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Recommended Concrete for Machine Foundation Subjected To Impact Loads

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Abstract: *Most machine foundation researches focus on the dynamic analysis of the foundation and the soil behavior specially for Machine foundations subjected to impact loads. The aim of this study is to improve the properties of the concrete itself to avoid the failure of machine foundations including the failure of anchor bolts. It is important to improve strength, durability, time dependent deformations and permeability for well performance of machine foundations concrete. This paper presents a case study for reconstructing of two concrete machine foundations subjected to dynamic loads. They are resting on a semi infinite half space. The concrete mixes have Ordinary Portland cement (O.P.C.) with 350 kg/m^3 (590 lb/yd^3) and 1% suprplasticizer. The concrete foundations are cured with forced water to get adequate curing for core of the massive foundations. The surfaces of the foundations cured with admixture for waterproofing. The use of superplastisizer in machine foundation concrete mixes with the ratio 1% of cement content improves the concrete properties and the time dependent deformations to reduce cracks.*

Key words*: machine foundation; concrete; curing; creep; shrinkage*

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I. Introduction

To avoid the failure of machine foundations including the failure of anchor bolts, especially for machine foundations subjected to impact loads; it is required to have very good concrete for machine foundations subjected to dynamic loads comply with code requirements. Barkan [1] study the analysis of machine foundation vibrations. George Gazetas [2] has found that the various results are synthesized in a case study referring to the response of rigid massive foundations and practical recommendations are made on how to inexpensively predict the response of foundations supported by actual soil deposits. Gary Yung [3] presented a case study of large machine foundation with stringent vibration limits will be to demonstrate the necessity and complexity of a full dynamic analysis. And he concluded that a static force does not always give the full picture. K.G. Bhatia [4] studies the effects of earthquakes on machines as well as on their foundations. Piyush K. Bhandari, Ayan Sengupta [5] have found that with effect to depth of embedment there has been increase in natural frequency but considerable decrease in amplitude of foundation vibrations. Harivadi et al [6] study the anchor bolt cone failure. They compare the cone stresses between experimental results and design standers. The results show that the cone stress of the experimental results is lower than the design standers because of cracking spread widely with the lower cone slope. The serviceability failures of machine foundations including anchor bolts failures is affected strongly by the deterioration of concrete. The common failure is often involving excessive cracking as a result of the time-dependent deformations of concrete. Adequately account for the effects of creep and shrinkage of the concrete is not available. Design for serviceability is complicated by the non-linear and inelastic behavior of concrete at service loads. The case study in this paper is to improve the durability and the time dependent deformations of the concrete used for reconstructing of five different machine foundations subjected to impact loads.

II. Research Significant

Machine foundation for both normal and massive concrete bases takes a special care in design, materials, casting and curing specially for machine foundations subjected to impact loads. Considering the normal requirements of reinforced concrete construction given in codes of practice, there are some additional requirements to improve the time dependent deformations and durability of concrete to avoid serviceability failures of machine foundations. A concrete mixes are examined for time dependent deformations to use in the practical case study. The results insure the importance of deep curing with forced water, the use of superplastisizers to improve durability and time dependent deformations of concrete to eliminate the machine foundations concrete deterioration.

Experimental investigation

III. Materials

For concert of the machine foundations in this case study the coarse aggregate is crushed pink lime stone with nominal maximum size 38.1mm. (1.5 in.) ASTM-C 33-84 [7]. The fine aggregate is sand with fineness module 2.4. The Ordinary Portland cement content is 350 kg/m3 (590 lb/yd3). To increase workability and reduce permeability the concrete mix contains superplasticizer admixture type F with the ratio 1% of cement weight according to ASTM-C 494-82 [8]. The concrete mixes are examined for shrinkage according to ASTM-C 157-80 [9], and creep according to ASTM-C512-83 [10].

Test specimens

The test specimens are the standard cylindrical molds 150 mm (6 in.) diameter and 300 mm (12 in.) height. The standard cylindrical specimens are used to measure the compressive strength, the modulus of elasticity and the creep according to ASTM-C39-83 [11], ASTM-C 469-83 [12] and ASTM-C512-83 [10] respectively. Shrinkage test specimen for concrete is a prism with square section 75 mm (3 in) and 285 mm (11.25 in) long according to (ASTM-C 157-80) [9]. Test specimens of all mixes are stored in water until the age of 28 days. Table no1 presents the proportions of the Ordinary Portland cement concrete with and without admixture.

Properties of concrete

Table 1 shows the properties of different mixes, w/c ratio, modulus of elasticity, and concrete stress Fc. The results show that the use of 1% superplasisizer admixture reduces water cement ratio by 13.2% compared with mix without admixture and slump range 75-100 mm. (3-4 in.). The compressive strength and modulus of elasticity for the standard cylindrical specimens used in the current study is increased by 16.3% and 28% respectively for mix with 1% superplastisizer compared with mix without admixture. It is recommended to study effect of superplastisizer type F on the time dependent deformation of the concrete mixes used in machine foundations. The creep and shrinkage of the concrete mixes with and without admixture are examined according to ASTM-C512-83 [9] and (ASTM-C 157-80) [10]. The creep and shrinkage of the concrete mixes are shown in figure 1 and figure 2. Figure 1 shows that after 20 days since application of load the creep of concrete with 1% superplastisizer admixture type F at a certain time is 20%- 26 % less than that of concrete without admixture. Figure 2 shows that the use of 1% superplastisizer type F after 120 have almost the same shrinkage for mixes with and without admixtures. These results insure that the use of superplastisizers admixture with 1% of cement content improve the concrete properties.

