Theme: Energy Pile

Research Topic:

“Selection of material used for thermopiles for recycling heat within a building”

- Gautami Patel

AIM

To assess the type of concrete and circulating liquid suitable for a thermopile

OBJECTIVES

1. Suitable type of concrete

   OPC, OPC+pfa & OPC+ggbs

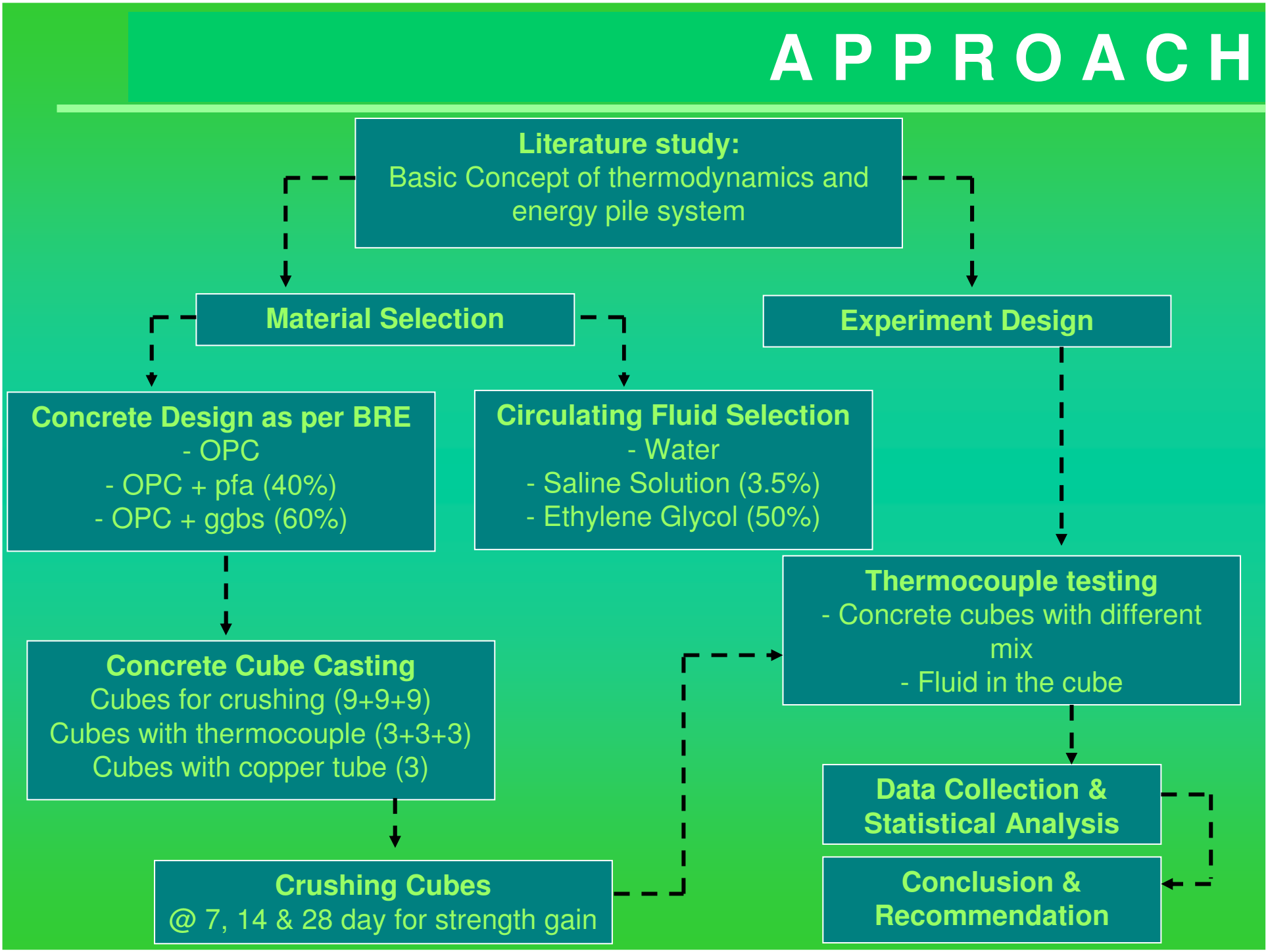
2. Suitable type of liquid

   Water, Saline solution, glycol

SCOPE & LIMITATION

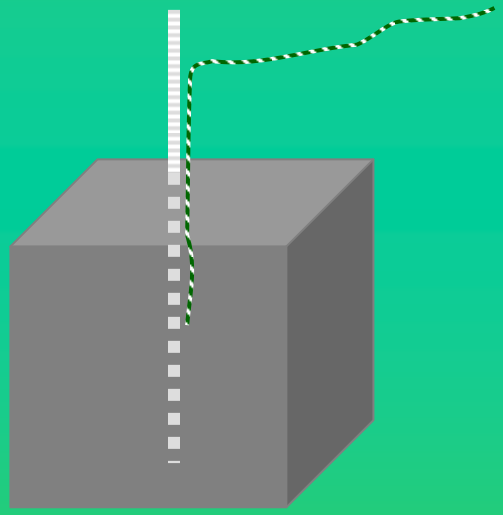
- Concrete design as per BRE
- 3 Types of Concrete
  - OPC, OPC + pfa, & OPC + ggbs
- 3 Types of liquid
  - Water, 3.5% saline solution, 50% glycol solution
- Liquids tested with OPC cubes
- No. of test per cube/liquid – 2
- No. of specimen per mix - 3

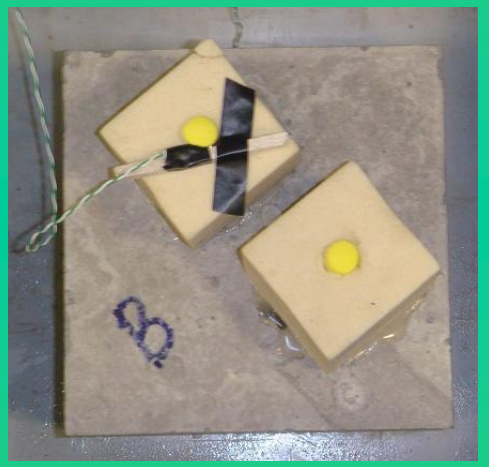
APPROACH

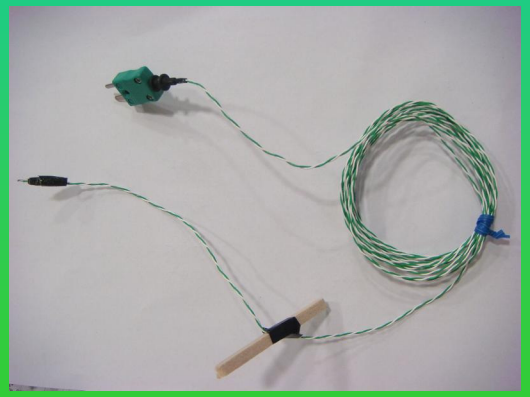

Literature study:
Basic Concept of thermodynamics and energy pile system
Material Selection
Experiment Design
Concrete Design as per BRE
- OPC
- OPC + pfa (40%)
- OPC + ggbs (60%)
Circulating Fluid Selection
- Water
- Saline Solution (3.5%)
- Ethylene Glycol (50%)
Thermocouple testing
- Concrete cubes with different mix
- Fluid in the cube
Concrete Cube Casting
Cubes for crushing (9+9+9)
Cubes with thermocouple (3+3+3)
Cubes with copper tube (3)
Data Collection & Statistical Analysis
Crushing Cubes
@ 7, 14 & 28 day for strength gain
Conclusion & Recommendation

THERMOCOUPLE TEST

Preparing Cube for Test







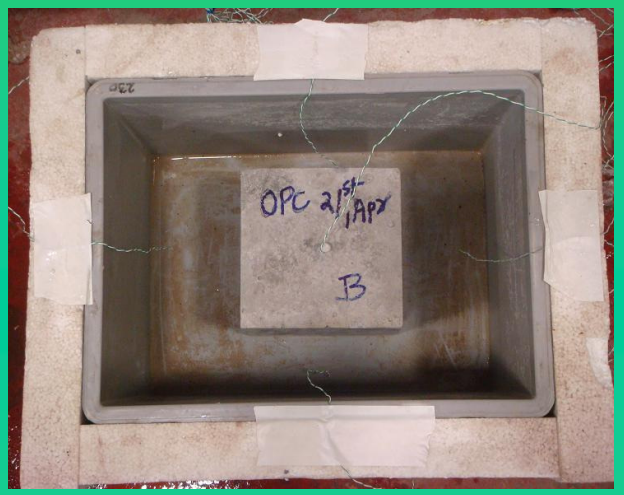
THERMOCOUPLE TEST

Experiment Design

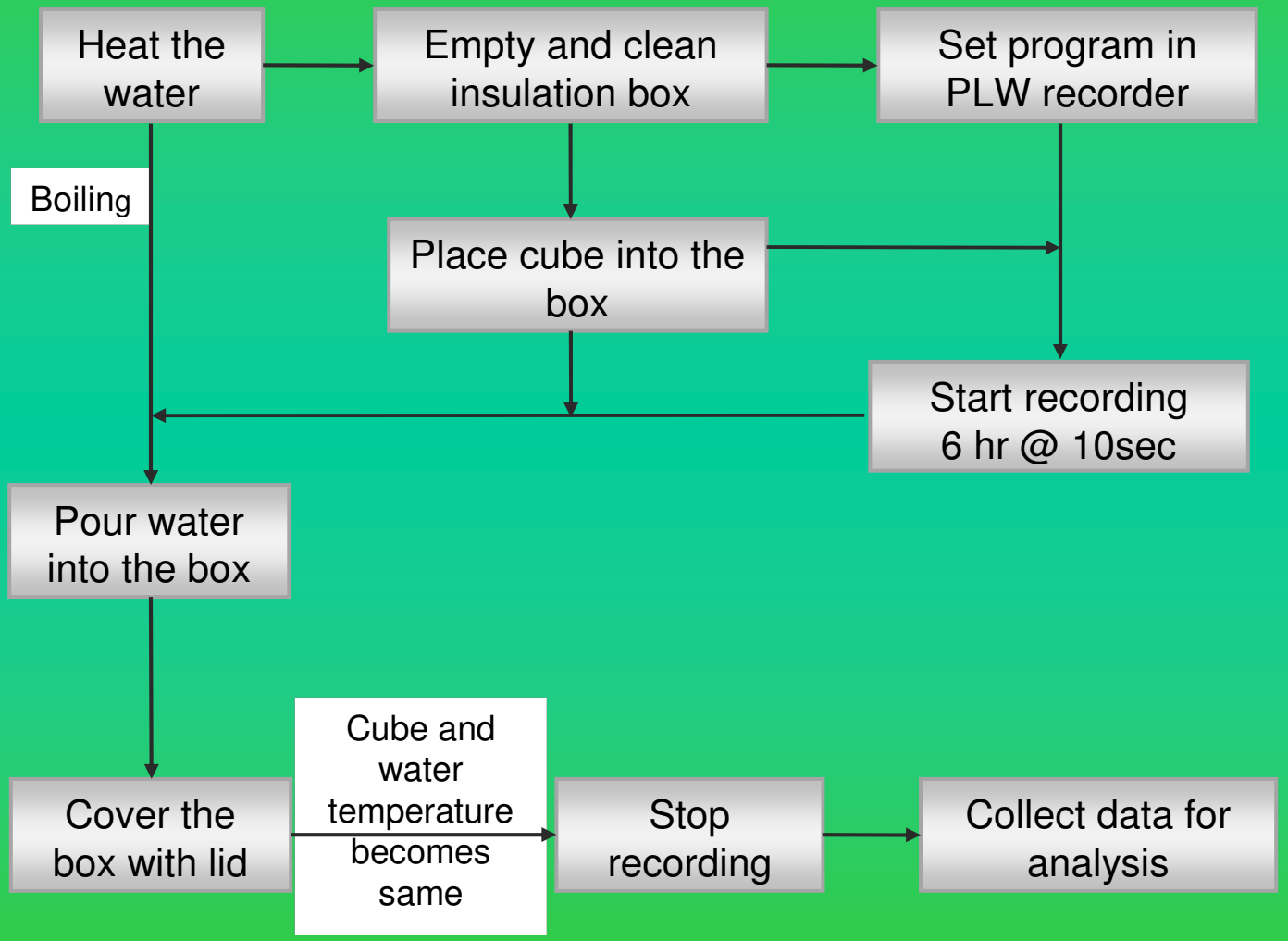
- 6 Thermocouples – K Type
- 14/10 Ltr Water in the box
- Pico Technology
- 1st Test

Readings for 6 hrs @ 10sec

- Readings stopped once cube temperature same as water temperature



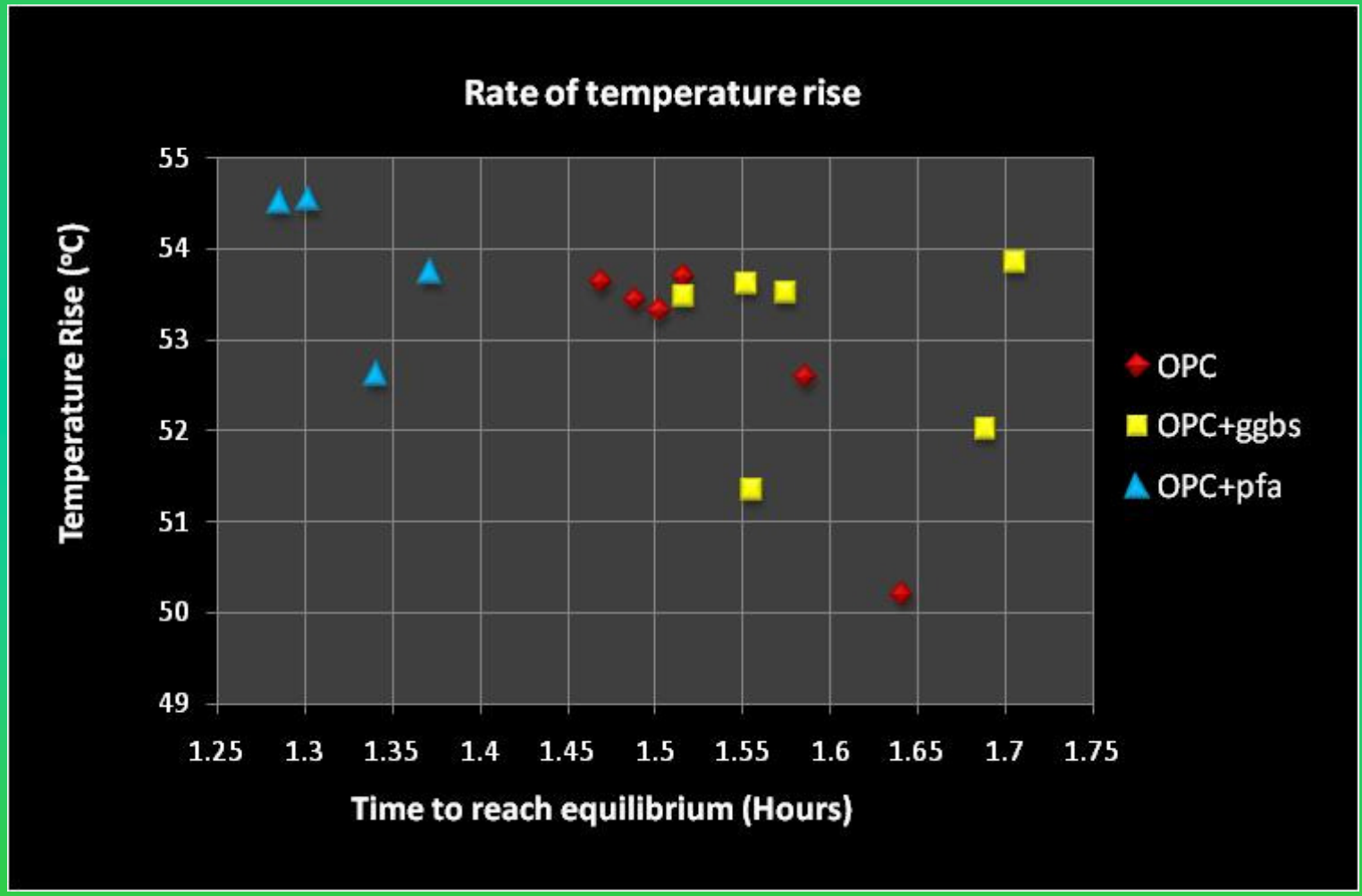
THERMOCOUPLE EXPERIMENT PROCEDURE



SUMMARY – CONCRETE MIX

Concrete Cube (No. of cubes X No. of test)`		Cube Temperature	Equilibrium Temperature	Temperature Rise (ΔT)	Time taken to reach equilibrium	Avg Rate of temperature Rise
		°C	°C	°C	Hrs	°C/min
OPC (3X2)	Min	21.00	71.64	50.20	1.47	0.51
	Max	22.06	75.48	53.70	1.64	0.61
	Avg			52.81 (1.22)	1.53 (0.06)	0.58 (0.03)
OPC + ggbs (3X2)	Min	19.87	73.38	51.35	1.52	0.51
	Max	23.81	76.41	53.85	1.71	0.59
	Avg			52.97 (0.94)	1.60 (0.07)	0.55 (0.02)
OPC + pfa (2X2)	Min	20.93	75.47	52.62	1.29	0.65
	Max	23.06	76.54	54.54	1.37	0.71
	Avg			53.40 (0.90)	1.43 (0.11)	0.63 (0.05)

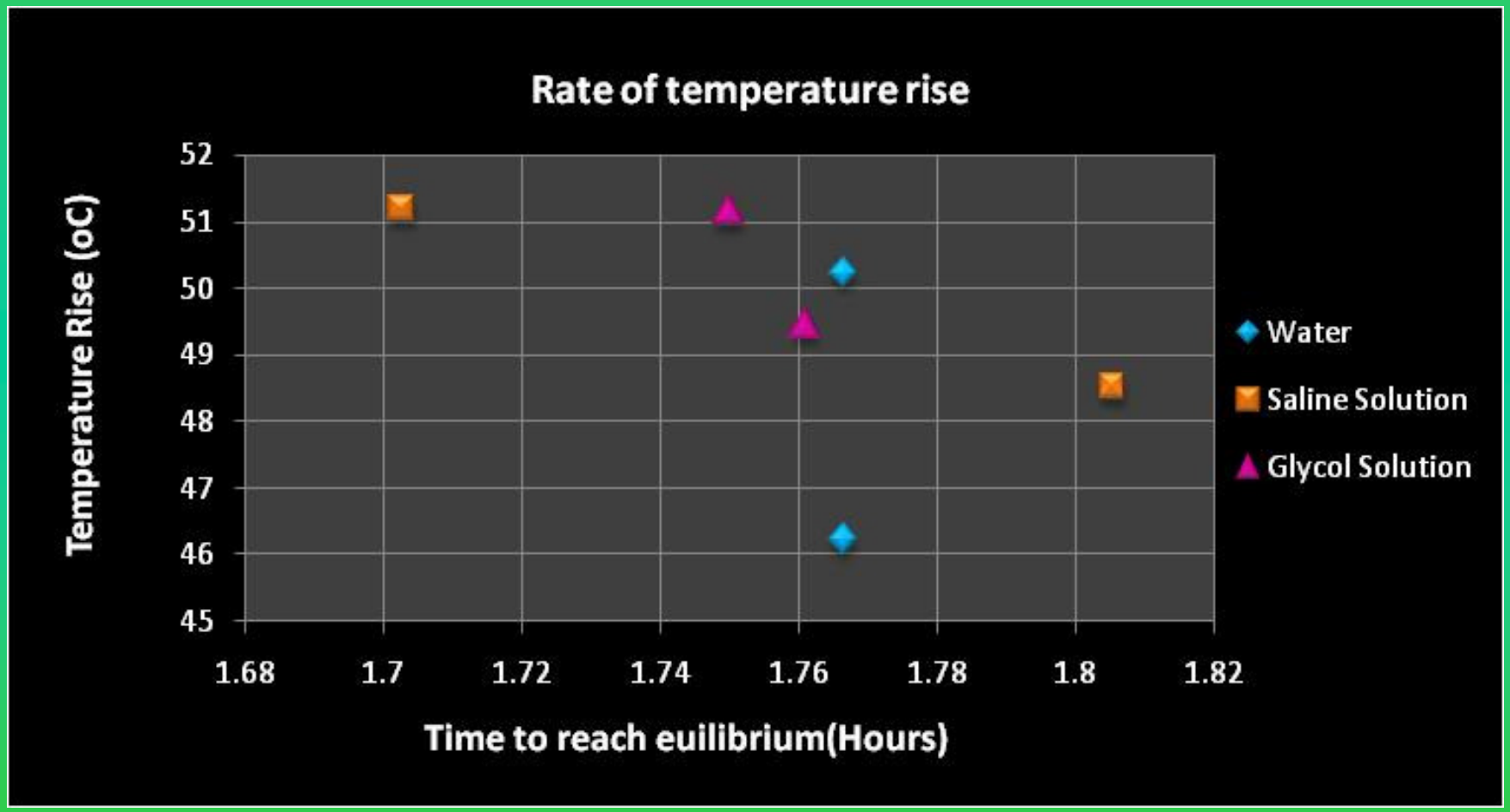
GRAPH – CONCRETE MIX



SUMMARY – CIRCULATING LIQUID

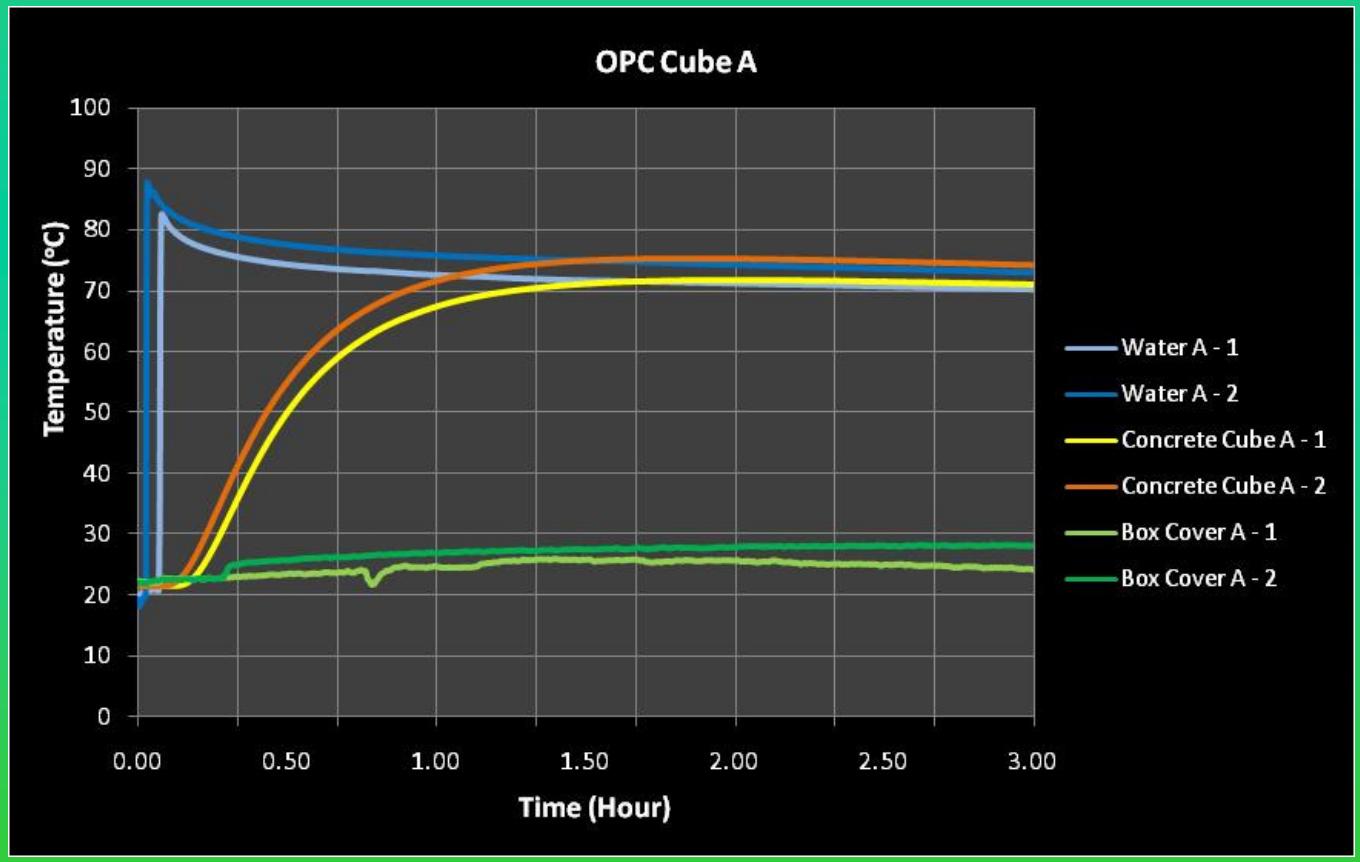
Circulating liquid		Initial Liquid Temperature	Equilibrium Temperature	Temperature Rise (ΔT)	Time taken to reach equilibrium	Avg Rate of temperature Rise
		°C	°C	°C	Hrs	°C/min
Water	A	20.09	70.32	50.23	1.77	0.47
	B	23.17	69.39	46.22	1.77	0.44
	Avg			48.23 (2.01)	1.77 (0.00)	0.45 (0.02)
Saline Solution (3.5%)	A	21.59	70.11	48.52	1.81	0.45
	B	18.18	69.37	51.19	1.71	0.50
	Avg			49.86 (1.34)	1.75 (0.05)	0.47 (0.03)
Glycol Solution (50%)	A	21.10	70.56	49.46	1.76	0.47
	B	18.95	70.11	51.16	1.75	0.49
	Avg			50.31 (0.85)	1.76 (0.01)	0.48 (0.01)

