

Low heat concrete hydration thermal reduction with bioconc

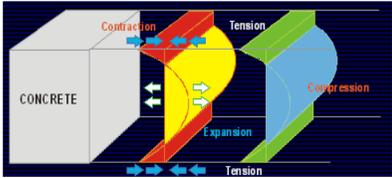


Fig. 1 Masscon Thermal Stress

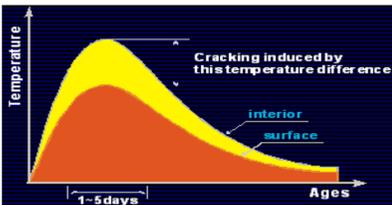


Fig. 2 Core-edge Thermal vs Time

Introduction

The basic issue of *mass concrete* is the potential thermal cracking, because of the hydration heat of the cement content in mass concrete between its layers as Fig. 1 and Fig 2. Therefore, the hydration heat control of the mass concrete is the centre of potential problem that should be solved. Controlling the mass concrete hydration heat by reducing the cement content on the significant level up to forty percent may control the hydration heat of the concrete on the acceptable thermal difference. In this research, reducing of cement weight was compensated with *bioconcrete* as microfiller. The concrete strength in laboratory scale was fix at 25 MPa as well as the mock up of mass concrete with a size of 1000x1000x2500 mm³. Thermocouple was used for monitoring the peak temperature. It was occurred at 63.5°C in 29,5 hours after pouring and maximum thermal differential layers bioconc low heat concrete was 19,5°C. The control specimen as bench marking showed its peak temperature of 62.6°C in 71 hours after pouring and its maximum thermal differential between its layers was 7,9 °C. In addition, a fly ash based low heat concrete's peak temperature was 68.8°C in 60 hours after pouring and maximum thermal differential between its layers was 8,9°C.

Material and Methods

- Concrete grade Fc'25 on various treatment Fc'25 + FA.40%, Fc'25+FA20%+Ice Block as standard references Masscon hydration control compared with the researched Fc'25 + Bioconc R.40%, prior lab scale trial mix of Fc'25+Bio.R20 ; Fc'25+Bio.R25 ; Fc'25+Bio.R30 ; Fc'25+Bio.R40 ; refer to Fig. 5 then choose the Fc'25+ Bio. R.40% mean Fc'25 with Bioconc admixture 600 cc/m³ concrete reduce cement content 40%.
- Industrial scale modelling of bioconc based low heat concrete was made on mock up 1000x1000x2500 mm³.
- Mock up concrete quality control was checked slump test, initial concrete temperature and compression test.
- 4 temperature probes were installed as fig. 7, for thermocouple monitoring every 30 minutes, Fig. 8,9,10,11.

