

## **The Engineering and Economic Feasibility Application of Bioconc on Concrete Quality Treatment in Low Heat Concrete**

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### **ABSTRACT**

This paper discuss the concrete *hydration thermal control* with the economical and *eco-friendly* Method Statement, based on the basic performance of concrete bio-admixture, Bioconc, which is produce micro-filler, reduce the binder content up to 40%. The concrete hydration thermal sources is from the cement as binder, since Bioconc may reduce up to 40% binder content, the concrete hydration thermal can be controlled and worked as *Low Heat Concrete*. The paper limited discuss about the application of the Bioconc, for laboratory scale trial mix, *Low Heat Concrete* mock up modelling test and comparison with another 2 (two) *Low Heat Concrete* above mentioned <sup>[1]. [4]</sup> and does not discuss the Bioconc ingredient. The research started by laboratory scale trial mix Fc'25 *Low Heat Concrete* Bioconc based concrete Job Mix, from cement content reduction 20%, 25%, 30% and 40%. The attached result shows optimum jobmix is Fc'25 *Low Heat Concrete* Bioconc based concrete Job Mix on 40% cement as binder content reduction, was choosen as *Low Heat Concrete* Mix Mock Up. Later on, further research make mock up for sampling mass concrete dimension 1000x1000x2500 mm<sup>3</sup> was executed. The attached Graph Thermal Monitoring *Low Heat Concrete* shows that the peak temperature occurred 63,5°C in 29,5 hours after pouring and maximum thermal differential between LHC layers is 19,5°C. Another two *Low Heat Concrete* Method Statement, i.e.: Pre-cooling and *Low Heat Concrete* with Fly Ash 40%, Mock Up Graph Thermal Monitoring also attached for comparison study. The observation and analysis proof that, “*Low Heat Concrete* Hydration Thermal Reduction with Bioconc” is work simplifier and economically, for mass pouring. The most essential thing is that, the basic concept of Bioconc’s *Low Heat Concrete* on reducing the mass concrete cement-binder content means reducing CO<sub>2</sub> emission in every concrete production, without any hazard impact to the environment. Its mean Bioconc based *Low Heat Concrete* contribute to develop the green technology and eco-friendly technology on the concrete industry as sustainable green technology.

**Keywords :** *Mass Concrete, Concrete Hydration Thermal Control, Low Heat Concrete, Pre-Cooling, Post Cooling, Bioconc , Green Technology , Eco-Friendly*

### **I. INTRODUCTION**

Concrete is most common construction material which is use on every construction project. Mostly concrete construction material, especially related to highrise buiding structural elements, in large dimension forms mass concrete. Mass concrete is any volume of concrete with dimension large enough to require that measures be taken to cope with the generation of heat from hydration of cement and attendant volume change to minimize cracking. The design of mass concrete structure is generally based on durability, economy, and concrete hydration thermal control, and strength often being secondary concern. <sup>7)</sup>

Therefore this journal is written the research on how to control the hydration thermal control with Bioconc, in concentration of discussion to observe the engineering feasibility and economical feasibility.

#### **1.1. Research's Object**

The Object of Research is how to control concrete thermal hydration on mass concrete with bio-admixtures Bioconc, compared with existing common method statement in control mass concrete thermal hydration, on precooling as described previously on reference [1] and [4]. One of Bioconc component produce microfiller insert the microgap of the concrete aggregate composite which is usually filled cement binder, so the cement content will be reduced and the composite aggregate surface binded increase, this increasement proofed related to the strength increasement on next research data result. Following pictures shown the comparison of Scan Electronic Microscopy (SEM) of Bioconc treated concrete (Photo-1) and normal concrete (Photo-2).