G R A P H – CIRCULATING LIQUID



EXPERIMENT OBSERVATIONS

Initial maximum water temperature has the major impact on the equilibrium temperature value, though temperature rise pattern remains the same.



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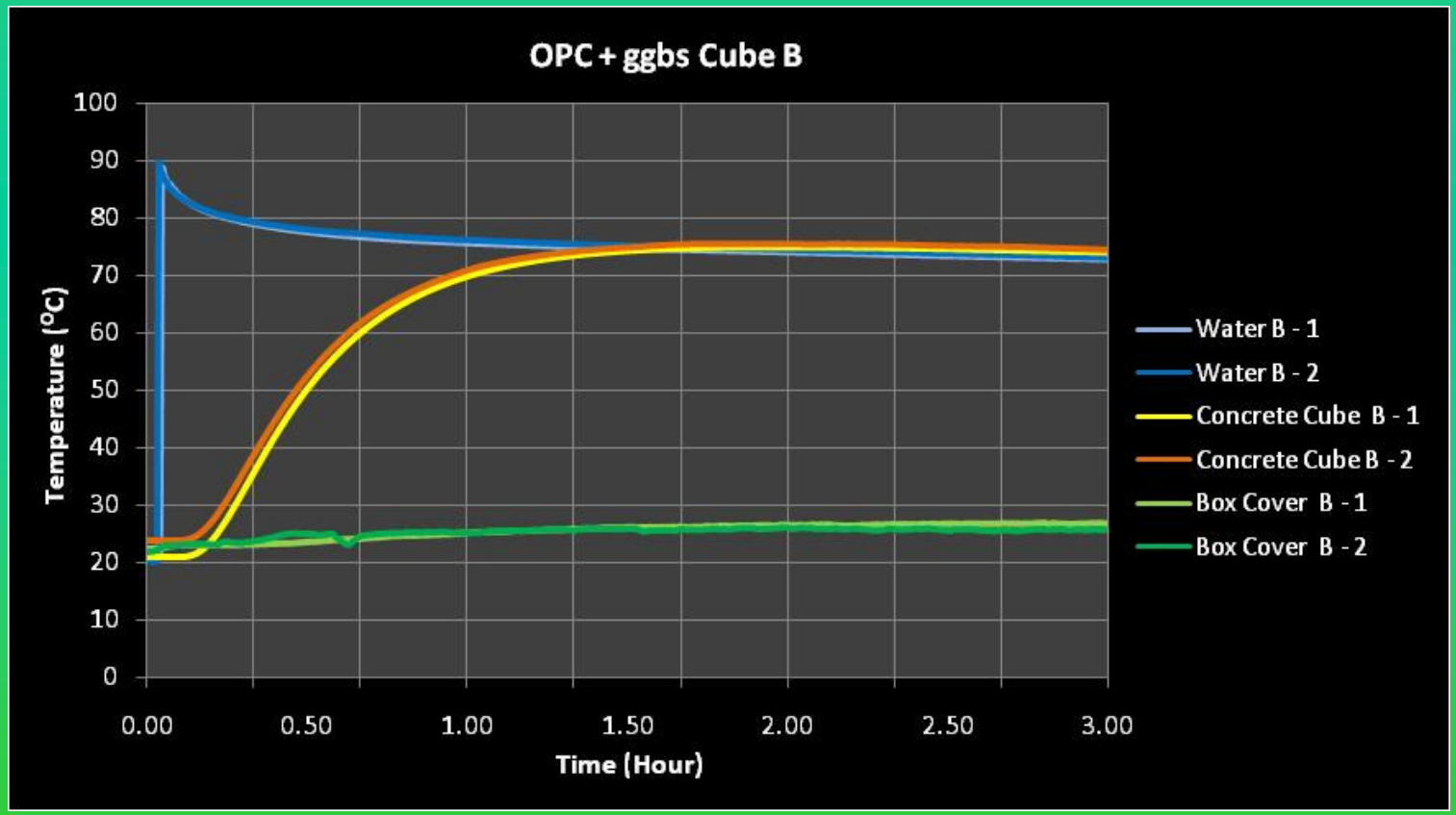


