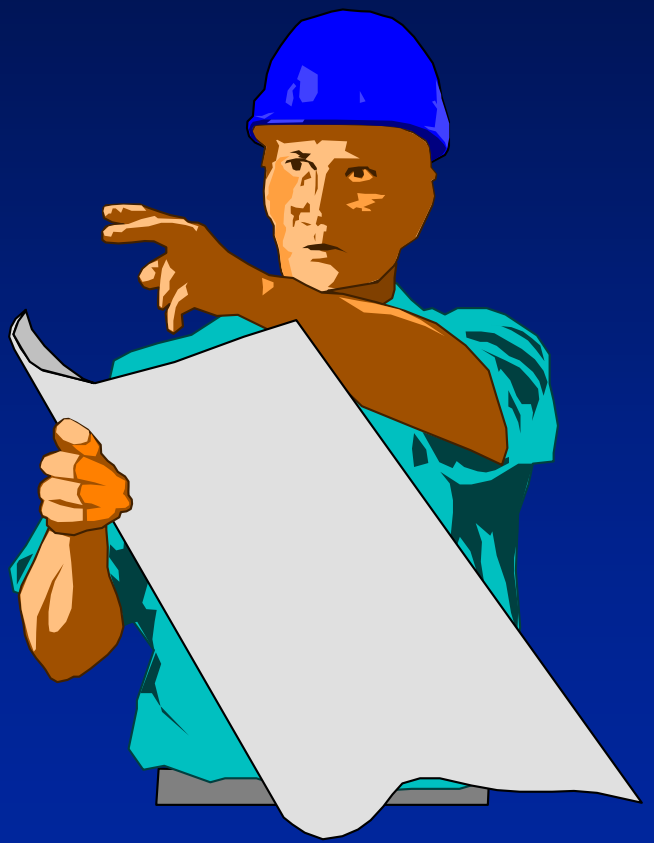
Fast Track Repair Materials and Methods

Fast Track

- New Technology for mix designs
- Sequencing methodology
- Innovative Bidding

Need for Fast-Track

- Expedite construction
- Minimize airport traffic disruption
- Minimize revenue loss
  - Toll facilities
  - Businesses



Fast-Track

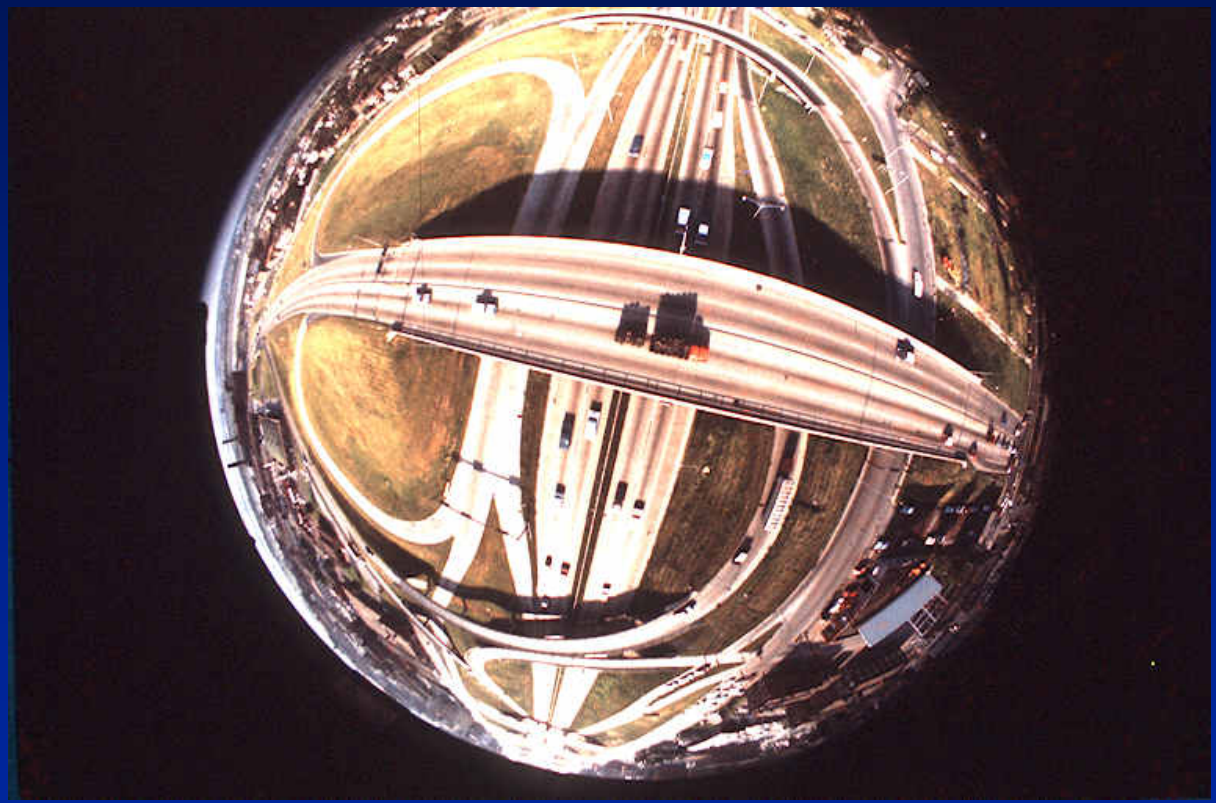
Current Definition:

- A series of techniques that decrease concrete pavement construction/rehabilitation time
- It is a system!

Planning Considerations

- Traffic management
- Fast track materials selection
- Fast track construction
- Team coordination
- Emergency planning

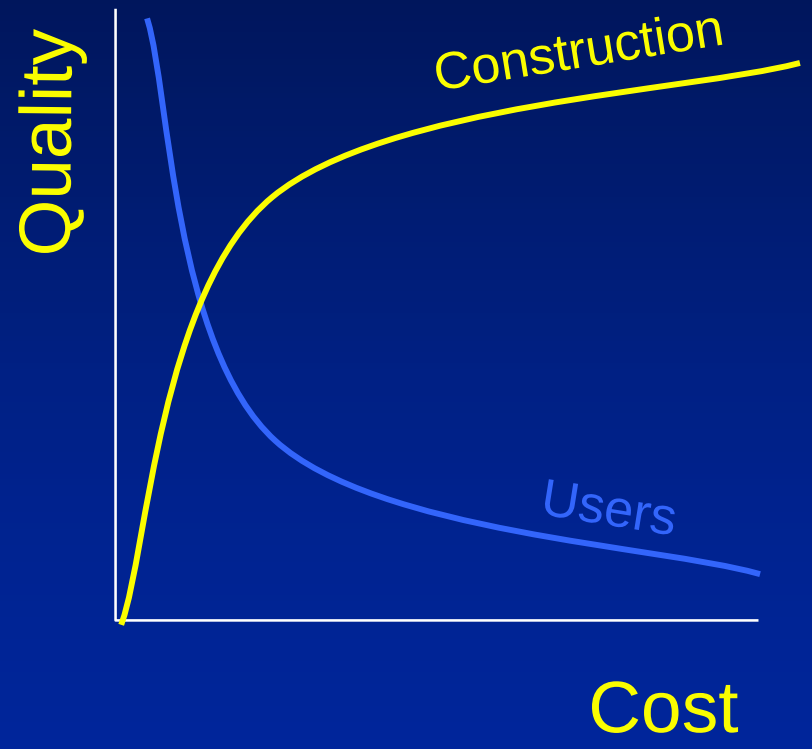
Traffic Management



Traffic Control Strategy

Optimizing Plan:

- Project Cost
- Societal Cost
- Safety
- Traffic Management



Traffic Management Scenarios
Night Time Closures

Project Components to Modify for Fast-Track

- Planning & Specifications
- Concrete Materials
- Jointing & Sealing Procedures
- Concrete Curing & Temperature Management Procedures
- Strength Testing Methods
- Traffic Opening Requirements

Planning & Specifications
Possible Changes for Fast-Track

- Use partnering-based project management
- Consider night construction
- Use innovative equipment & materials
- Consider more than one concrete mixture
- Provide multiple options for contractors
  (not step-by-step procedures)
- Use incentives and disincentives

Site Rental Contracting
for Fast-Track

- Cost-plus-time (A+B)
  - Bid Project Cost
  - Bid Time
- Continuous site rental
  - Bid like a completion-date contract

Material Considerations for Fast-Track

- Rapid early strength gain
- Long-term strength
- Freeze-thaw durability
- Workability
- Abrasion Resistance

Materials
Possible Changes for Fast-Track

- Try different cement types
  - Type I, II, or III
  - Special blended cements
- Use helpful admixtures
- Keep water-cementitious ratio below 0.43

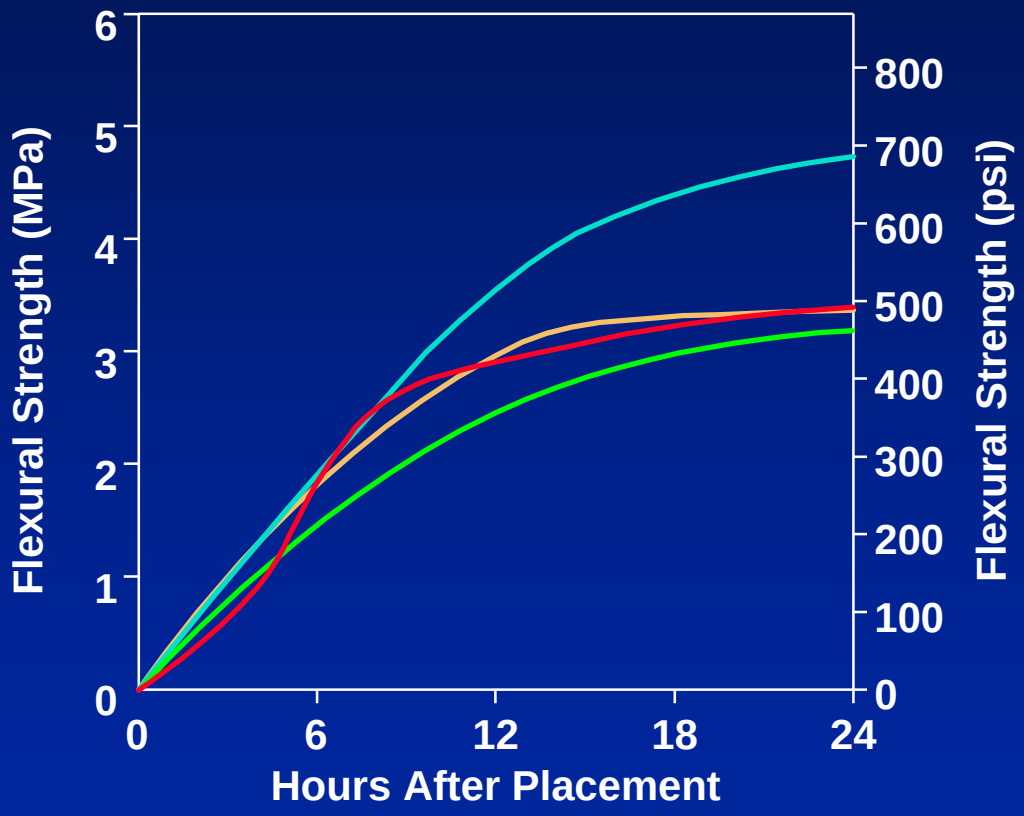
Mix Proportioning
for Fast-Track

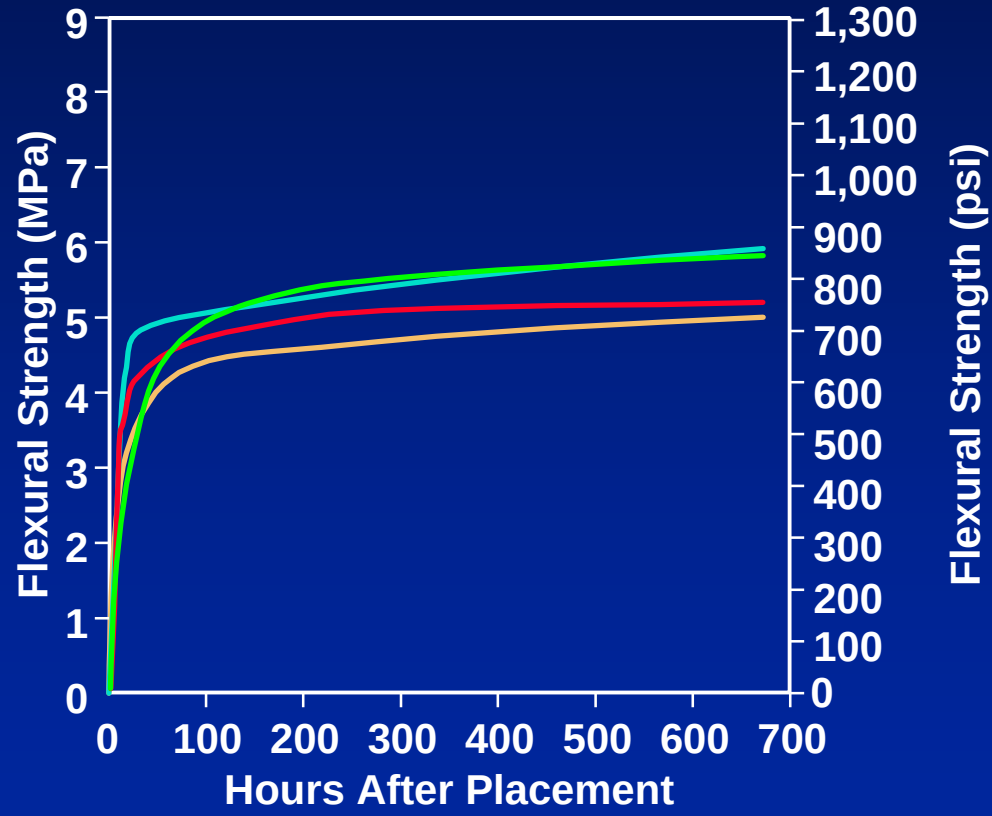
- No specific proportions
- Most local materials acceptable
- Verify compatibility of components in lab

Mix Proportions from Actual Fast-Track Projects

Material	Runway Ext. Dane Co. Wisconsin	US-71BOL Storm Lake Iowa	US-81 Recon. Menominee Nebraska	Interchange I-90 & SR-832 Pennsylvania
Cement Type	Type III	Type III	Type III	Type I
Cement (lbs/yd^3)	863	837	800	982
Fly ash (lbs/yd^3)	0	92 (Class C)	0	0
Coarse Agg. (lbs/yd^3)	1154	2216	1176	2253
Fine Agg. (lbs/yd^3)	1541	1476	2733	1284
W/C Ratio	0.455	0.45	0.423	0.37
AE Admixture	Yes	Yes	Yes	Yes
Other Admixtures	WR-Type A	WR-Type A	WR-Type F	SRA-Type D WR-Type F

Flexural Strengths for Actual Fast-Track Projects





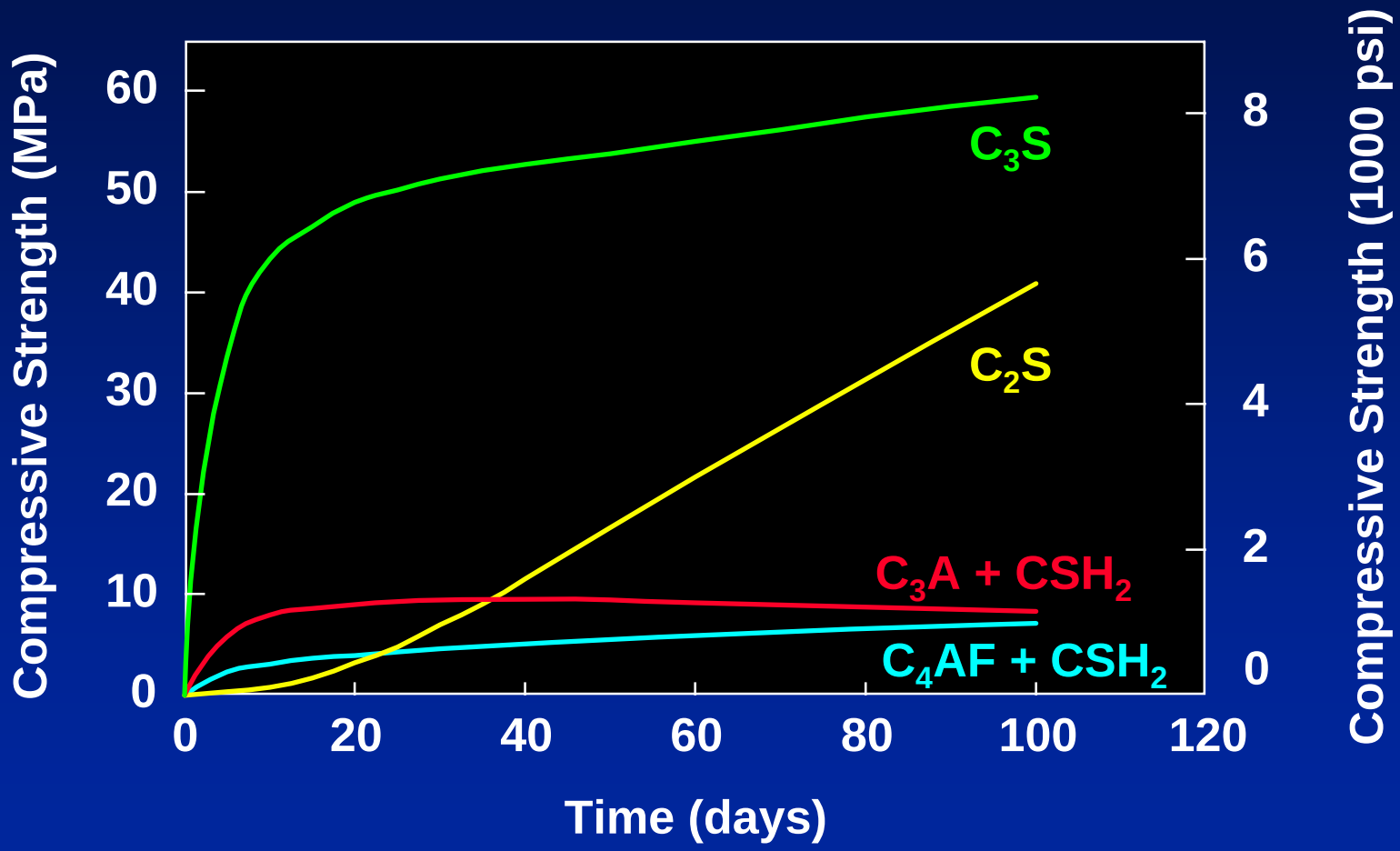
Mix Proportions for Fast-Track Projects

Material	VDOT 6hr Mix	VDOT 6hr Mix	MdSHA 12hr Mix	
Cement Type	Type II	Type II	Type I	
Cement (lbs/yd^3)	850	800	800	
Fly ash (lbs/yd^3)	0	0	0	
Coarse Agg. (lbs/yd^3)	1740	1748	Not Specified	
Fine Agg. (lbs/yd^3)	1039	1076	Not Specified	
W/C Ratio	0.294	0.313	0.45	
AE Admixture	Yes	Yes	Required	
Other Admixtures	WR-Type A	WR-Type A	WR-Yes	

Portland Cement
for Fast-Track

- Different cements react differently
- Heat generation important
- Fineness of grind influential
  - Type I: Blaine fineness 300-400 m^2/kg
  - Type III: Blaine fineness 500-600 m^2/kg
- Tricalcium Silicate (C_3S) content important

Contribution of Cement Compounds



Supplementary Cementing Materials for Fast-Track

- Tend to slow initial set!
- Act as fine particle fillers for workability
- Fly ash
  - Type C
  - Type F
- GGBFS
  - Very temperature sensitive

Chemical Admixtures
for Fast-Track

- Air-entraining
- Water-reducing
  - Improves workability at constant water content
  - Reduces necessary water by dispersing cement particles
- Accelerating
  - Increases reaction rate of C_3A
  - Chloride vs. non-chloride

Curing & Temperature Management
Possible Changes for Fast-Track

- Specify blanket curing
- Monitor concrete temperature
- Control concrete temperature with heated water

Curing Compound
for Fast-Track

- Do not delay application!
- Application rate
  - Normal: 5.00 m^2/L
  - Fast-track: 3.75 m^2/L
  - Overlay: 2.50 m^2/L

Temperature Management
for Fast-Track

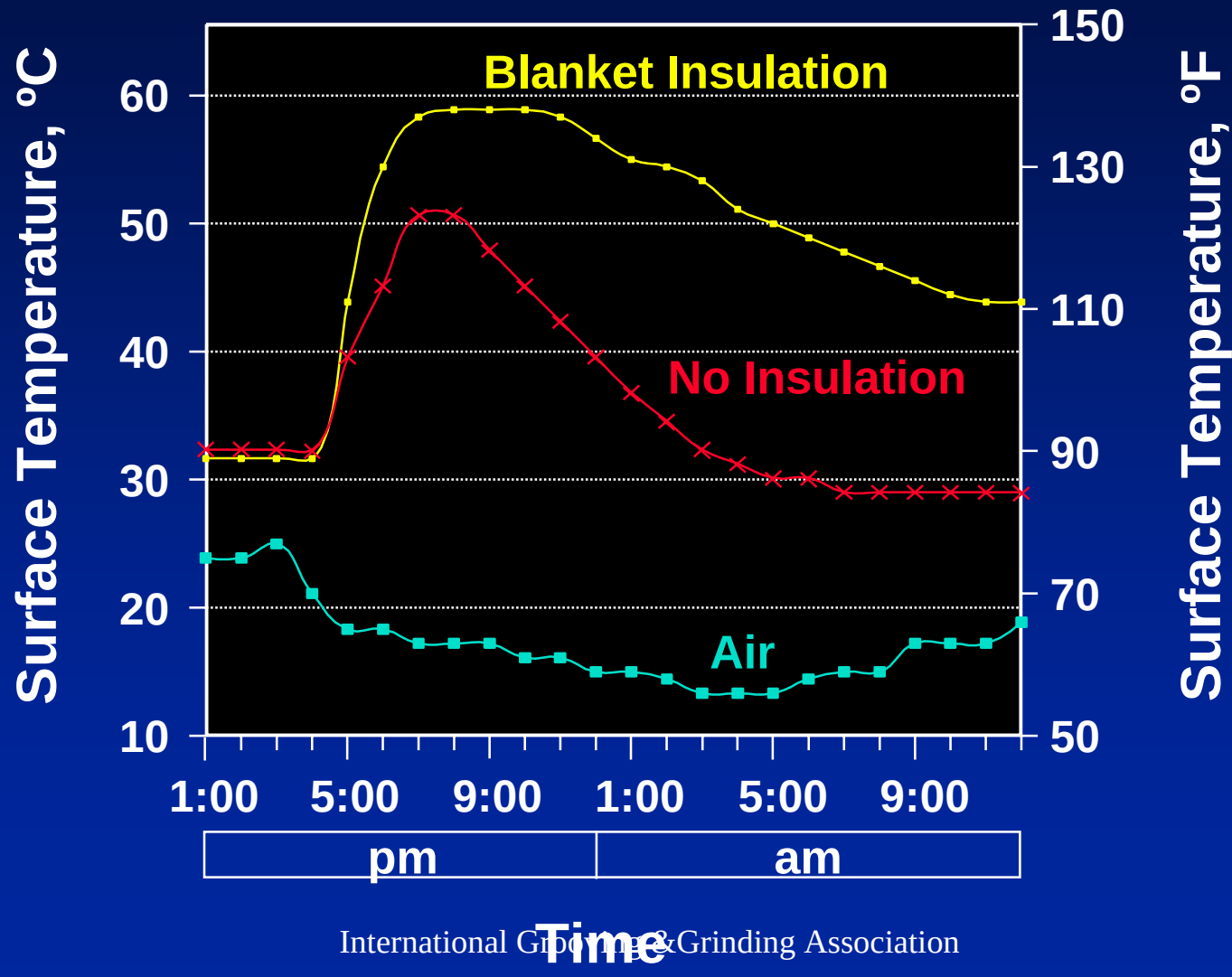
Benefits:

- Aid strength development
- Understand sawing window
- Avoid cracking

Blanket Insulation
for Fast-Track

- Place after spraying curing compound
- Reduce loss of hydration heat
- Lessen effects of:
  - Air temperature
  - Solar radiation

Blanket Insulation Effects



Temperature and Plastic Shrinkage

- Primary cause: rapid surface evaporation
- Factors:
  - Air temperature
  - Relative humidity
  - Wind velocity
  - Concrete temperature
- Potential greater when $T_{concrete} > T_{air}$

Temperature and Plastic Shrinkage

To reduce evaporation:

- Pave in evening or nighttime
- Water mist aggregate stockpiles
- Use resin-based Type 2/Class B curing compound

Strength Testing
Possible Changes for Fast-Track

- Use non-destructive methods
  - Supplement cylinders and beams
  - Replace cylinders and beams
- Use Concrete maturity
  - Monitor concrete temperature and strength
- Use Pulse-velocity
  - Monitor strength

Maturity Testing

Internal temperature of concrete relates directly to concrete strength

- Develop correlation curve in lab
- Precision to baseline cylinders: ±5%

Maturity Testing

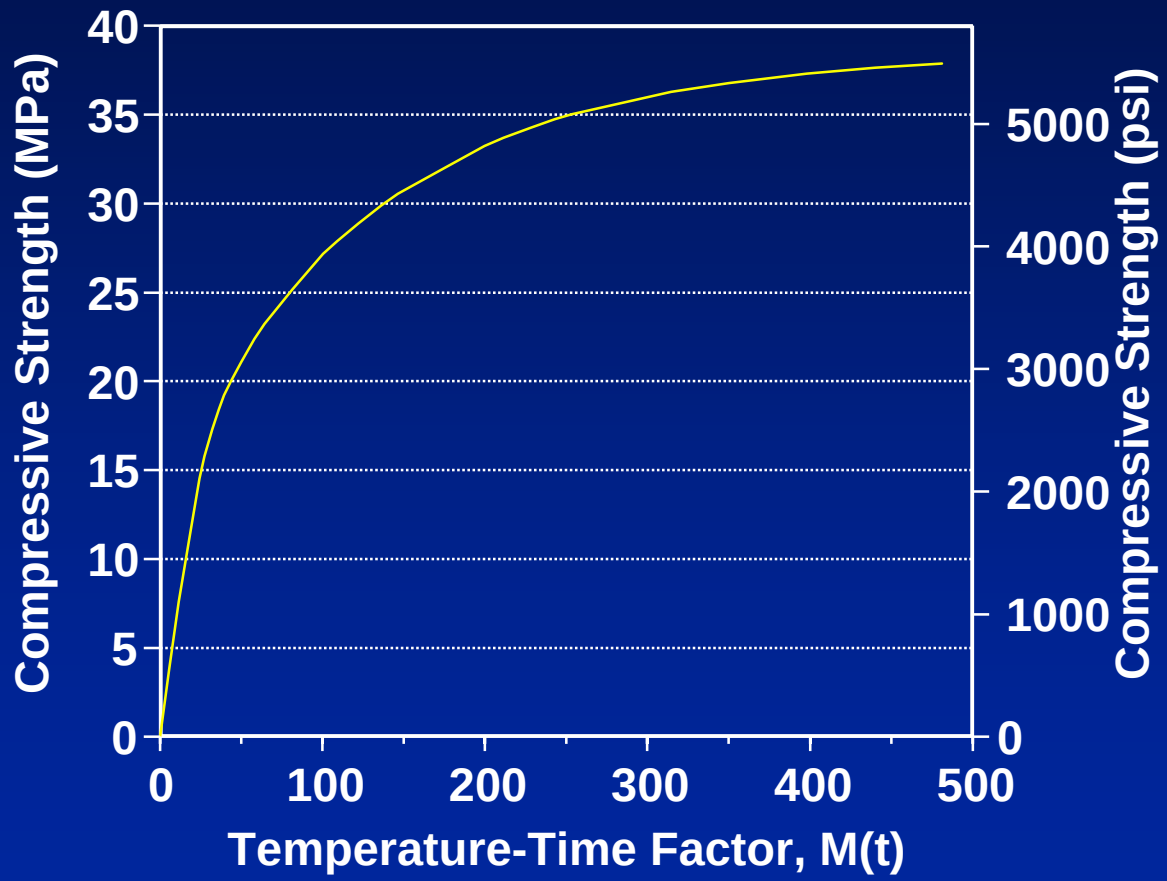
$$M(t) = \Sigma(T_a - T_o)\,\Delta t$$

M(t) = temperature-time factor

Δt = time interval

T_a = average concrete temp.

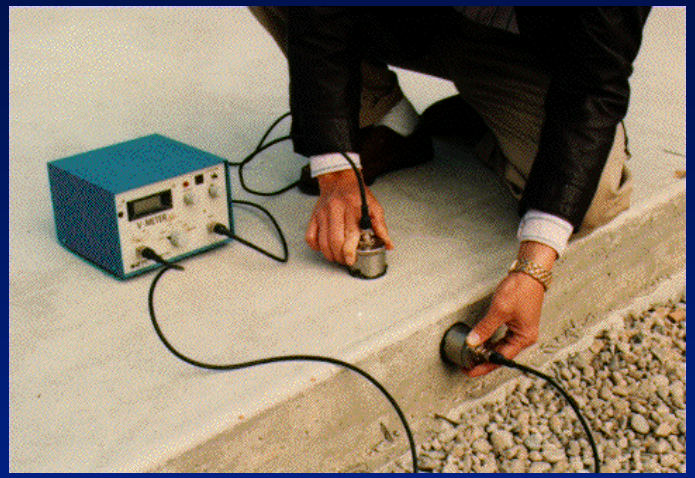
T_o = datum temp. (-10°C)