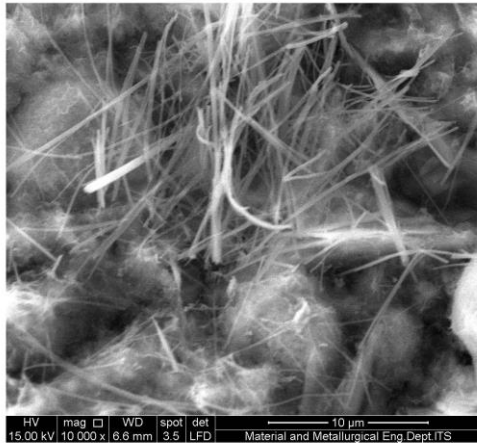


Foto 1 : SEM Bioconc Treated Concrete

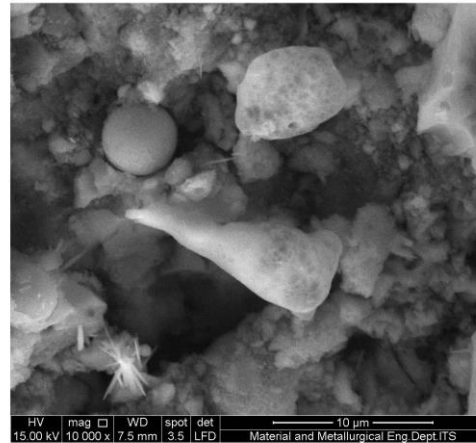


Foto 2 : SEM Regular Concrete

## 1.2. The Aim of Research

The Research's Aim is directed to observe the following objects :

1.2.1. The engineering effectiveness of concrete bio-admixture, Bioconc on control the concrete thermal hydration, compared with another mass concrete hydration thermal control as reference [1] and [4].

1.2.2. The effectiveness of concrete bio-admixture, Bioconc on increase the mass concrete quality, compared with another mass concrete hydration thermal control as reference [1] and [4].

1.2.3. The economical effectiveness of the application of concrete bio-admixture, Bioconc on control the concrete thermal hydration on Low Heat Mass Concrete compared with another mass concrete hydration thermal control as reference [1] and [4].

## 1.3. Scope of Discussion and Discussion Limit

The discussion scope is directed on the following object :

1.3.1. Laboratory scale trial mix, directed to observe the optimum Bioconc's Low Heat Concrete Jobmix.

1.3.2. The mass concrete modelling or mock up scale of Bioconc based, Low Heat Concrete 1000x1000x2500 mm<sup>3</sup> dimension, observation to discover the peak temperature on peak time.

1.3.3. Simply economical calculation of the Bioconc based, Low Heat Concrete application.

Those scope of discussion are compared with another mass concrete hydration thermal control reference [1] and [4].

This journal will not discuss the following objects :

- Bio-admixtures ingredients
- Bio-chemical process on bio-admixture works in concrete quality treatment
- All related to the production-line

## II. METHOD STATEMENT

The bio-admixture Bioconc treatment concrete job mix modification from original job mix (non fly ash job mix) is describe on the following table-1 :

Observed cement content (binder content) reduction	= R %
Concrete Job Mix - Grade (G)	= Fc'25 (in this research, but not limited to)
Concrete Volume - standard jobmix reference	= 1 m <sup>3</sup>
Optimum Bioconc dosage in 1 m <sup>3</sup> of Concrete	= 600 cc. <sup>[10]</sup>

Table-1 : NFA Job Mix and Bioconc Jobmix Modification

Material Mix	NFA Mix	Bioconc Jobmix Modification
Cement	A	A . ( 1 - R% )
Water	B	B . ( 1 - R% )
Coarse Ag-1	C	C+ (A+B).R%.{C/[C+D+E]}
Coarse Ag-2	D	D+(A+B).R%.{D/[C+D+E]}
Fine Aggregt	E	E +(A+B).R%.{E/[C+D+E]}
Bioconc (cc)	-	600 cc
Total Weight	A+B+C+D+E	A+B+C+D+E+600cc

The sequence of the research execute as the following method statement, refer to the previoust research on reference <sup>[8], [9], [10]</sup>, describe on the following flow chart :

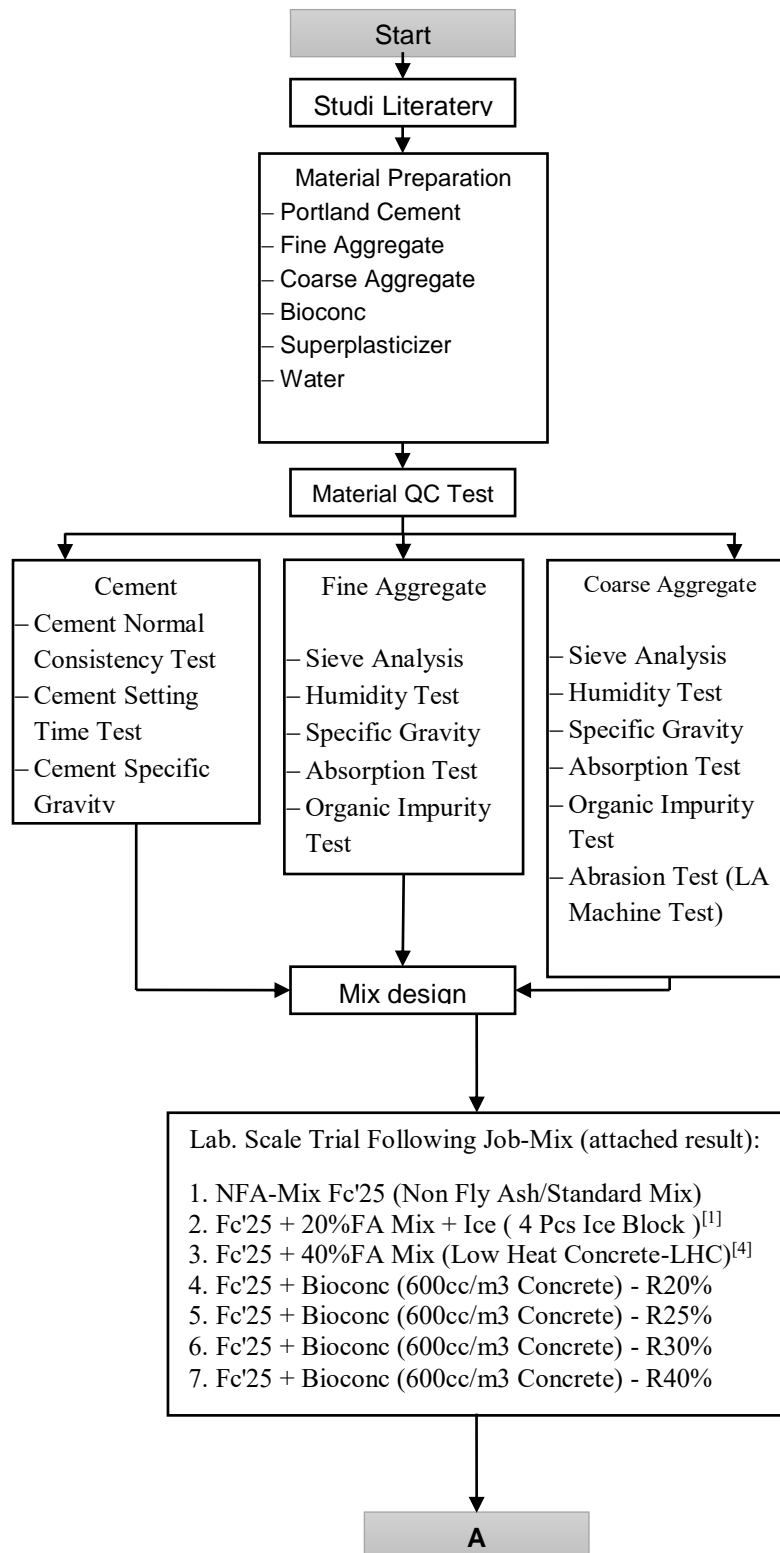


Figure-3 : Flow Chart of Research Method Sequence

**Bioconc Centre Foundation**

**Low Heat Concrete Fc'25 Trial Mix**

Bioconc Treatment Low Heat Concrete Fc'25 Trial Mix Observation In Order to Find Out Optimum Low Heat Concrete Job Mix and Comparison with another 2 (two) Low Heat Concrete Method



Age (days)	Concrete Strength (Mpa) Compared another 2 LHC-Method		Standard Fc'25 (Mpa)	Trial Mix Low Heat Concrete Fc'25-With Bioconc as Microfiller Cement on Various Concrete Mix Cement Content Reduction Strength (Mpa)				Mock-Up LHC-Bioconc FAS=0,45 Fc'25_R=40% (Mpa)	Notes
	Low Heat Concrete Fc'25 - FA=40%	Ice Concrete Fc'25 ( 4 Ice-Block/m3)		R = 20%	R = 25%	R = 30%	R = 40%		
0	0	0	0	0	0	0	0	0	
3	20.0	12.8	11.5	31.14	27.17	24.73	12.46	12.46	
7	24.5	18.3	17.5	35.61	31.33	31.33	21.89	25.48	
14	30.6	24.7	20.5	40.80	36.80	33.40	25.48	29.44	
28	35.3	29.0	25	43.1	40.7	39.3	26.82	30.164	

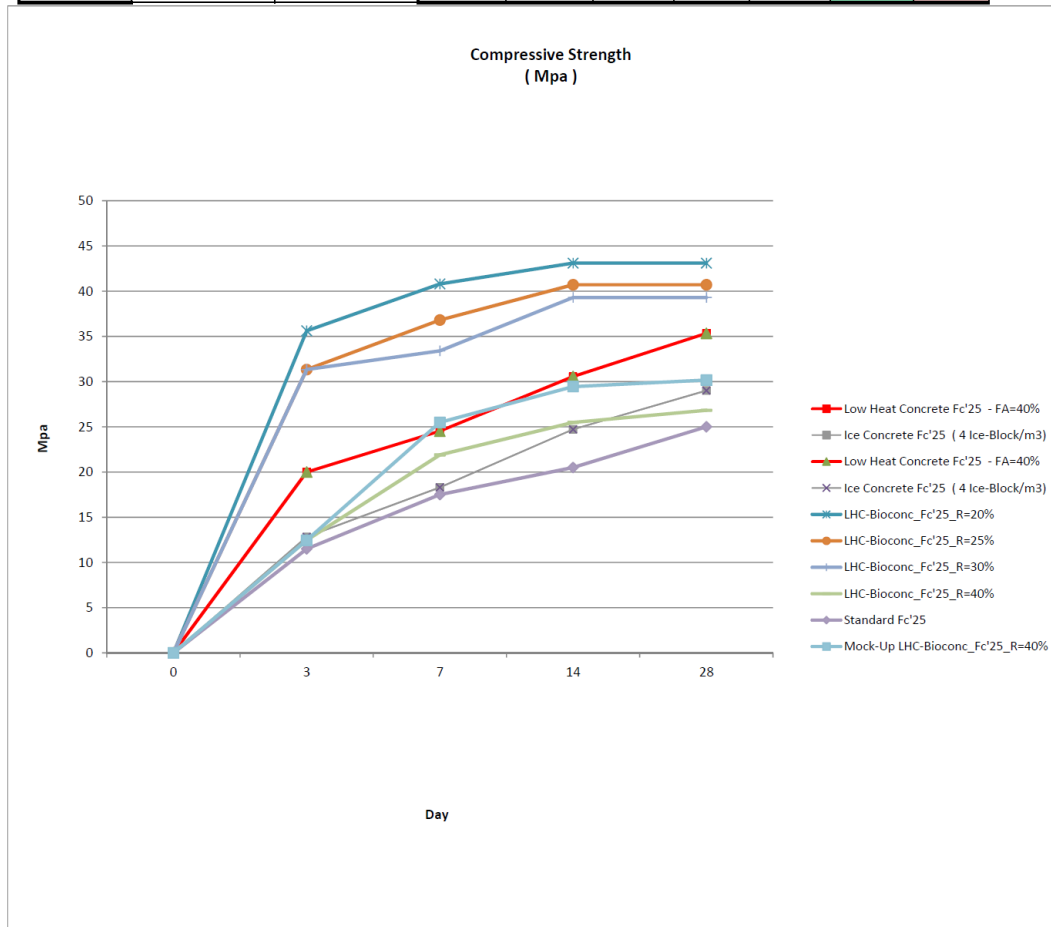


Figure-4 : Strength Test of Cylindrical Samples Lab Trial & Site Mock Up Mass Concrete

A

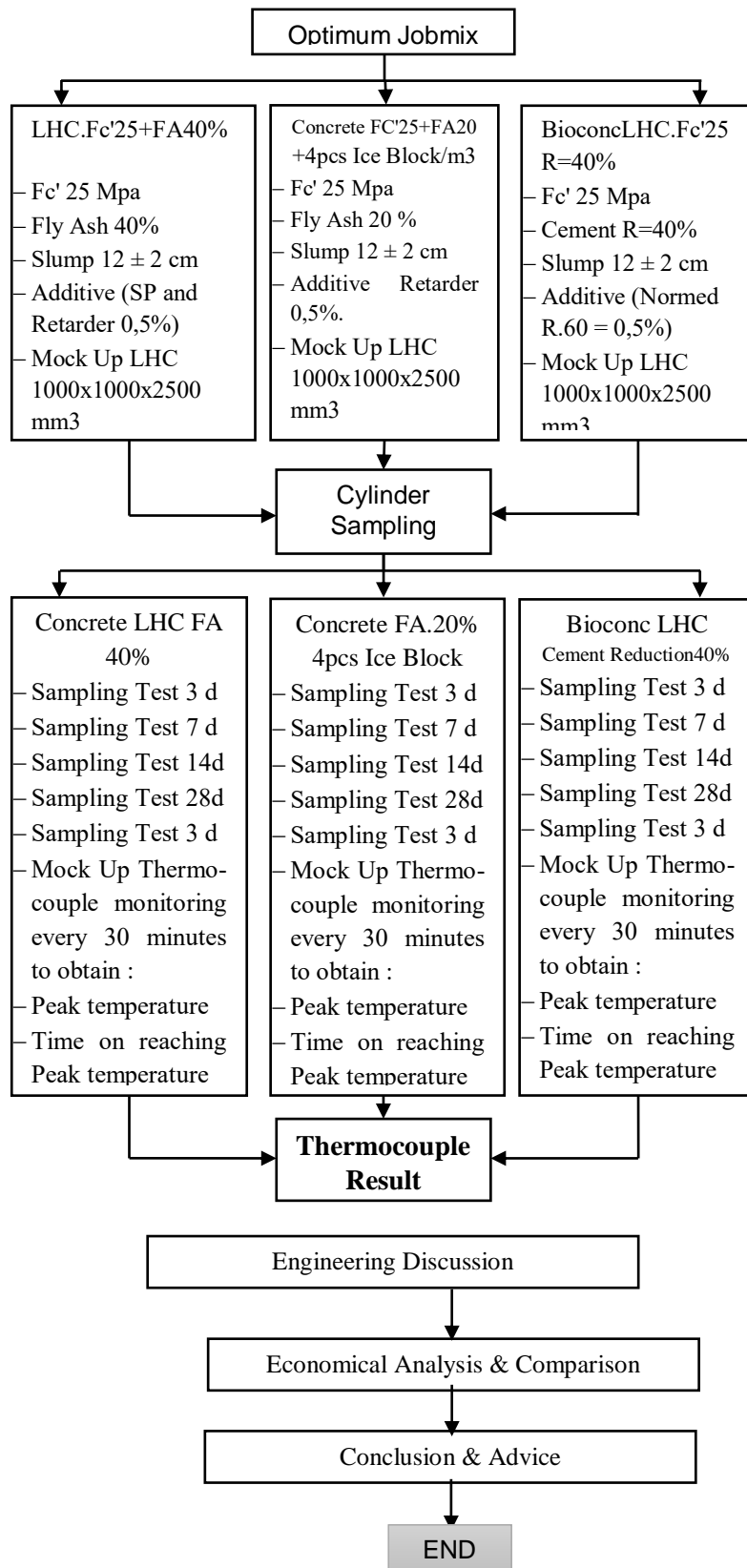


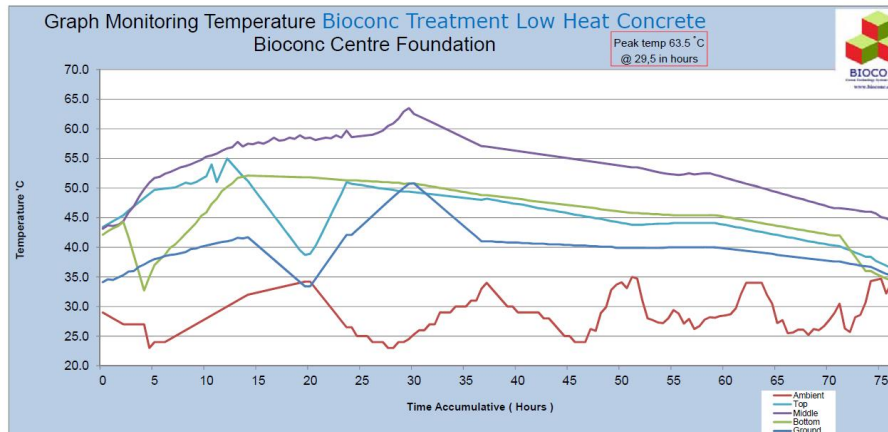
Figure-5 : Sequence of Mass Concrete Hydration Thermal Control Research

### III. RESULT

Based on the above mentioned sequences method of research, the following output data found :

#### 3.1. Bioconc Low Heat Concrete Fc'25, with Cement Binder Content Reduction R=40% Research Data Result

The Mock Up Bioconc Treatment Low Heat Concrete with cement binder content reduction R=40% to control concrete hydration thermal, on mass concrete modelling 1000x1000x2500 mm<sup>3</sup>, Graph thermocouple monitoring output data, figured on the following graph (Picture-3) :



LOW HEAT CONCRETE - BIOCONC BASED PERFORMANCE AS MICROFILLER ON R=40%							
Temp °C	Ambient	TOP	MIDDLE	BOTTOM	TOP-MIDDLE	MID-BOTM	Bottom-Ground
Min	23.0	36.0	43.1	32.7	-1.1	0.1	-4.4
Max	35.0	55.0	63.5	52.1	19.7	17.1	18.4
Average	28.34	45.58	53.80	46.01	8.22	7.79	5.99

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

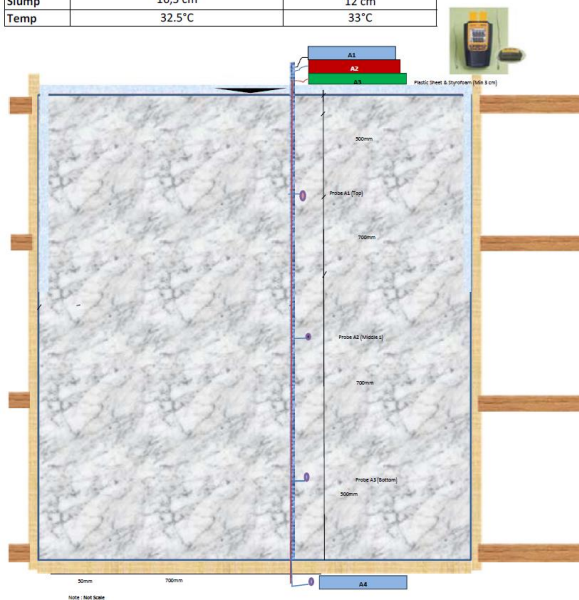
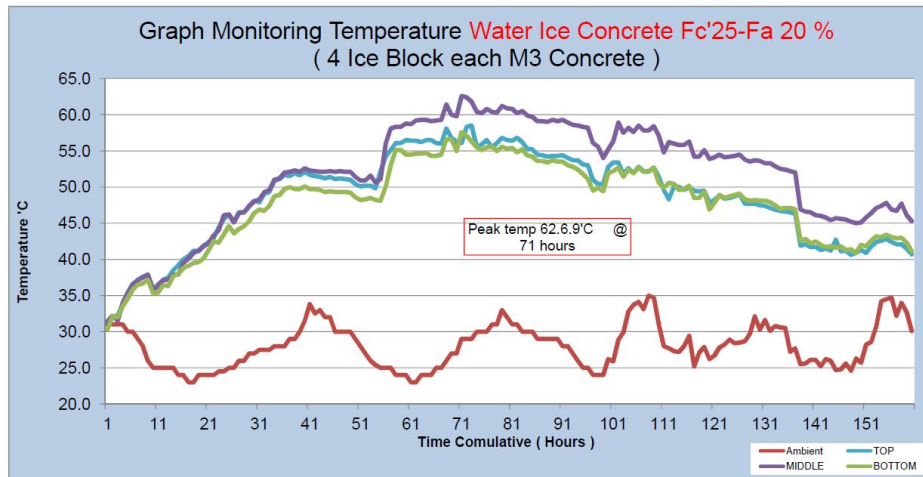


Figure-6 : Thermocouple Bioconc-LHC Monitoring , Summary Data & Mock Up Sketch

#### 3.2. Fc'25 +Concrete Fly-Ash 20% + 4 pcs Ice Block/m<sup>3</sup> Concrete Research Data Result

The Mock Up of Fc'25+FA20%+4pcs Ice Block to control concrete hydration heat, on mass concrete modelling 1000x1000x2500 mm<sup>3</sup>, Graph thermocouple monitoring output data, figured on the following graph (Picture-4) :



NORMAL CONCRETE + ICE						
Temp °C	Ambient	TOP	MIDDLE	BOTTOM	TOP-MIDDLE	MIDDLE-BOTTOM
Min	23.0	31.3	31.4	30.3	-1.3	-0.5
Max	35.0	58.5	62.6	57.6	7.9	7.1
Average	27.46	48.39	51.55	47.63	3.16	3.92

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



Figure-7 : Thermocouple Fc'25 Concrete+20%FA+Ice, Monitoring , Summary Data & Mock Up Sketch

### 3.3. Fc'25 +Concrete Fly-Ash 40% Low Heat Concrete Research Data Result

The Mock Up of Fc'25+FA40% Low Heat Concrete to control concrete hydration heat, on mass concrete modelling 1000x1000x2500 mm<sup>3</sup>, Graph thermocouple monitoring output data, figured on the following graph (Picture-5) :





Figure -8 : Thermocouple Fc'25+FA40%-LHC Graph Monitoring , Summary Data & Mock Up Sketch

IV. DISCUSSION

Mainly concern of mass concrete Quality Control is on the Hydration Thermal Control, as the above mentioned research data result (item 3.1, 3.2 and 3.3) can be summarized as following table :

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

Based on Table-2, Bioconc Treatment Low Heat Concrete the faster method to reach the peak time on 29,5 hours from concrete pouring. On construction process, its mean cost advantage, since faster the peak temperature of mass concrete occurred, faster the next step of construction can be execute, also cheaper over head cost in maintaining the mass concrete, such as rent of mass concrete tends, curing, etc.

Secondly concern of mass concrete Quality Control is on the concrete strength is the concrete cylindrical samples strength test as describe on Figure-4, shown that varioust Concrete Strength Tests are match to the specified.

5. Economical Feasibility Analysis

Based on the each jobmix material proportion, Low Heat Concrete LHC-Fc'25+FA40%, Fc'25+FA20%+Ice block and Bioconc Treatment Low Heat Concrete with cement binder content reduction R=40%, can be analysed the initial each cost of production as the following table-3 :

No.	Material Composition				Rate @ Rp.	Cost of LHC FA 40% Rp.	Cost of LHC FA 20% + Ice Block Rp.	Cost Of LHC Bioconc Rp.	Remark
	Material	LHC FA 40	LHC FA 20 + Ice Block	Bioconc LHC+R=40%					
1	Cement	236.0	315.0	236.0	1,000	236,000	315,000	236,000	
2	Water	158.0	158.0	158.0	100	15,800	15,800	15,800	
3	Fly Ash	158.0	79.0	-	100	15,800	7,900	-	
4	Coarse Agg	1,160.0	1,160.0	1,160.0	250	290,000	290,000	290,000	
5	Fine Agg	760.0	760.0	760.0	175	133,000	133,000	133,000	
6	Ice Block	-	4.0	-	35,000	0	140,000	0	
7	Ice Block Storage System	-	1.0 Lump-sum	-	52,500	-	52,500	-	
8	Bioconc	-	-	0.6	80,000	-	-	48,000	
Total Initial Cost of Production						690,600	954,200	722,800	

Table-3 : Initial Cost Of Production Analysis and Comparison

Based on Table-3 , Fc'25-LHC+FA40% is the cheapest one, but considering the risk of environmental hazard and human health <sup>[5]</sup> , <sup>[6]</sup> the Bioconc Treatment Low Heat Concrete as the mass concrete's hydration thermal control is the wise option to avoid any environmental hazard and human health.

