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Affect of Fly Ash and Superplasticiser on the Fresh Properties Self Compacting-Concrete

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Abstract: *The self-compacting concrete is a relatively innovative type of concrete that differs from the conventional vibrated concrete in that it contains a novel superplasticiser, Flay ash which contributes significantly to increasing the ease and rate of it flow and another advantage is that the novel superplasticiser is very cheap and available compare with the conventional one because it originated from waste material It was first introduced in late 1980s in Japan when the researcher realized that poor compaction was the major contribution to the declined of quality construction work. Since then various research investigations have been carried out for establishing rational mix design methods in order to be self- compactable. The fresh concrete must show high fluidity beside good cohesiveness to make self-compacting concrete a standard concrete. This research presents the result of an experimental programme that has been carried out, aimed at investigating of fresh properties of SCC contain fly ash and novel superplasticiser. The fresh state properties of the concrete were evaluated. Finally, some hardened state properties of the concrete were assessed. Portland cement was partially replaced with 30% ,50% 70% and 90% fly ash the water cement ratio was maintained 0.5 for all the mixes .Properties included workability ,compressive strength, all were evaluated . The result indicated that the medium volume contain of fly ash can be used in SCC to produce good strength concrete with this type of superplasticiser that originated from waste material .High absorption values are obtained with increasing amount of fly ash however almost all the specimen exhibits absorption of less than 5%. The concrete mixes contained 3 different dosage of a novel super plasticiser based on the carboxylic with and without fly ash .the percentage of dosage of superplasticiser is 0.25%, 1%, and 2% respectively. The increase in superplasticiser dosage from 0.25% to 2% the workability increase so the required slump flow meet the criteria of EFNARC also the result of mechanical properties compressive strength for 0.25% ,1% and 2% have shown significant performance compare with the control mixes. The workability test utilised in this research were the slump flow, L-box and j-ring, which can be used to assess the passing ability of self-compacting concrete .based upon the experimental result there are some linear relationship between fresh properties and each of the workability tests achieved.*

Key words: *Self-compacting, concrete, novel Super plasticiser, fly ash, fresh properties*

INTRODUCTION

The self-compacting concrete is a relatively innovative type of concrete that differs from the conventional vibrated concrete in that it contains a super plasticiser, Flay ash which contributes significantly to increasing the ease and rate of its flow and another advantage is that the novel superplasticiser is very cheap and available compare with the conventional one because it originated from waste material (Krishna et al., 2012). A self-compacting concrete can fill any part of formwork only under its own weight, without the need for compaction or external vibration. This differ from conventional concretes in structural elements of complex and difficult shapes, e.g. congested working area or curved members, in which the conventional concrete maybe difficult to compact, especially in the congested reinforcement area . Goodier, (2003). Furthermore, SCC offers many health and safety benefits. The elimination of vibratory compaction on site means that the workers are no longer exposed to vibration and its related impact, e.g. waste energy spoil hand, besides providing a noiseless working environment. It was first introduced in late 1980s in japan when the investigator realized that poor compaction was the major contribution to the degenerated of quality construction work. Since then various researches have been conducted for establishing rational mix design methods in order to be self- compactable. (Aslani and Nejadi, 2012). Self-compacting concrete mixes can be possible with the use of local coarse aggregate without much effect for the mix designs. The fresh concrete must show good fluidity and good cohesiveness to make self-compacting concrete a standard concrete (Murthy et al,2012). The SCC was also called high performance concrete. This was included in **Okamura's** definition (1992), which is shown below.

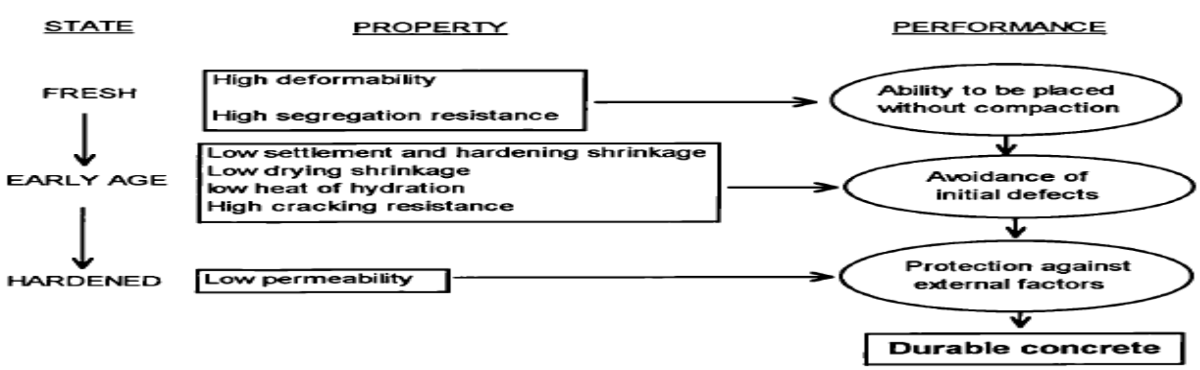


Fig 1.1 Definition of Self-compacting high performance concrete

[Adapted from Okamura et al., (1992)].

SELECTION OF MIX PROPORTIONS IN SELF COMPACTING CONCRETE:

In designing for SCC mix, it is essential and useful to consider the relative proportions of the main components by volume than by the mass. The following key proportions for the mixes highlighted below Air content (by volume) ,Coarse aggregate content (by volume) , Paste content (by volume), Binder (cementations) content (by weight) , Replacement of mineral admixture by percentage binder weight, Water binder ratio (by weight) , Volume of fine aggregate volume of mortar , SP dosage by percentage cementations (binder) weight , VMA dosage by percentage cementations (binder) weight water binder ratio by weight, volume of the fine aggregate, volume of the water (Krishna et al., 2012).

METHODOLOGY

EXPERIMENTAL PROGRAMME:

The aims of the experimental programme are to investigate the FRESH engineering properties of self-compacting concrete containing fly ash and novel super plasticiser.

This STEP describes the materials used in the whole experimental, the mixing, casting, and curing procedures of concrete investigated in this study. The methods of measuring workability, density, compressive strength and, as well as the apparatus used, are also described.

MATERIAL USED:

All materials used throughout this study were the same. They were in accordance with relevant BS EN standards and were confirmed to be suitable for the scope of this study.

CEMENT:

Cement ordinary Portland cement is general purpose cement is one of the essential concrete components that bind the concrete ingredients all together. In order to attain more workable mix, an increased paste is required to realize the required deformability. The correct select of cement type is normally depending on the particular requirements of each application or what is presently being used by the producer rather than the specific requirements of Self-compacting concrete (Dumne, 2014).

The cement used at this experiment work was general purpose Hanson cement used for casting the cubes for all samples mixes. The cement was of uniform colour that is grey with high greenish shade and was free from any impurities.

FINE AGGREGATE:

The fine aggregate (sand) used in the experimental programme was locally sand from river which package in bag for general purpose used as fine aggregate. The finest module of the aggregate used was like 2.44mm.

WATER:

Mixing water for concrete should be in good quality; it should not contain undesirable organic substances or inorganic ingredients above allowable amount. In the UK, water used in concrete mix shall conform to BS EN 1008. Therefore, tap water was used throughout the mixing and curing procedures for the concrete in this study.

COARSE AGGREGATE:

The coarse aggregate used was graded aggregate 20mm maximum size and locally available river sand were used as natural coarse and fine aggregate respectively . Comprising crushed stone with a nominal size ranging from 5 to 20 mm.The physical properties of coarse aggregate like bulk density, specific gravity, gradation and fineness modulus are tested in accordance with BS 8882; 1992.

PULVERISE FLY ASH (PFA):

The Pulverised fly ash used in this experimental work was **EN 450-1 S GRADE PFA**Fly ash is an industrial waste that is generated after combustion of coal during the production of electricity. These fine particles consist primarily of silica, alumina and iron. This type Fly ash is used to improve the durability and strength of concrete mixtures and make the concrete free flowing and sound.

Fly ash also acts as an industrial by product, generated from burning of coal in the thermal power plants. The increasing insufficiency of raw materials and the urgent need to safeguard the environment against the pollution has emphasized the significance of developing new building material based on industrial waste generated from coal fired thermal power station creating incontrollable disposal problems due to their likely to pollute the environment (Jino et al., 2012).

ADMIXTURE SUPERPLASTICISER:

The admixture superplasticizer used for this experimental work was NJ100 is hydrocarbon super plasticiser base on grafted acrylic ester was also originated from waste material. Which were used throughout the mixes except for number one which is the control mix as Shows the detail in the table below.it was originated from Poly Ethylene acrylic acid (PEAA) collected from waste material Hexadecyl alcohol (HDA),Hexadecyl amine (HDM), Vinyl acetate (VA), Benzoyl peroxide (BzPO) and P-Toluene sulfonicacid monohydrate (PTSA) are from Aldrich Chemicals is used for evaluating the performance of the synthesized polymeric additives (Shafey et al., 2011).

MIXING:

Tilting drum mixers were used throughout this study with capacities of 120 by, 90 litres with 220-240 volt ac, and 50HZ 1PH, which were chosen depending on the volume of the concrete batch needed. The concrete mixes were done in accordance with BS 1881-125:1986. The aggregates were added in the following order: initially about half of the coarse aggregate, then the fine aggregate and the residue of the coarse aggregate. The mixer was then started for 15 to 30 seconds. The mixing continued after adding about half of the total water for two to three minutes. All the cementations materials were then added and the mixing was continued. Then the remaining water was added after 30 seconds, continuing mixing until two to three minutes after all the materials were added.

Total of 8 mixes were made to investigate the engineering properties of self-compacting concrete containing fly ash and novel superplasticiser .investigated were made, workability using j rings and L box,densiy,weight,. Detail of mixes are given in the table below for different proportional fly ash of 30%, 50%, 70% and 90% replaced with cement and superplasticiser in different percentage for other control 0.24% 1%, 2% respectively.

TABLE 3.1 MIXES PROPORTION FOR THE RESEARCH EXPERIMENT.

S.NO	MIX %	Cement kg/m^3	Fly ash kg/m^3	Fine aggregate kg/m^3	Coarse aggregate kg/m^3	Water kg/m^3	s.p. gm/m^3	w/cc
1.	**SP-0%**	**4888.5**		**16523.2**	**8811.4**	**4888.5**	**0**	**0.5**
2.	**SP0.25%**	**4888.5**		**16523.2**	**8811.4**	**4888.5**	**24.3**	**0.5**
3.	**SP I%**	**4888.5**		**16523.2**	**8811.4**	**4888.5**	**98**	**0.5**
4.	**Sp2%**	**4888.5**		**16523.2**	**8811.4**	**4888.5**	**196**	**0.5**
5.	**F30**	**6843.2**	**2932.8**	**16523.2**	**8811.4**	**4888.5**	**196**	**0.5**
6.	**F50**	**4888.0**	**4888.0**	**16523.2**	**8811.4**	**4888.5**	**196**	**0.5**
7.	**F70**	**2932.8**	**6843.2**	**16523.2**	**8811.4**	**4888.5**	**196**	**0.5**
8.	**F90**	**977.7**	**8799.3**	**16523.2**	**8811.4**	**4888.5**	**196**	**0.5**

The water cement ratio w/c ration as you see in the table 3.1 above all the mixes was maintain constant ratio at 0.5 and no adjustment to the water content was made for mixes containing fly ash.

Where,

SP-0= is the control mix that is no fly ash no superplasticiser. SP 0.25= admixture super plasticiser with 0.24% SP1%=admixture super plasticiser with 1%

SP2%=admixture super plasticiser with 2% F30%=mix with 30% fly ash replaced by a cement.

F50%=mix with 40% fly ash replace by a cement F70=mix with 70% fly ash replace by a cement F90=mix with 90% fly ash replace by a cement.

