EFFECTS OF WITHHOLDING MIXING WATER AND RETEMPERING ON WORKABILITY OF CONCRETE

Madhur Dwivedi[1], Dr. Rajeev Chandak[2]
[1]M.E.-scholar (Structural Engineering), [2]Head of Department, Department of Civil Engineering, Jabalpur Engineering College, Jabalpur, Madhya Pradesh, India.

Abstract: ***Because of delay in placing concrete may undergo loss of workability because of which it may not be fit for the desired purpose and turned into wastage. This wastage results into loss of economy, effort and time. In mass concreting this type of wastage causes huge loss of material. In such conditions and in hot weather concreting also, process of retempering is commonly preferred to restore lost workability. This experimental investigation evaluates the effects of retempering with withholding mixing water or redosage with water in excess of design water-cement ratio, on workability of concrete. The effects of varying the withholding time and amount of water withheld were examined. Observations of this investigation show that workability is not restored by retempering with withholding mixing water.***

Keywords: Concrete, Retempering, Witholding Mixing Water, Workability.

I. INTRODUCTION

Concrete is most commonly used structural material. About 170 million cubic meters of concrete is produced in India annually in other words for every human being on earth more than a tonne of concrete is produced each year. Such a huge amount of consumption results in indirect impact on environment due to consumption of cement and aggregates from natural resources. Portland cement is the most energy intensive material produced after steel and aluminium. More than 7% of the world's carbon dioxide emissions are attributed to Portland cement. In addition to CO2 emission the burning of Portland cement at high temperature (14500C) is costly in terms of fossil fuel usage. Also continuous exploitation of aggregates from natural resources poses severe threat to the environment. The availability of commonly used natural sand which is normally rounded and smooth textured is shrinking at a faster rate and becoming costly. Furthermore by some estimate concrete industry is largest consumer of natural resources such as water, sand, gravel and crushed rock. In the conditions like failure of any concreting equipment or quarrels between the labours or suddenly erupted strikes on the site or concreting in hot weather may pose the green concrete into unmanageable situation. In this condition concrete may have to wait for a longer time before placing into the formwork. This results in loss of plasticity, affecting strength, durability and other characteristics of concrete. Normally in such a situation rejection of a batch or otherwise good concrete, on the grounds of insufficient workability, has to be done. If not rejected, excessive vibration would be required to fully compact the concrete, with the risk of incomplete compaction, expensive repair, or at worst removal of the hardened concrete. This causes loss of material, effort and money especially in mass concreting. Also this wastage of concrete should be avoided due to its indirect, harmful effect on environment. It can be done by retempering of concrete.

Retempering is the process of remixing of concrete with addition of just the required quantity of water. Also a small quantity of extra water is sometimes added while retempering. Retempering of concrete, which has been questioned for many years is a common construction practice. Retempering is done mainly to recover workability of concrete but it should not result into degraded quality concrete. Therefore it is necessary to investigate the effects of withholding mixing water and retempering on workability of concrete.

II. MATERIALS AND METHODOLOGY

In this experimental work, materials used in the preparation of concrete are cement, sand, coarse aggregates, and water. Ordinary Portland Cement of 43 grade was used for making concrete, the specific gravity of which is 3.15. Locally available natural river sand passed through 4.75 mm sieve was used as fine aggregates. Through sieve analysis it was found to be of zone II grading as per IS 383:1970 specification for coarse and fine aggregates from natural sources for concrete. The specific gravity of fine aggregate is found to be 2.62. Locally available Coarse aggregates of machine crushed broken stone type was used which was angular in shape. Coarse aggregates of 20mm and 10mm sizes, confirming to IS: 383-1970, was used in fractions having specific gravity of 2.81. Water used for mixing as well as for curing was ordinary tape water which was potable and free from chemical substances and suspended particles.

Methodology

In this study, M25 grade of concrete was designed as per IS: 10262 – 2009 and testing program was investigating the effect of retempering on the workability of concrete. Utilised retempering methods were retempering with withholded water and retempering with redosage of water. Major variables which were examined are amount of water withheld and later added and length of withholding time.

Retempering considering 45 min and 75 min time delay with 5% and 10% withholding of mixing water was done. Also the effect of redosage with 5% water above and beyond the design water-cement ratio required at 45min and 75 min time delay was examined. This redosage attempts to restore workability which is reduced. Property of the concrete examined was workability (slump).

Table 2.1 shows specimen series for testing concrete. Here C stands for control mix with 0% water withheld, RW stands for retempering with withholded mixing water and RD stands for retempering with redosage of water. Also superscript number of this nomenclature shows time delay and subscript number shows percentage of water withheld or redose.

After mixing of ingredients in dry state, water was added (all water added initially for control mixes and specified amount of water withholded which was added latter after specified time delay for different batches as can be seen in table 2.1) and thoroughly mixed. At this stage initial slump was measured then the fresh concrete was kept for specified time delay and again slump was measured at this intermittent period and thereafter witholded water was added and after that final slump cone test was performed as per IS 1199:1959.

Table -2.1
Designation of Mixes for Specimen Series

TIME DELAY / WATER WITHHELD	No delay	45 min	75 min	with 5% redose: No delay	with 5% redose: 45 min	with 5% redose: 75 min
0% Withheld	C^0 (Control mix)	C^{45} (Control mix)	C^{75} (Control mix)	$RD^0{}_0$	$RD^{45}{}_0$	$RD^{75}{}_0$
5% Withheld	X	$RW^{45}{}_5$	$RW^{75}{}_5$	X	$RD^{45}{}_5$	$RD^{75}{}_5$
10% Withheld	X	$RW^{45}{}_{10}$	$RW^{75}{}_{10}$	X	$RD^{45}{}_{10}$	$RD^{75}{}_{10}$

III. RESULTS AND DISCUSSIONS

The results of workability test i.e. slump cone test are given as in Table-3.1 and corresponding graphs are shown in Figures (from graph 3.1 to graph 3.4).

In series $C^0 \rightarrow C^{45} \rightarrow C^{75}$ decrease in air content of concrete and loss of moisture in atmosphere by evaporation which in turn causes decrease in w/c ratio leads to decreased workability or slump as shown in table 3.1, with time. Which means as the time passes mix becomes more stiff.

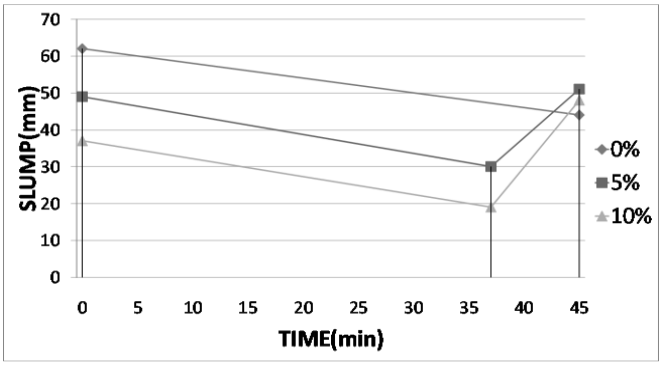
Workability is not restored to value of control mix in RW series when compared to C series as shown in graph 3.1 and graph 3.2 because w/c ratio is also decreases with time despite of retempering increases air voids. Also $RW^{45} \rightarrow RW^{75}$ series showed decreased workability due loss of moisture in atmosphere by evaporation which in turn causes decrease in w/c ratio as shown in table 3.1, as observed in C series i.e. as the time passes mix becomes more stiff. Also RW_{10} mixes are harsher as shown in graph 3.1 and graph 3.2, than RW_5.

Water cement ratio of RD series is higher than C and RW series which causes better workability as can be seen in table 3.1, than C series. $RD_0{}^0 \rightarrow RD_0{}^{45} \rightarrow RD_0{}^{75}$ series as shown in table 3.1 indicates decrease in workability with time due to loss of moisture in atmosphere by evaporation.

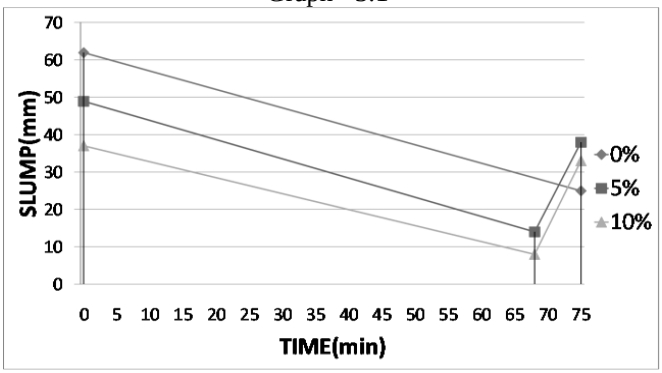
In $RD^{45} \rightarrow RD^{75}$ series workability is decreased as shown in table 3.1 because of decrease in w/c ratio with time. Also RD_{10} mixes are harsher than RD_5 as shown in graph 3.3 and graph 3.4. RD_5 and RD_{10} series shows comparable workability to RD_0 and also workability is restored to an extent in $RD_0{}^0$ and RD^{45} series compared to C series as shown in table 3.1.

Table -3.1
Slump (in mm) Observed in Specimen Series

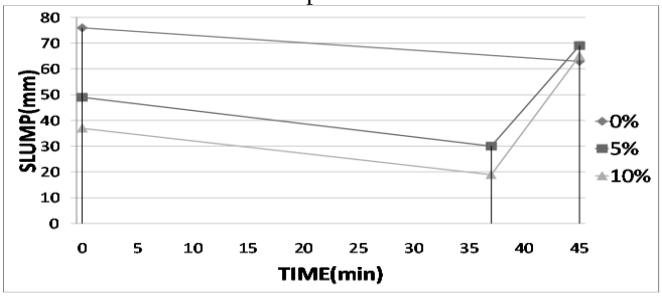
TIME DELAY / WATER WITHHELD	No delay	37 min	45 min	68 min	75 min	with 5% redose: No delay	with 5% redose: 37 min	with 5% redose: 45 min	with 5% redose: 68 min	with 5% redose: 75 min
0% Withheld	62	X	44	X	25	76	X	63	X	48
5% Withheld	49	30	51	14	38	49	30	69	14	53
10 Withheld	37	19	48	8	33	37	19	65	8	51



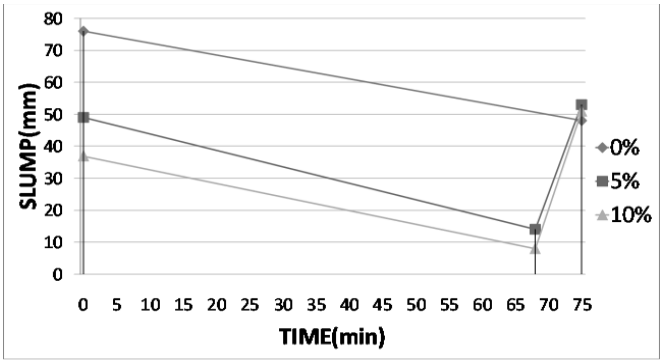
Slump vs Time for Mix Without Redosage
45 min Witholding Time
Graph - 3.1



Slump vs Time for Mix Without Redosage
75 min Witholding Time
Graph - 3.2



Slump vs Time for Mix With Redosage
45 min Witholding Time
Graph - 3.3



Slump vs Time for Mix With Redosage
75 min Witholding Time
Graph - 3.4

IV. CONCLUSIONS

The results of this study of retempered concrete shows that no benefit in workability was achieved by withholding mixing water followed by retempering, when compared with control mix in which all the water is added initially i.e. workability was not restored when compared with control mix and workability was decreased as the time delay increases. Slope of slump verses time characteristics appeared to be approximately same which indicates slump loss is found to be dependent upon initial slump. But retempering of concrete cannot be allowed based upon better workability only. retempered concrete should also have sufficient strength and other characteristics so that it fulfils the required purpose. If retempered concrete have characteristics upto the required standards for fulfilling the purpose it is intended for, than it can be adoptable. As well as retempering has contribution to waste minimization and resources conservation. Thus by adopting retempering cost of construction will also be reduced because of minimised wastage which in turn also saves time and effort. Huge amount of consumption of concrete results in indirect impact on environment due to consumption of cement and aggregates from natural resources, manufacturing or exploitation of which have indirect, harmful effects on environment. These effects will be reduced by using retempered concrete which otherwise get wasted.

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