Experimental study of accelerating early age concrete strength under elevated temperature, steaming, and chemical admixture addition of normal and high strength concrete

Suryawan Murtiadi[1*], *Akmaluddin* Akmaluddin[1] , *Buan* Anshari[1] , and *Suparjo* Suparjo[2]

[1]Master Program of Civil Engineering, Mataram University, Indonesia
[2]Department of Civil Engineering, Mataram University, Indonesia

***Corresponding author: s.murtiadi@unram.ac.id**

PRESENTATION OUTLINE

- INTRODUCTION
- EXPERIMENTAL PROGRAM
- RESULTS AND DISCUSSIONS
- CONCLUSIONS
- ACKNOWLEDGMENT

INTRODUCTION

- Concrete needs a curing to maintain adequate moisture content during chemical reaction at early ages
- Curing begins immediately after placement and finishing so that the concrete may develop the desired strength and durability
- Traditionally, curing is performed by moisturizing concrete periodically to reduce water loss due to evaporation and concrete hydration
- This traditional method requires a relatively long maintenance time.

- Concrete with a high initial strength to accelerate time consuming of the whole construction is needed
- This study focused on early age concrete strength treated with special curing:
  - early heating treatment
  - steaming.
  - The addition of chemical accelerator
- Tests were conducted on normal and high strength concrete specimens.

Steam curing of precast concrete industry

EXPERIMENTAL PROGRAM

Table 1. Concrete Mix Proportion

Spec.	f'c (MPa)	w/c	Water	Cement	Fine Aggregate	Coarse Aggregate	Accel erator	Super plasti cizer
			(kg)					
NN	30	0.45	225.00	500	565.46	906.54	-	-
NA			185.63	500	565.46	906.54	79.20	-
HN	50	0.30	225.00	750	551.46	761.54	-	2.48
HA			185.63	750	551.46	761.54	79.20	2.48

NN = Normal-strength concrete
NA = Normal-strength concrete with accelerator
HN = High-strength concrete
HA = High-strength concrete with accelerator

Test specimens

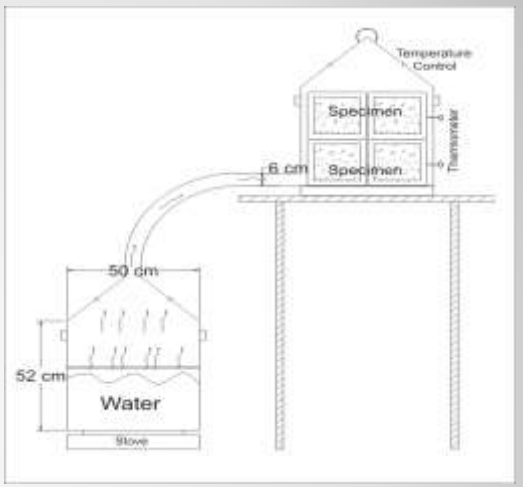
- 15 × 15 × 15 cm cube
- compressive strength testing at ages:
  3, 7, 14 and 28 days