THE J-RING:

The j ring Test aims was to studying both the passing ability and filling ability andof Self-compacting concrete. It can also be used to examine the resistance of self-compacting concrete to segregation by comparing test results from two different percentages of samples. The J-ring test measures three parameters: flow spread, flow time T50J and blocking step. The J-ring flow spread shows the restricted deformability of Self-compacting concrete this is due to blocking effect of reinforcement bars and the flow time T50J directs the rate of deformation within a clear flow distance. The blocking step quantifies the result of blocking. Place the cleaned base plate in a stable and flat position. Fill the bucket with 6 to7 litres of typical fresh Self-compacting concrete and let the sample stand still for about 1 minute plus or minus 10 seconds respectively. "Under the 1 minute waiting period pre-wet the inner surface of the cone and the test Surface of the base plate using the moist cleaning utensil or cloth, and place the cone in the centre on The 200 mm circle of the base plate and put the weight ring on the top of the cone to keep it in Place. (If a heavy cone is used, or the cone is kept in position by hand no weight ring is needed in that case) Place the J-ring on the base plate around the cone (Schutter 2005).

L-BOX:

This method aims to investigate the passing ability of SCC. It measures the flow distance of fresh Self-compacting concrete after passing through the specified gaps of steel bars and flowing within a Clear flow space. Put the L-box in a stable and equal position. Fill the vertical part of the L-box, with the extra adapter fixed, with 12.7 litres of representative fresh Self-compacting concrete. Let the concrete rest in the vertical part for one minute or 10 seconds). During this time the concrete will show whether it is steady or not (segregation). Sliding the gate and let the concrete flow out from the vertical part into the horizontal part of the L-box. When the concrete has not flowing , measure the average distance with tape , between the top edge of the box and the concrete that reached the end of the Box, at 3 the positions, one at the centre and two at each side see the fig above . In an only movement, in such a method that the concrete is allowed to flow out easily without obstacle from the cone-shaped, and start the stopwatch the moment the cone loose the contact with the base plate. Stop the stopwatch when the front of the concrete first touches the circle of diameter 500 mm. The stopwatch reading is recorded as the T50J value. The test is completed when the concrete flow has stopped.(Schutter, 2005).

CASTING CURING AND TESTING:

Cubes of 100mm in size were used for determination of weight, density, ultrasonic pulse velocity and compressive strenght.where 50mm by 25mm used for determination of water absorption and capillary that is the 100mm cube divided in t0 two. That made the total number of 13 cubes two cubes divided it to half for capillary and water absorption. Before casting the workability test was made by the used of j ring and L box where the flow found satisfactorily because it flow under its own weight except for the control mix that is MO. Specimens cubes were then cast in steel mould and also no subjected to any compaction except for control mix again. The specimen kept covered in controlled chamber at 20 ±2^{o}C FOR 24hours except those that have high percentage of fly ash that from 50% to 90% have delays for it setting time to 48hour even more then 2days for the mixes contained 70% and 90% fly ash Until remoulding .Thereafter, cubes were place in the curing tank at 20$^{c}{}_{c}$omfort different age of curing 7days, 28day, 56day respectively. After then remove from the tanks take the weight, density ultrasonic pulse velocity, compressive strength water absorption, and capillary. For the determination of water absorption and capillary cubes were taking from curing tanks after certain age to place in an oven at 100^{o}C until constant mass achieved this took me about 5days.the cubes were allowed to cool in an air tight bag container. Measure the dry masses of the specimens was determined before they were immersed in water. For 0.02hrs 0.08hrs 0.17hrs, 1hrs, 4hrs, 24hrs, 72hrs, and 120hrs etc.

Fig 3.2. SP-o control mix no anything.

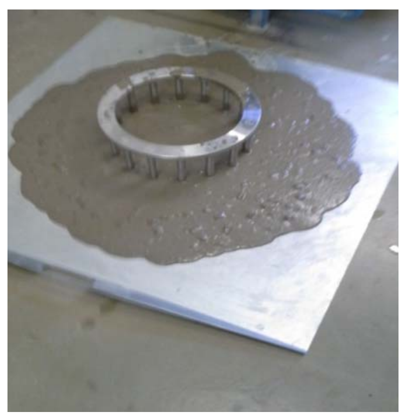


Fig 3.3. Super plasticizer 1%

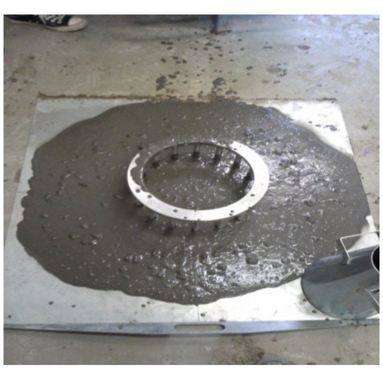


Fig 3.4 Fly ash with 70%

DISCUSSION OF THE RESULT: FRESH CONCRETE PROPERTIES:

In order to investigate the effect on fresh concrete properties when fly ash and admixture is added in to the concrete as cement replacement. The self-compacting concrete containing different proportion of fly ash that is 30%, 50%, 70% 90% and admixture novel super plasticiser 0.25%, 1% 2% were all tested for slump flow j-ring l-box etc.

The results of fresh properties of all specimens for SCC are indicated in the table below. The table shows the properties such as slump flow, l-box in terms of slump flow all mixes exhibited high workability for all mixes except for the control mix (M0) the slump flow is in range of 550mm-900mm which is an indication of good deformability.

L-BOX BLOCKAGE:

s/no	Mix	l-box in sec
1.	SP 0	No flow
2.	SP 0.25%	4sec
3.	SP 1%	2sec
4.	SP2%	0 sec
5.	F30%	1 sec
6.	F50%	0sec
7.	F70%	0sec
8.	F90%	0sec

J RING FLOW IN MM: TABLE 4.2

s/no	Mix	J ring flow mm
1.	SP0	280mm

2.	S 0.25%	380mm
3.	S1%	403mm
4.	S2%	780mm
5.	F30%	773mm
6.	F50%	840mm
7.	F70%	880mm
8.	F90%	900mm

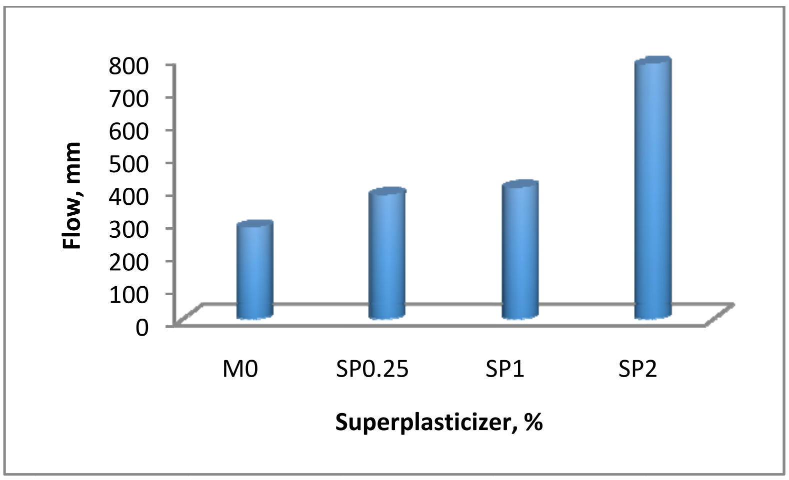


Figure 4.1. The effect of super plasticizer concentration on the flow of SCC.

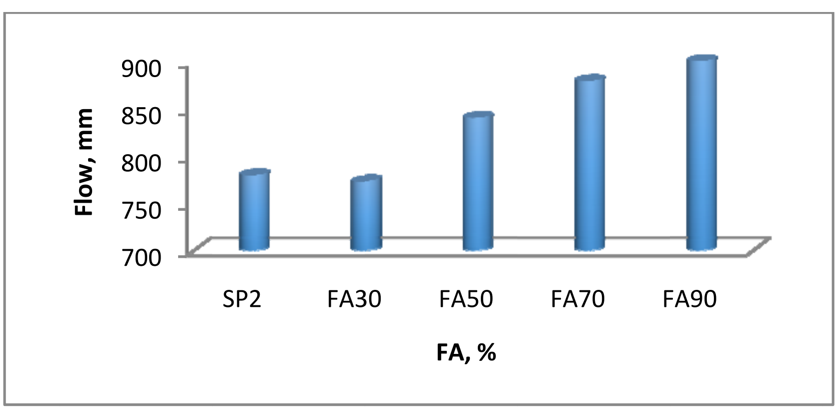
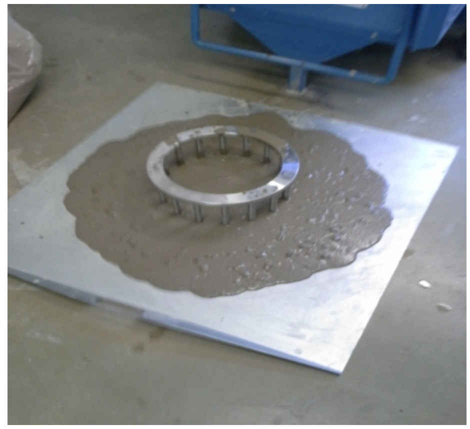