IV. Case Study

According to the results of the experimental investigation the concrete mix design used in this case study is 1% superplastisizer pink lime stone concrete with 350 kg/m3 (590 lb/yd3) ordinary Portland cement, (O1) as shown (Table 1). The case study in this paper is about the reconstructing of two concrete foundations for big and small surface grinding machines (Fig. 3) and (Fig. 4), hydraulic steel scissor (Fig 5), and two hammers (Fig 6), (Fig 7). Dimensions of the reinforced concrete for the big surface grinding machine foundation base are 7.60 m.* 3.40 m. * 1.30 m. (299.21in.* 133.86 in. *51.18 in.). The base plate of the machine is fixed in the concrete foundation by 8 anchor bolts. Dimensions of the reinforced concrete for the small surface grinding machine foundation base are 5.20 m.* 2.00 m. * 0.50 m. (204.7in.* 78.74 in.*19.68 in.) The base plate of the machine is fixed by 8 anchor bolts. The concrete foundation block of the hydraulic steel sheets scissor is 4.7 m. (185 in.) *3.45 m. (135.8 in.), a hammer with 250 kg. (551.16 lb.), and a hammer with 100 kg (220.46 lb) are the case study. All machine foundations are resting on 0.20 m. (7.87 in.) plain concrete. The soil under all bases is replaced for a depth of 1 meter (39.37in.) by crashed pink lime stone. The concrete machine foundations are cured with forced potable water for 8 days after casting them. The machines are fixed with anchor bolts with the base plates after 28 days of casting the concrete foundations. The machine foundations are in duty more than ten years and there is no surface concrete cracking on the machine foundations or around the anchor bolts.

V. Conclusions

In failure analysis of machine foundations, the deterioration of concrete machine foundations subjected to impact loads involving excessive cracking are strongly affected by creep and shrinkage of concrete. Durability of machine foundations is mainly dependent on quality of concrete materials and minimum cracking. From the results of this case study we concluded that:

1- The use 1% superplastisizer reduces creep by 20% -26 % compared with concrete without admixture.
2- The compressive strength is increased by 16.3 and modulus of elasticity is increased by 28% for the standard cylindrical specimens used in the current study compared with mix without admixture.

3- Curing of concrete with forced water and quality management of concrete construction increasing useful life of concrete.
4- The use of superplastisizer in concrete mixes with the ratio 1% of cement content improves the concrete properties and time dependent deformations to reduce cracks.
5- It is recommended to use 350 kg/m3 (590 lb/yd3) Ordinary Portland cement content for concrete mixes with 1% superplastisizers in machine foundation subjected to impact loads.

Acknowledgments

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References

[1]. Barkan, D.D. “Dynamics of Bases and Foundations”, McGraw-Hill Book Company, New York, USA (1962).
[2]. George Gazetas, Analysis of machine foundation vibrations: State of the art, International Journal of Soil Dynamics and Earthquake Engineering. January (1983) 2(1):2-42 ·
[3]. Gary Yung, Dynamic Analysis of Machine Foundation: When a Static Force cannot Give the full picture, HKIE-IEM-CIE Tripartite Seminar Recent Developments in Limit State Design for Geotechnical Works, November (2014).
[4]. K.G. Bhatia, Foundations for industrial machines and earthquake effects, ISET Journal of Earthquake Technology, Paper No. 495, Vol. 45, No. 1-2, March-June 2008, pp. 13–29.
[5]. Piyush K. Bhandari, Ayan Sengupta, Dynamic analysis of machine foundation, International Journal of Innovative Research in Science, Volume 3, Special Issue 4, April 2014 National Conference – VISHWATECH.
[6]. Harivadi, Satoru M., Yoshimi S., Experimental analysis of anchor bolt in concrete under pull-out loading, Procedia Engineering,171 (2017) 926-933.
[7]. ASTM (American society for Testing and Materials). " Standard specifications for concrete aggregates." (1984) ASTM-C 33-84, USA.
[8]. ASTM (American society for Testing and Materials). " Standard specification for chemical admixtures for concrete. " (1982) ASTM-C 494-82, USA.
[9]. ASTM (American society for Testing and Materials). "Standard test method for creep of concrete in compression." (1983) ASTM-C 512-83 USA.
[10]. ASTM (American society for Testing and Materials). " Standard test method for length change of hardened cement mortar and concrete." (1980) ASTM–C 157-80, USA.
[11]. ASTM (American society for Testing and Materials). "Standard test method for compressive strength of cylindrical concrete specimens. " (1983) ASTM-C 39-83, USA.
[12]. ASTM (American society for Testing and Materials). "Standard test method for static modulus of elasticity and Poisson’s ratio of concrete in compression." (1983) ASTM-C 469-83, USA.