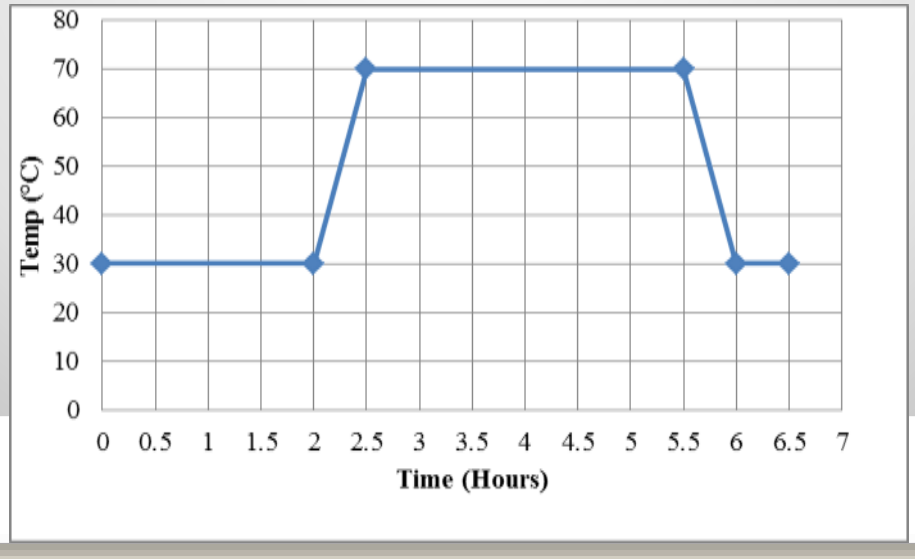
Table 2. Test Specimens

Concrete Strength	Curing	Number of Specimens under Compressive Test				Total
		3 Days	7 Days	14 Days	28 Days	
Normal Strength	Normal curing	3	3	3	3	12
	Steam curing	3	3	3	3	12
	Elevated temperature	3	3	3	3	12
	Accelerator	3	3	3	3	12
High Strength	Normal curing	3	3	3	3	12
	Steam curing	3	3	3	3	12
	Elevated temperature	3	3	3	3	12
	Accelerator	3	3	3	3	12
Total Number of Specimens						96

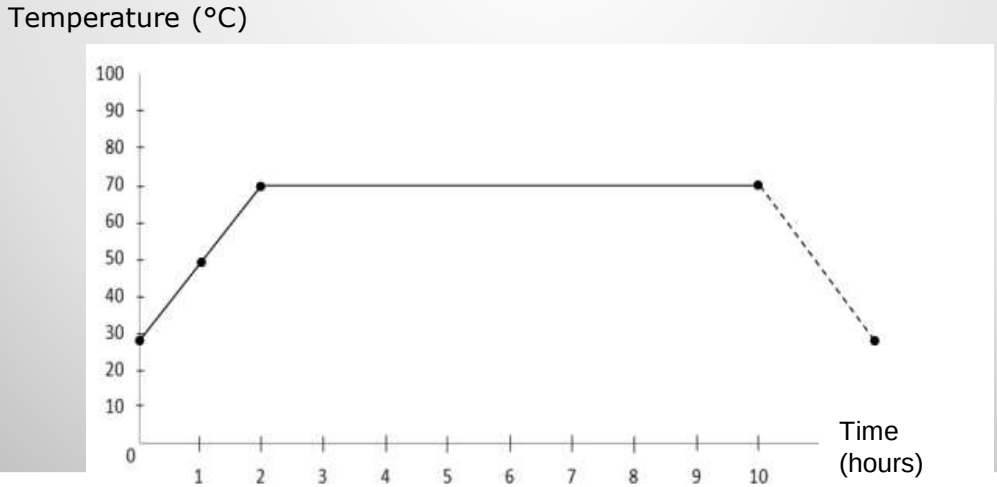
Instrumentation and test procedure

Steam curing





Elevated temperature curing



Time - temperature of oven

RESULTS AND DISCUSSIONS

Table 3. Compressive strength (MPa)

Specimens	Ages of specimens			
	3 Days	7 Days	14 Days	28 Days
NN	12.12	20.51	27.03	31.07
NA	16.67	25.01	30.34	33.34
NS	18.94	23.68	27.53	29.60
NT	17.78	25.01	28.02	30.13

NN = Normal strength concrete
NA = Normal strength concrete with accelerator
NS = Normal strength concrete under steam curing
NT = Normal strength concrete under elevated temperature curing.

Table 4. Normalized percentage of normal concrete compressive test to 28 days

Specimens	Ages of specimens			
	3 Days	7 Days	14 Days	28 Days
NN	39 %	66 %	87 %	100 %
NA	50 %	75 %	91 %	100 %
NS	64 %	80 %	93 %	100 %
NT	59 %	83 %	93 %	100 %

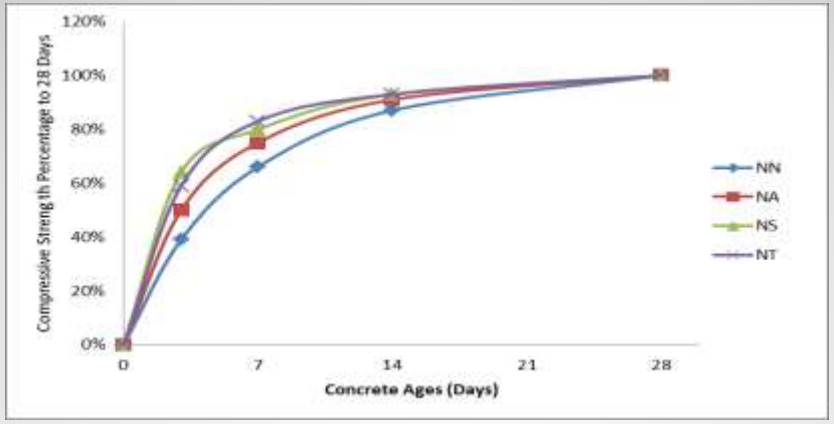
Table 5. Compressive strength (MPa)

