Properties of Self-curing High Strength Concrete by using Baby Polymer Diapers

Salmia Beddu^{1,*}, Daud Mohamad¹, Fadzli Mohamed Nazri², Siti Nabihah Sadon³, and Mohamed Galal Elshawesh¹

¹Civil Engineering Department, College of Engineering, Universiti Tenaga Nasional, Jln IKRAM-UNITEN, 43000 Kajang, Selangor, Malaysia

²School of Civil Engineering, Engineering Campus, Universiti Sains Malaysia, 14300 Nibong Tebal, Penang, Malaysia

³Civil Engineering, College of Graduate Studies, Universiti Tenaga Nasional, Jln IKRAM-UNITEN, 43000 Kajang, Selangor, Malaysia

Abstract. This study investigates the self-curing concrete using baby polymer diapers as substitute method of curing process in order to improve mechanical and physical properties of concrete. Three different proportion of baby polymer diapers which are 1%, 3% and 5% were mix with concrete. Slump, compressive strength and drying shrinkage test were performed in order to study the workability, strength and durability of the concrete. All concrete were tested for 1, 3, 7, 14, and 28 days for drying shrinkage test. Meanwhile, all concrete were test at 3, 7 and 28 days for compressive strength test. Compressive strength of concrete containing 5% baby polymer diapers show the highest strength at 28 days compared to others percentage. Thus, it indicates that application of baby polymer diaper as self-cure agent can improve the concrete performances.

1 Introduction

High performance concrete strength (HPCS) by using traditional method of curing has disadvantages due to low water to binder ratio and low permeability of high strength concrete. As an alternative to traditional method of curing, internal curing technology has been widely develop as a solution to overcome early-age cracking sensitivity of high strength concrete. Internal curing provides well distributed curing water from inside the element which it allow water to travel more effectively. Concrete structure are exposed to drying condition from early stage and it will induce cracking and decrease the strength of concrete[1].

Super absorbent polymer (SAP) was reported to have a hydrophilic network structure due to it can absorb up to thousand times of its dry weight. SAPs has been used in various application such as admixture or additive for concrete [2]. Baby diapers absorbent layer consists of super absorbent polymer gel or hydrogel which it locked urine and stored within it polymeric structure [3]. SAP and hydrogel polymer has quite similar function as a water

* Corresponding author: Salmia@uniten.edu.my

absorbent. At present, used baby diapers are not recycled and dump in the landfills which representing about 4% of municipal solid waste [4]. Impact associated to disposal of diapers landfilling include land use, methane production and leaching of organic compounds to soil and groundwater and combustion of diapers could lead to production of contaminants of carbon dioxide and chlorine compounds [5].

2 Material and method

2.1 Preparation of HPCS containing baby diapers polymer

The prepared HPCS samples are composed of ordinary Portland cement-type 1, Class F fly ash, silica fume, water, coarse aggregate, fine aggregate, baby diapers polymer and 0.8 % of superplasticizer (polycarboxylate-ether type). The design strength of the concrete is 60 MPa with constant water cement ratio of 0.29. By the mix proportions shown in Table 1, the sample were prepared using concrete mixer. During the mixing process, baby diapers polymer were added into the mix and concrete were poured into 100 mm x 100 mm x 100 mm cube mould and 75 mm x 75 mm x 285 mm prisms mould and compacted by using vibrator.

Table 1. Concrete mix proportions

Mix	OPC (kg)	Fine Aggregates (kg)	Coarse Aggregates (kg)	Silica Fume (kg)	Baby diapers polymer (%)
Control Mix	14	11	20	0	0
G60 (1%)	9	11	20	5	1
G60 (2%)	9	11	20	5	2
G60 (3%)	9	11	20	5	3

2.2 Test method

Slumps were performed to assess the fresh properties of concrete. Slump test were performed immediately after mixing the concrete batch in laboratory. Slump were measured according to ASTM C143[6]. Four fresh concrete samples were tested to assess all the fresh properties of concrete. To determine the hardened properties and durability of concrete, compressive strength and linear drying shrinkage tests were performed. Compressive strength were done as per provisions of BS 1881: Part 108:1983 [7]. The cubes of 100 x 100 x 100 mm size were prepared for the compressive strength test and concrete prism 75 x 75 x 285 mm size were prepared or linear drying shrinkage test. Compressive strength of concrete was determined at the ages of 3, 7, 28 and 90 days whereas linear drying shrinkage of concrete was measured at the age of 1,7,28,90 and 150 days.

3 Result and discussion

3.1 Slump

The slump was studied to assess the workability of concrete. The variation of slump of all concrete mixes is reported in Fig. 1. Slump was noticed to be increase by 10% when 1% of baby diapers polymer was used as compared to control mix. The addition of baby diapers polymer in low percentage has not affected the workability of the concrete when compared when compare to control mix [8]. The slump was increased by 26% and 50% by using 3% and 5% respectively as compared to control mix. The reduction in slump due to absorption capacity of baby diapers polymer and it has increased amount of water[2].

Fig. 1. Slump height for all mix

3.2 Compressive strength

To determine the compressive strength of cube specimens, a load was applied on cube specimen by a compression testing machine of 2000 kN capacity up to the failure specimens. Sample CM 1 represent concrete sample without curing meanwhile CM 2 represent concrete sample with curing. Sample G60 (1%), G60 (3%) and G60 (5%) represent concrete containing 1%, 3% and 5% baby diapers polymer respectively. It was observed that the use of baby diapers polymer in concrete has improved the compressive strength as compared to control mix. Concrete sample with 5% baby diapers polymer has increased the compressive strength of concrete by 18% as compared to control concrete, CM 2. But the use of low percentage baby diapers polymer was found to be significant with CM 1 at early ages as shown in Fig. 2. It was notice that the improvement in compressive strength was reduced at early ages but as the age of concrete increased from 7 days to 28 days the increment in strength increased. For concrete mix G60 (1%), G60 (3%) and G60 (5%) the compressive strength at 3 days similar to CM 1. While G60 (1%) compressive strength was observed to be decrease up to 43% compared to CM 2.

Fig. 2. Compressive Strength for all mix

Compressive strength of G60 (3%) and G60 (5%) were observed to be decreased 28% and 15% compared to CM 2. Compressive strength at 7 days show similar strength development for G60 (1%) and G60 (3%) compared with CM 1. Meanwhile, compressive strength of G60 (5%) has significant strength with CM 2. During later age, it can be observed that G60 (5%) has the highest strength compared to CM 1 and CM 2. While, compressive strength of G60 (1%) and G60 (3%) was observed to be increased up to 1% and 33% compared to CM 2. This was due to microstructure become denser due to the effect of internal curing and this compensate for the loss of strength that can be cause by the formation of polymer voids [9].

3.3 Linear Drying Shrinkage

The results of drying shrinkage test of concrete are shown in Fig. 3. As shown in Fig. 3, the results showed that the baby diapers polymer had a significant effect on drying shrinkage, the G60 (5%) concrete mixture exhibit the highest shrinkage value than the control sample. Meanwhile, control sample CM 1 and CM 2 has significant drying shrinkage even though without curing process. Concrete sample G60 (1%) and G60 (5%) was observed to be higher compared to both control sample. As the addition of silica fume and baby diapers polymer, it can be concluded that it would increase the shrinkage. Pozzolanic material that acts as cement replacement material were reported to reduce concrete shrinkage[10]. Higher shrinkage value indicates the absorption and water retention capacities are higher [11].

Fig. 3. Linear drying shrinkage for all mix

Conclusion

Based the experimental results and the analysis performed on all concrete sample presented in this paper, the following conclusions are drawn:

1. The slump was increased by 26% and 50% by using 3% and 5% respectively as compared to control mix.
2. During later age, it can be observed that G60 (5%) has the highest strength compared to CM 1 and CM 2. While, compressive strength of G60 (1%) and G60 (3%) was observed to be increased up to 1% and 33% compared to CM 2.
3. Concrete sample G60 (1%) and G60 (5%) was observed to be higher compared to both control sample. As the addition of silica fume and baby diapers polymer, it can be concluded that it would increase the shrinkage. Pozzolanic material that acts as cement replacement material were reported to reduce concrete shrinkage

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