Table no1 - Properties of different mixes, w/c ratio, modulus of elasticity E and concrete stress Fc

Parameters	Mixes	
Type of cement	Ordinary Portland cement	Ordinary Portland cement
MIX.	O1	O2
Wt. of cement kg/m3 (lb/yd3)	350 kg/m3 (590) (lb/yd3)	350 kg/m3 (590) (lb/yd3)
Wt. Of course agg. kg/m3 (lb/yd3)	1067 kg/m3 (1799) (lb/yd3)	1067 kg/m3 (1799) (lb/yd3)
Wt. of water kg/m3 (lb/yd3)	184.5 kg/m3 (311) (lb/yd3)	160.5 kg/m (270.6) (lb/yd3)
Wt. Of sand kg/m3 (lb/yd3)	687 kg/m3 (1158) (lb/yd3)	742 (kg/m3) (1251) (lb/yd3)
Wt. of adm. kg/m3 (lb/yd3)	0 kg/m3 (0) (lb/yd3)	3.5 kg/m3 (5.9) (lb/yd3)

Slump mm. (in.)	75-100 mm. (3-4)in.	75-100 mm. (3-4)in.
W / c	0.53	0.46
Agg. / cement	5	5.17
Fc kg/cm2 (lb/in.2)	215 t/cm2 (3056) (lb/in.2)	250 t/cm2 (3556) (lb/in2)
E t/cm2 (lb/in.2)	180 kg/cm2 (2560*103) (lb/in.2)	230 t/cm2 (3271*103) (lb/in.2)

(yd =yard), (lb= pound), (E= modulus of elasticity), (Fc = concrete stress)

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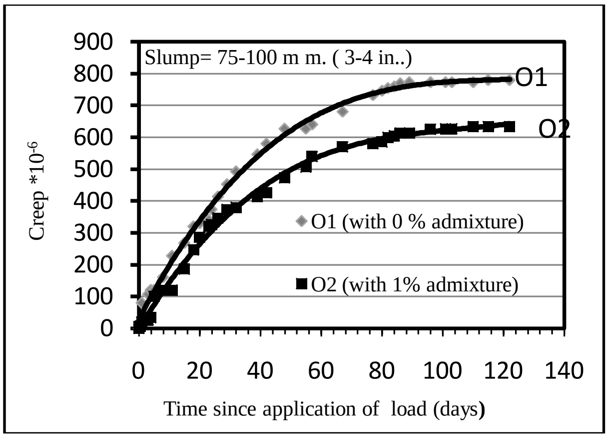

Fig. 1 Creep of 350 kg/m3(590 lb/yd3) Ordinary Portland cement content for content mixes with and without admixture subjected to a stress of 68 kg/cm2 (967.12 lb/in.2)

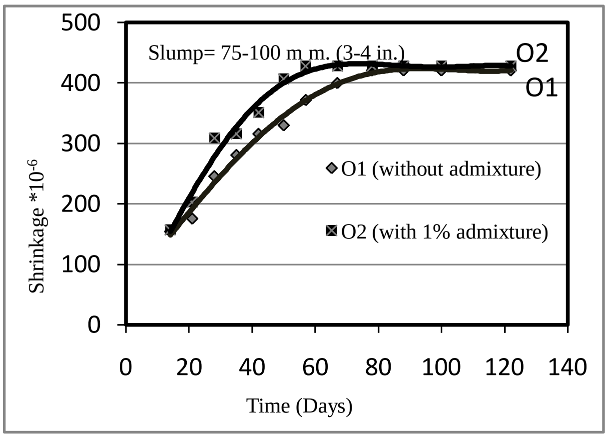

Fig. 2 Shrinkage of 350 kg/m3 (590 lb/yd3) Ordinary Portland cement content for concrete mixes with and without admixture

Fig. 3 Big Surface grinding machine

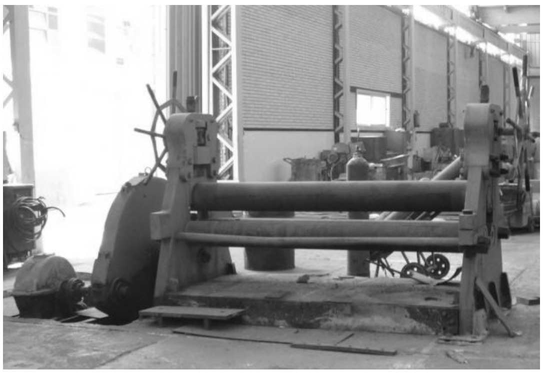

Fig. 4 Small Surface grinding machine

Fig. 5 Hydraulic steel scissor

Fig. 6 Hammer with 250 kg. (551.16 lb.) dropping parts

Fig. 7 Hammer with 100 kg. (220.46 lb.) dropping parts

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