CONCLUSION

- Considering thermal properties of material only
- PFA suitable for absorbing more heat – energy piles
- 50% glycol solution suitable for circulating fluid

FUTURE SCOPE

- Material efficiency in monetary terms
- Concrete with varying % of pfa
- Glycol solution with varying % of water
- Aggregates used in concrete mix

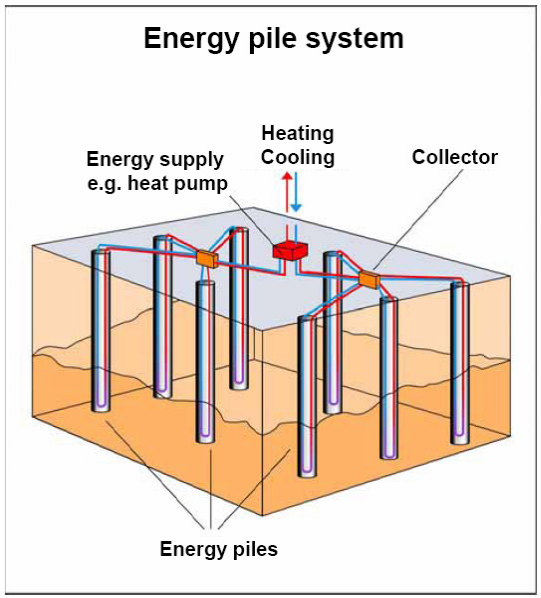
THANK YOU

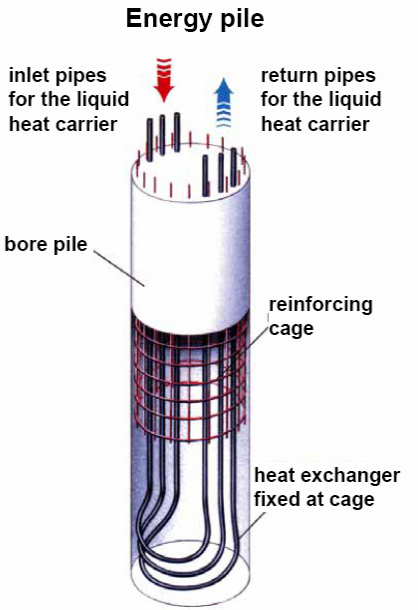
????

INTRODUCTION

- 10 – 20 mtr depth – ground temperature constant at 13ºC
- Thermopile - extract thermal energy from ground via appropriate foundations system

Haka Gerodur, Energy Piles – the European Experience, Presentation by Alfons Ebnother





- Dual Purpose – Heating & Cooling

WHY USE THERMOPILES?

- Climate change – green house gas emission from human activity
- Energy crisis – need to use renewable source of energy
- Operation cost reduction and no maintenance
- Long service life