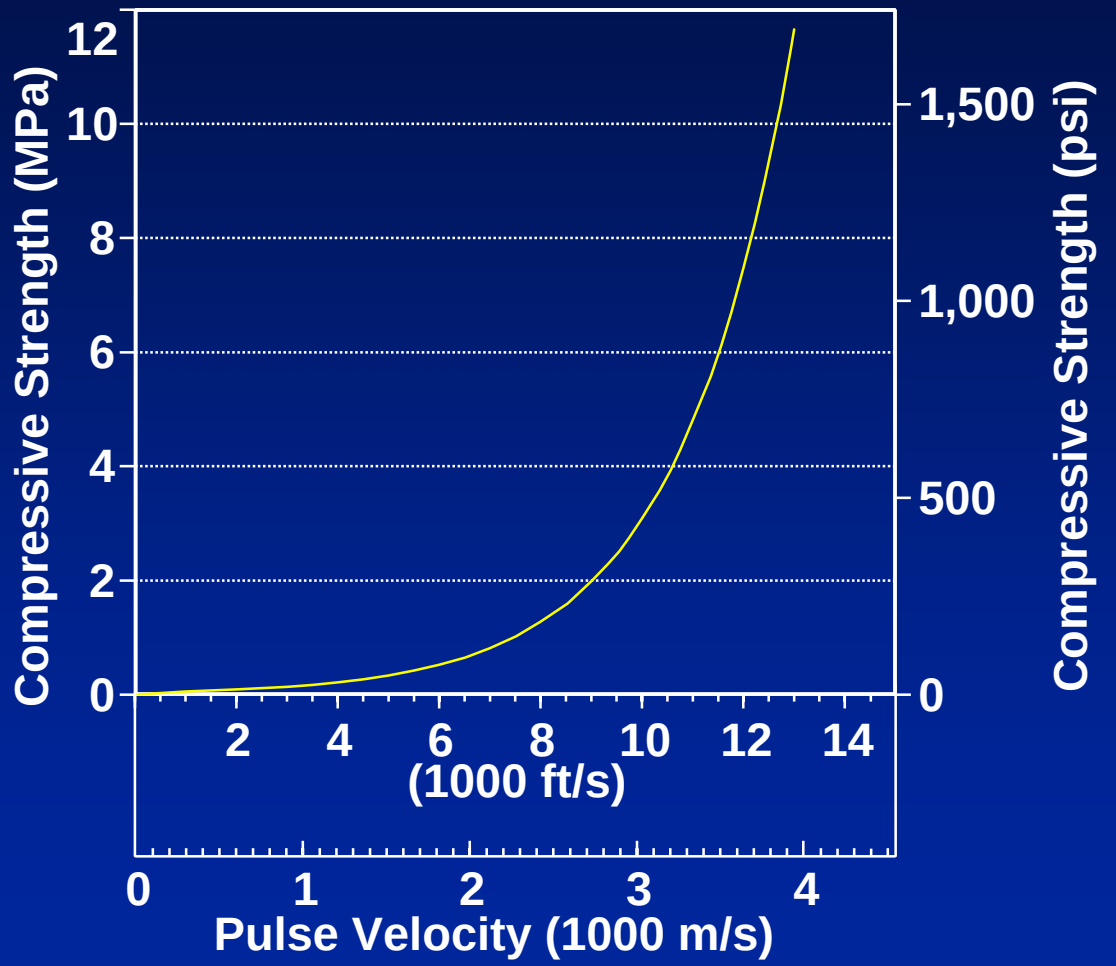
Pulse Velocity Testing

- Velocity of sound wave from transducer to receiver through concrete relates to concrete strength
- Develop correlation curve in lab
- Precision to baseline cylinders: ±10%

Pulse Velocity



Semi-direct mode



Traffic Opening
Possible Changes for Fast-Track

- Revise criteria from time to strength
- Channel early loads away from slab edges
- Restrict early use to lesser loading

Fast Track Summary

- Fast-Track works for all types of concrete pavement
- Start by considering fast-track in planning
- Use specifications that give contractors options
- Consider more than one mix
- Use innovative equipment
- Use non-destructive testing