0027	0.0017	2.23	7.3	2.56
Q4	0.0023	0.0012	2.19	7.4	2.62
Q5	0.003	0.0013	2.33	7.3	2.55
Q6	0.0049	0.0018	2.47	7.5	2.64
Q7	0.0035	0.0014	2.31	7.4	2.75
Q8	0.0027	0.0012	2.29	7.5	2.67
Q9	0.0032	0.0015	2.44	7.4	2.62
Q10	0.0042	0.0016	2.42	7.3	2.53
Q11	0.0026	0.0011	2.35	7.5	2.59
Q12	0.0044	0.0014	2.33	7.3	2.56
Q13	0.005	0.0019	2.35	7.4	2.58
Q14	0.0058	0.00156	2.44	7.5	2.53
Q15	0.0061	0.00134	2.34	7.4	2.57
Q16	0.007	0.00145	2.37	7.3	2.56
Q17	0.0031	0.00132	2.38	7.3	2.63
Q18	0.0055	0.00142	2.3	7.4	2.60
Q19	0.0028	0.00123	2.41	7.4	2.58
Q20	0.0015	0.00135	2.42	7.5	2.62
Q21	0.002	0.0019	2.35	7.4	2.58
Q22	0.0006	0.00156	2.44	7.4	
Limits[a]	<0.06	<0.002	<2.5%	⩽7.5	

[a] Limits according to the Egyptian code 2003.

Fig. 2. Thin section for sample no. 1.

Fig. 3. Thin section for sample no. 2.

2.4. X-ray diffraction for gravel

Samples for XRD analysis were obtained from the grain-size analysis samples. Approximately 4–5 g of the grain-size analysis