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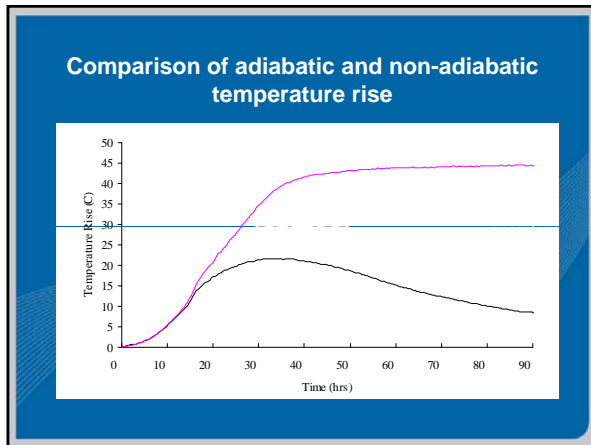
## High volume SCM concrete in the Emirates: Control of thermal strain

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## Temperature Rise

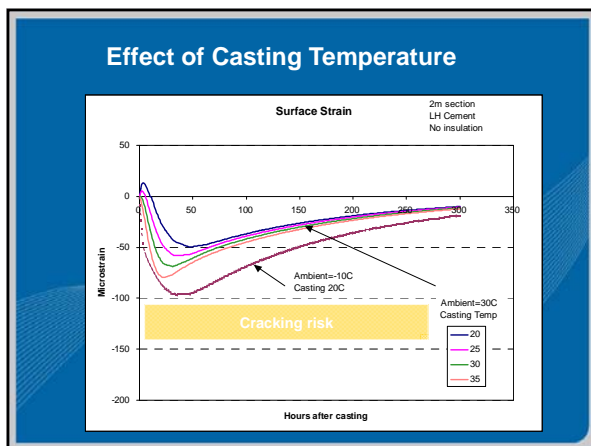
- Cement hydration reaction produces heat
- Outside layers of concrete (or insulation) prevent hydration heat escaping from core
- Significant temperature rise occurs in large concrete volumes



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## Thermal Cracking

- Thermal cracking occurs if tensile strain capacity of concrete exceeded
- **Internal Restraint**  
Tensile strains develop in core as outside surface contracts – During heat-up.
- **External Restraint**  
Tensile strains develop near interface with substrate – During cool-down



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## Internal Restraint – cracking risk

Factors determining cracking risk:

- Tensile strain capacity of concrete (controlled by aggregate)
- Not significantly effected by concrete placing temp in hot weather
- Largely a cold weather problem
- Gulf specifications inherited from North America/Europe

**BS 8110: Part 2 Guidelines**

**Table 3.2 – Estimated limiting temperature changes to avoid cracking**

Aggregate type	Thermal expansion coefficient	Tensile strain capacity (10 <sup>-6</sup> )	Limiting temperature drop for varying restraint factor (R)				Limiting temperature differential when R = 0.36
			1.00	0.75	0.50	0.25	
Oxwall	10.0	70	7.8	9.7	14.6	20.0	20.0
Granite	10.0	80	10.0	13.3	20.0	40.0	27.7
Limestone	8.0	90	14.1	18.8	28.2	36.3	39.0
Sintered p.f.a.	7.0	110	19.6	26.2	39.2	78.4	54.6

- External Restraint**
- Difference between peak temperature of section and ambient
  - Strains increase during “cool-down” cycle
  - Factors determining restrained strain development:
    - Magnitude of external restraint
    - Concrete temperature at placement
    - Magnitude and rate of heat evolved in hydration
    - Ambient temperature
    - Heat loss from the concrete surface

- External Restraint**
- Slab cast onto rock
  - Wall restrained by footing (base restraint)
  - 2nd lift restrained by 1st lift (base restraint)
  - Infill slabs (edge restraint)