Specimens	Ages of specimens			
	3 Days	7 Days	14 Days	28 Days
HN	19.09	33.54	43.86	51.60
HA	30.09	37.37	43.19	48.53
HS	31.92	38.96	42.25	46.94
HT	32.28	37.29	42.29	45.47

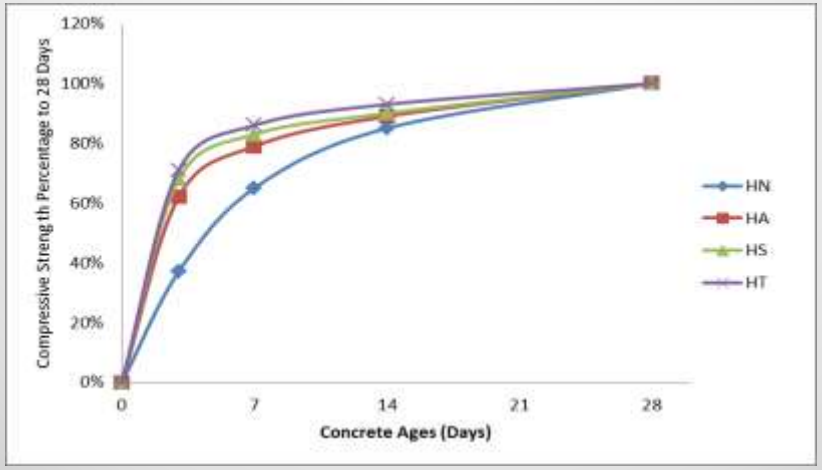
HN = High strength concrete with accelerator
HA = High strength concrete with accelerator
HS = High strength concrete under steam curing
HT = High strength concrete under elevated temperature curing.

Table 6. Normalized percentage of high strength concrete compressive test to 28 days

Specimens	Ages of specimens			
	3 Days	7 Days	14 Days	28 Days
HN	37 %	65 %	85 %	100 %
HA	62 %	77 %	89 %	100 %
HS	68 %	83 %	90 %	100 %
HT	71 %	82 %	93 %	100 %



Percentage of normal strength concrete compressive test to 28 days



Percentage of high strength concrete compressive test to 28 days

CONCLUSION

- Under normal curing, chemical accelerator, steam curing, and elevated temperature curing, the compressive strength of

Normal strength concrete:

- 3-days were 12.12 MPa, 16.67 MPa, 18.94 MPa, and 17.78 MPa, respectively.
- 7-days were 20.51 MPa, 25.01 MPa, 23.68 MPa, and 25.01 MPa, respectively.
- 14-days were 27.03 MPa, 30.34 MPa, 27.53 MPa, and 28.02 MPa, respectively.
- 28-days were 31.07 MPa, 33.34 MPa, 29.60 MPa and 30.13 MPa, respectively

Normalized percentage result to 28 day concrete strength:

- 3-days were 39%, 50%, 64% and 59%, respectively.
- 7-days were 66%, 75%, 80% and 83%, respectively.
- 14-days were 87%, 91%, 93% and 93%, respectively.

For high-strength concrete:

- 3-days were 19.09 MPa, 30.09 MPa, 31.92 MPa, and 32.28 MPa, respectively.
- 7-days were 33.54 MPa, 37.37 MPa, 38.96 MPa, and 37.29 MPa, respectively.
- 14-days were 43.86 MPa, 43.19 MPa, 42.25 MPa, and 42.29 MPa, respectively.
- 28-days were 51.60 MPa, 48.53 MPa, 46.94 MPa, and 45.47 MPa, respectively.

Normalized percentage result to 28 day concrete strength:

- 3-days were 37%, 62%, 68% and 71%, respectively.
- 7-days were 65%, 77%, 83% and 82%, respectively.
- 14-days were 85%, 89%, 90% and 93%, respectively

- Test results indicated that in order to gain the high early strength concrete, the additions of chemical accelerator as well as steam and elevated temperature curing are highly recommended

ACKNOWLEDGEMENT

Grateful acknowledgement is addressed to the Post Graduate Program, University of Mataram for the financial support. Acknowledgement is also expressed to the Head of Civil Engineering Department, Faculty of Engineering, University of Mataram for facilities provided. Special thanks to Silvia, Wirandhini, Riyadi, and Yanuar for the support and assistance during experimental works.

THANK YOU