## VI. CONCLUSION

- 6.1. Considering the eco-friendly, engineering and economical aspect, the Bioconc Treatment Low Heat Concrete satisfy all related condition.
- 6.2. Considering the time required to reach peak temperature, the Bioconc Treatment Low Heat Concrete fastest method to control mass concrete's hydration thermal in 29,5 hours after pouring. This facts impact to reduce indirect cost of production of the mass concrete, and speed up to execute the next stage of construction.

## Acknowledgments

First of all, I would like to thank to Alloh SWT, for His Blessing on read one of His natural verse, Bioconc, and implementing for the sustainable eco-friendly construction system. Later on, I would like to thanks in advance to all following partners who support on this research :

- 7.1. SCG Readymix Indonesia - Surabaya Branch, Mr. Fery Farozdaq and team, who totally support this research.
- 7.2. Dean of Civil Engineering Magister Department - Narotama University -Surabaya, Mr. Dr. Ir. Koespiadi, MT
- 7.3. Dr. Eng. Januarti Jaya Ekaputri, ST, MT and Prof. Dr. Ir. Triwulan, DEA. Institut Teknologi Sepuluh Nopember (ITS) – Surabaya, which have been colabored Bioconc Aplication Research with the Author.
- 7.4. KSO Waskita-Darmo Permai, which is give permit to make mock up research, Mr. Ir. M.S. Rishan Kurnia.

- 7.5. PT Manajemen Konstruksi Utama – Surabaya, Dr. Andi, ST, M.Eng and Dr. Lie, M.Constr.Mngmt.
- 7.6. PT Pulau Intan Baja Perkasa, Mr. Ir. Benyamin and team, who support on making mock up formwork.
- 7.7. My wife and my only daughter, who support me in this research.
- 7.8. All partners who support this research, which can not stated all on this paper.

## REFERENCES

- [1] <https://www.scribd.com/document/109689638/Mass-Concrete-Method-Statement>
- [2] [https://www.concreteconstruction.net/how-to/materials/precooling-mass-concrete\\_o](https://www.concreteconstruction.net/how-to/materials/precooling-mass-concrete_o)
- [3] <https://www.forconstructionpros.com/concrete/equipment-products/article/11598829/11598829/how-to-plan-and-manage-curing-for-mass-concrete-pours>
- [4] SCG Readymix Indonesia, Mock Up Trial Low Heat Concrete & Mass Concrete Fc'25+Ice Block, on Avenue88 Project - Surabaya (2017)
- [5] Physicians for Social Responsibility : Coal Ash : Hazardous to Human Health, United States Affiliate of International Physician for Prevention of Nuclear War (2010)
- [6] Juliana Karantonis : The Hazard of Fly Ash, Final Thesis Report, University of New South Wales Australia Defence Force Academy, School of Engineering and Information Technology, Canberra, ACT2600, Australia
- [7] ACI Committee 207, Guide to Mass Concrete, American Concrete Institute-ACI 207.1R-05 (2006)
- [8] James Hartopo Tappangrara, Dr. Eng. Januarti Jaya Ekaputri, ST.MT., Prof. Dr. Ir. Triwulan, DEA : Pengaruh Penambahan Silica Fume Sebagai Pengganti Sebagian Semen Pada Kuat Tekan Beton Mutu Tinggi Dengan Tambahan Black Liquor dan Mikrobakteri, Tugas Akhir Fakultas Teknik Sipil dan Perencanaan Institut Teknologi Sepuluh Nopember, Surabaya, 2016
- [9] Azhar Annas, Dr. Eng. Januarti Jaya Ekaputri, ST.MT., Prof. Dr. Ir. Triwulan, DEA : Pemanfaatan Mikrobakteri Pada Beton Mutu Tinggi Dengan Tambahan Silica Fume, Tugas Akhir Fakultas Teknik Sipil dan Perencanaan Institut Teknologi Sepuluh Nopember, Surabaya, 2016
- [10] Tony Hartono Bagio, Makno Basoeki, Sofyan Ali Pradana : Optimum Concrete Compression Strength Using Bio Enzyme,EACEF 2017. The 6th International Conference of Euro Asia Civil Engineering Forum;Seoul-Korea, 2017