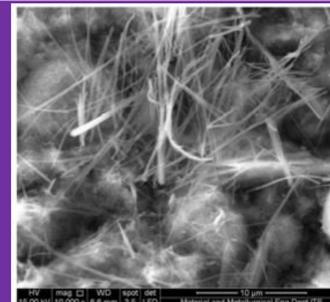


Fig. 3 S.E.M. Bioconc - Concrete

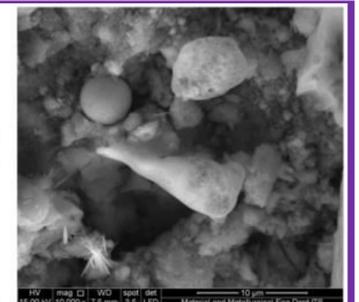


Fig. 4 Normal Concrete

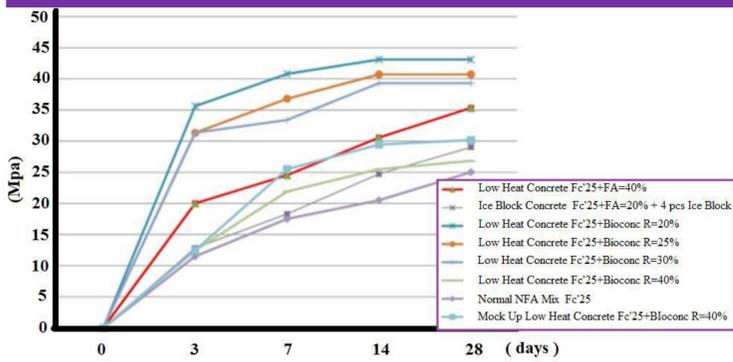


Fig. 5 Compression Test Fc'25 on various treatment



Fig. 6 Mock Up Bioconc LHC

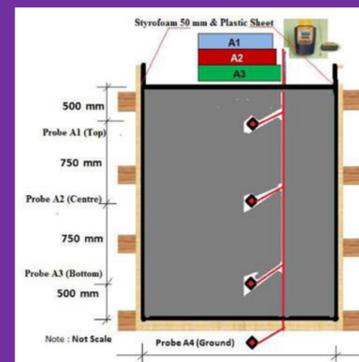


Fig. 7 Probe installation for thermocouple monitoring

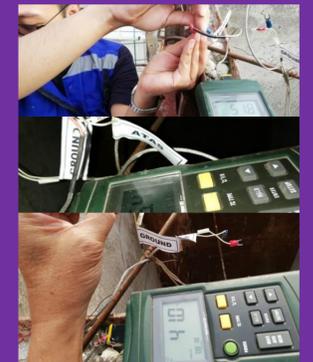
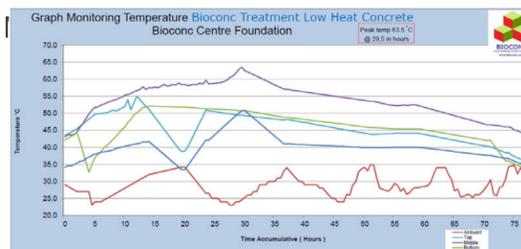
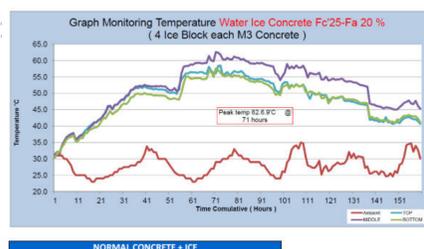


Fig. 8. Thermocouple Monitoring

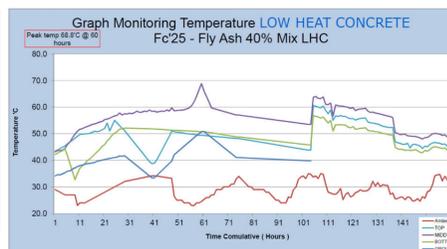
Results



Temp. °C	at Plant	at Site
Initial	16,5 °C	12 °C
Slump	32,5 °C	33 °C



Temp. °C	at Plant	at Site
Initial	12 °C	11 °C
Slump	22 °C	25 °C



Temp. °C	at Plant	at Site
Initial	12,5 °C	12 °C
Slump	30 °C	32 °C

Material Mix	Bioconc LHC	FA20%+Ice	LHC-FA40%
Peak Thermal	63,5 ° C	62,6 ° C	68,8 ° C
Peak Time	29,5 hours	71 hours	60 hours
Dif. Thermal	19,7 ° C	7,9 ° C	8,9 ° C

Fig. 12. Mock up masscon Summary

No.	Material	Masscon Fc'25FA40	System FA.20+Ice Con.R40	Model (kg)	Cost LHC Fc'25FA40 US\$	Cost Fc'25FA20+Ice US\$	Cost Bioconc Fc'25 US\$
1	Cement	256	315	256	0,07	16,56	22,11
2	Water	158	158	158	0,01	1,11	1,11
3	Fly Ash	158	79	-	0,002	0,28	0,14
4	Coarse Ag	1160	1160	1160	0,02	20,35	20,35
5	Fine Agg	760	760	760	0,01	9,33	9,33
6	Ice Block	-	5	-	2,46	-	12,28
7	Ice Process	-	1	-	3,51	-	3,51
8	SP (Litre)	1,5	1,3	1,4	2,46	3,56	3,19
9	Bioconc	-	-	0,6	6,52	-	3,79
		Total Material Cost of Mass Concrete Production =			51,30	72,90	54,60

Fig.9 Mock up masscon "bioconc LHC" Thermonitoring Fig. 10 Mock up masscon "pre-cooling" Fig. 11 Mock up masscon "LHC" Fc'25+FA=40% Fig. 13 Raw Material Production Cost-Comparison



Discussions & Conclusions

- Refer to summary Fig. 11 was founded that bioconc low heat concrete the fastest peak temperature reacher and acceptable peak temperature 63,5 °C and mock up core to edge thermal differential 19,7 °C.
- Refer to summary Fig. 12 was founded that bioconc low heat concrete raw material production cost US\$ 54.6 / m³ concrete, compared with precooling masscon raw material cost US\$ 72.0 /m³ concrete and fly ash based 40% Low Heat Concrete masscon raw material cost US\$ 51.30/m³ concrete
- Refer to PSR-Physicians for Social Responsibility, publication, 1985, researched and concluded that coal ash on concrete fly ash is dangerously toxic and poses a threat to human health. This research solve the problem that bioconc works as microfiller and substitute the coal ash or fly ash on treat the concrete economically and eco-friendly.

Acknowledgements

We would like to thanks to Metalurgical Department&Concrete Laboratory Institut Teknologi 10 Nopember Surabaya and PT SCG Jaya Readymix Indonesia, who support this research.

Makno Basoeki^{1*}, Koespiadi², J J Ekaputri^{3*}

¹Bioconc Centre Foundation, Sidoarjo, Indonesia.

²Universitas Narotama, Surabaya, Indonesia.

³Civil Engineering Department, Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia.