

# 8. Concrete

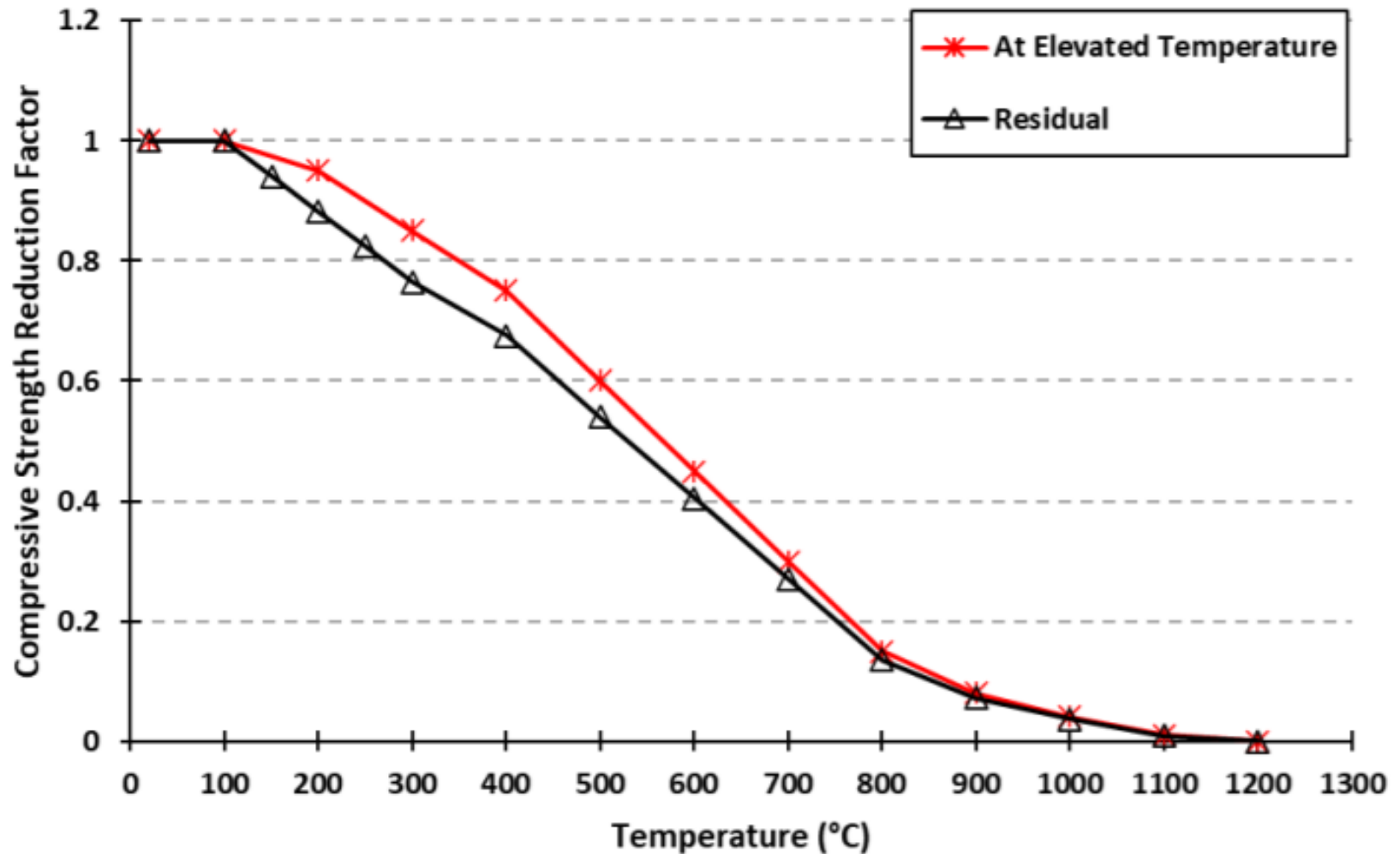
- Temperature Effects:
  - 400 to 600 F ----- insignificant
  - 600 F ----- the onset of damage
  - 900 F ----- 40% to 60% loss of strength
  - 1500 F ----- 10% to 20% loss of strength
  - 1650 F ----- cement turn to powder

The time to heat concrete can be surprisingly long due to thermal insulating properties

The damage will be worse at the surface.

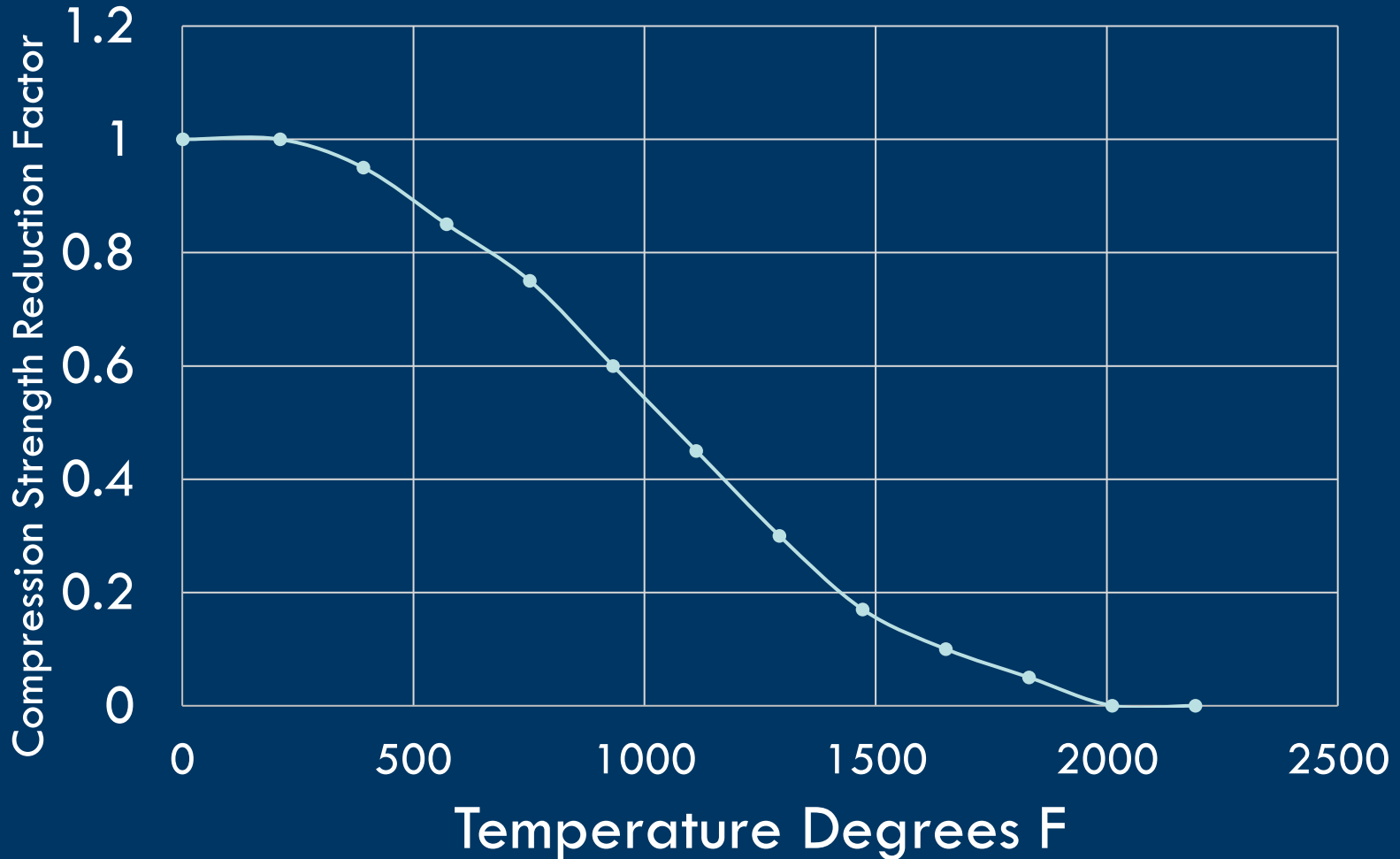


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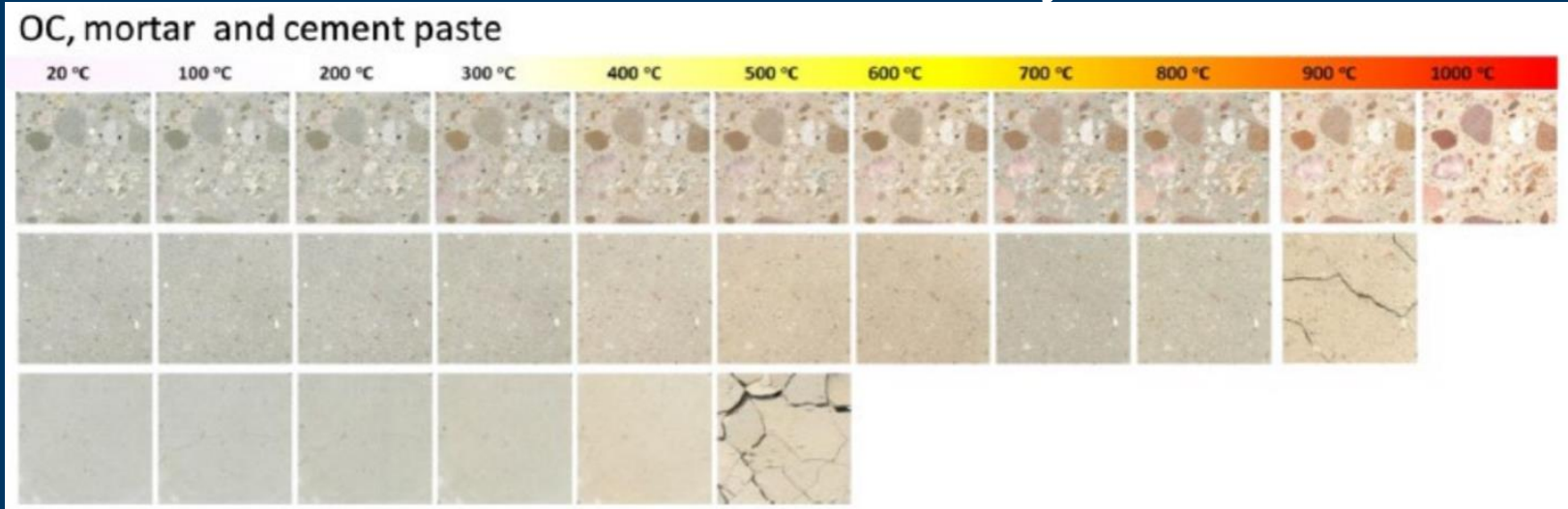
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Reduction of Concrete Strength vs Temperature



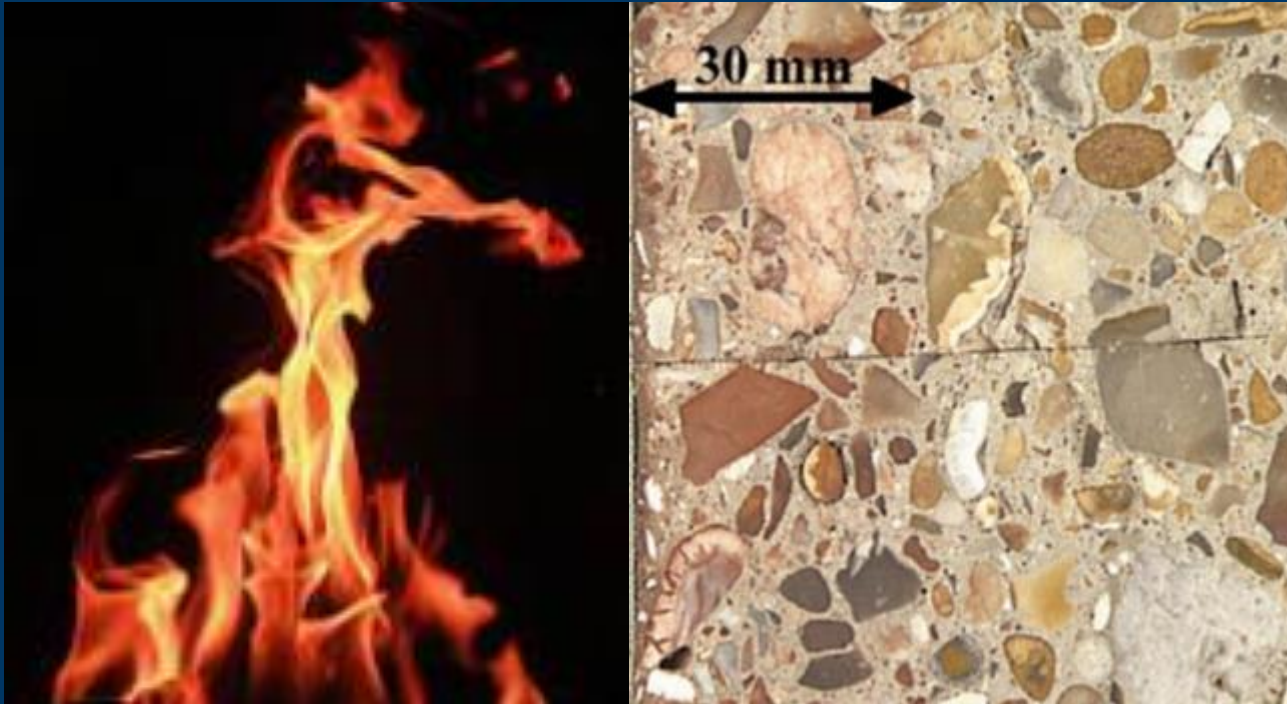
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- Concrete Color Changes due to Heat:
  - 300 - 600 C (600 to 1100 F) ----- red to pink color
    - This could be potentially damaged concrete
    - A drill could be used to find the depth of color
  - 600 to 900 C (1100 - 1700 F) ---- whitish gray color
  - 900 to 1000 C (1700 - 1800 F) ---- yellowish brown



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- Concrete Color Changes due to Heat:
  - The depth of damage can be small.
  - 30 mm = 1.25 inches





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## Impact Hammer



# 8. Concrete

- Fire Damage Evidence:
  - Cracks with or w/o smoke damage
    - Quick uneven cooling with water
  - Fresh spalls (sudden contraction)
- Inspection and Testing Techniques:
  - Visual
  - Sounding with a hammer to find spalling
  - Impact rebound hammer to test compressive strength
- Repair:
  - Cut/chip
  - Patch / Fill (using bonding agent)





# 8. Concrete Slab





# 8. Concrete - Steel Reinforcing

- Temperature Effects – permanent loss of strength/ductility above:
  - 1100 F ----- 80% to 100% original strength
  - 1100 F ----- 40% to 60% original strength for pre-stressing steel
- Fire Damage Evidence:
  - Excessive deformation/deflection
  - Discoloration
  - Spalling



# Summary - Scientific Method

1. We start with a non-biased question.
  - What is the extent of damage?
  - What are the repair recommendations?
2. Gathering information
  - Site Observations
  - Event data
3. Construct a Hypothesis – answer the question
4. Using engineering principles
  - Test the individual hypothesis one by one.
  - Analyze the data, draw conclusions
  - Accept or reject the hypothesis.
5. Communicate the results.



# Summary - Scientific Method

## 1. Non-biased Questions - Scope of Work

What is the extent of structural damage?

What are the repair recommendations?