Figure 4.2 The effect of FA concentration on the flow of SCC in presence of 2% of SP.



Mo control mix no anything Superplasticizer 1%

Fly ash with 70%. **Control mixes no** superplasticiser.

Time ranging 06-12 seconds is considered adequate for SCC (EFNARC 2002).The L- box flow times were in the range of 4-10second except for the control mix. The result of the investigation indicated that all SCC mixes meet the requirements of allowable flow time .based on the experimental result examined of the different mixes replaced by flash was further increase in workability as shown in mixes containing high percentage of fly ash the flow is within 800-900mm compare with the control mixture. Generally the use of fly ash in concrete reduce the water demand for a given workability .Therefore concrete containing fly ash will cause an increase in workability at constant water binder ratio. Furthermore, based on the investigation mixes containing high percentage of fly ash that is 70%-90% the workability is very high which it even lead to segregation as you see in mix contain 90% flash.

As in the result table above as the dosage of super plasticiser increases, the slum flow increases. This is expected because as the super plasticiser dosage increase the fluidity of the concrete also increase the L-box values increase as superplasticiser dosage increases this interpret that as the dosage increase concrete is more able to flow through reinforcement or congested side to fill everywhere on it weight.

CONCLUSION:

The following observation and conclusion have been made based on the Finding result of the present investigations result:

With this type of novel superplasticiser high percentage of fly ash can be used to produce self-compacting concrete with adequate compressive strength. Using up to 30% fly ash as cement replacement can produce self-compacting concrete with the strength as higher as 40mpa.Higher compressive strength has been obtained for fly ash replacement 0f 30% also the increase in cement replacement 0f 70% and 90% of fly ash resulted in a decrease in strength and increase in workability. Compressive strength is powerfully decreased with the increase of fly ash.

The chemical resistance of self-compacting concrete with fly ash was higher compared with the other specimens with no fly ash ,the setting time of the mixes contain high percentage of fly ash 70%, 90% was up to 5days while the specimens contain only superplasticiser was 1day.

Based on the result investigation saturated water absorption is increase with the increase of fly ash 30%-70% replacement of cement .when the mixes immersed in water tank for curing for 7days 28days and 56days respectively the average reduction in weight increase and the weight decrease when the fly ash was increase especially high content of fly ash 70% and 90% replacement of cement. The medium water absorption level in self-compacting concrete is good indicators of limited open porosity that can contain high flow of water in to the concrete.

Based on the result analysis the novel supeplasticiser modified used has substantial influence on the fresh properties of self-compacting concrete a small change in the dosage make a substantial change in the SCC properties that is flowing ability, passing ability, stability, and segregation resistance as in the result findings, the increase in superplasticiser dosage from 0.25% to 2% the workability increase so the required slump flow meet the criteria of EFNARC.

Finally The 70% and 90% fly ash specimen is totally no good as you see in the result table though it achieved good workability on it fresh state .but the mechanical properties is very low and the developin setting it takes long time at least one week before final setting and when it immerse in water it dissolve because of high chemical reaction that were taking place which lead to degradation .I will finally concluded that 90% and 70% of fly ash is not recommended to use with this type of novel superplasticiser. The 50% contain of fly ash the mechanical properties that is the compressive strength it little bid well but no enough compare with the control mixes it need to be upgrade compare with the one with normal conventional superplasticiser for other researchers the strength is reasonable, but the fresh properties workability is very good.

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