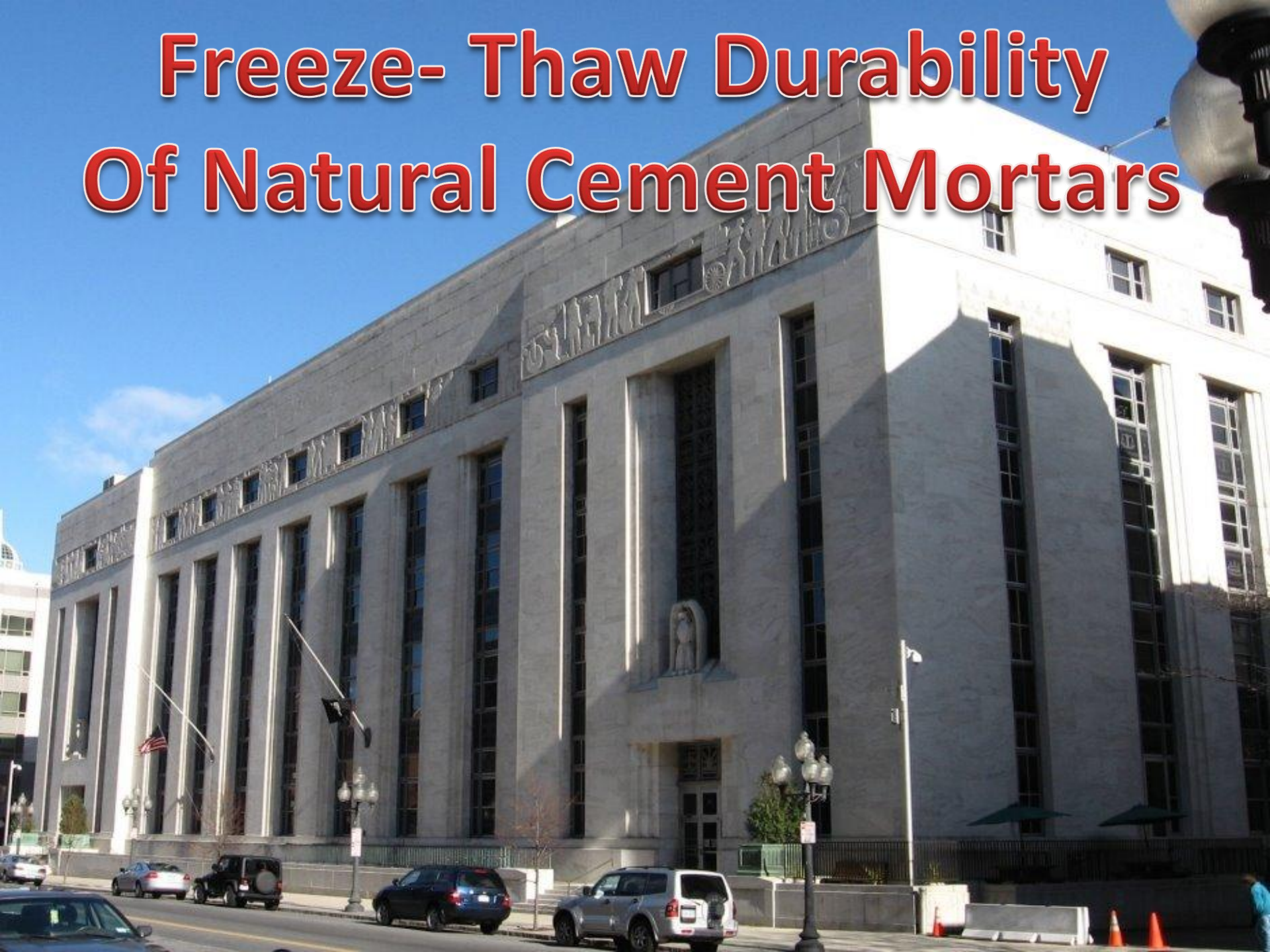


Freeze- Thaw Durability Of Natural Cement Mortars





ASTM C666: Resistance of Concrete to Rapid Freeze-thaw

- American Natural Cement and Sand
- 1:1, 1:1.5, and 1:2
- 28 day cure
- 16 hrs at 0 °F and 8 hrs at 72 °F



0 Cycles



50 Cycles



ASTM C672: Scaling Resistance Of Concrete Surfaces Exposed To Deicing Chemicals

- ¼ in of 4% Calcium Chloride Solution
- 18 hrs at 0 °F and 6 hrs at 72 °F



Mortars Tested

- Type M (7 day)
- Type O w/ polymer (7 day)
- American Natural Cement 1:1 (56 day)
- American Natural Cement 1:1 w/ 12 % air (28 day)
- American Natural Cement 1:1 w/ polymer (28 day)
- European Natural Cement 1:1 w/ polymer (28 day)
- NHL 3.5 1:2.5 w/ polymer (28 day)



ASTM C672: Scaling Ratings

- 0 = no scaling
- 1 = very slight scaling (no aggregate visible)
- 2 = slight to moderate scaling
- 3 = moderate scaling (some aggregate visible)
- 4 = moderate to severe scaling
- 5 = severe scaling (all aggregate visible)



Type M (7 day)



Results: 5 cycles=0, 10 cycles=2, 15 cycles=3,
25 cycles=4, 27 cycles=5

Type 0 w/ polymer (7 days)



Results: 5 cycles=0, 10 cycles=1, 15 cycles=2,
20 cycles=3

American Natural Cement 1:1 (56 day)



Results: 1 cycles=2, 3 cycles=5

American Natural Cement 1:1 w/ air (28 days)



Results: 3 cycles=1, 5 cycles=3, 10 cycles=5

American Natural Cement 1:1 w/ polymer (28 days)



Results: 5 cycles=0, 10 cycles=0, 15 cycles=1, 25 cycles=1,
50 cycles = 1

European Natural Cement 1:1 w/ polymer (28 days)



Results: 5 cycles=0, 10 cycles=0, 15 cycles=0, 25 cycles=2,
30 cycles=2, 40 cycles=5

NHL 3.5 1:2.5 w/ polymer (28 days)



Results: 5 cycles=0, 10 cycles=0, 15 cycles=1

ASTM C67: Part 8 Absorption

- Cold Water Submersion
5 hrs at 72 °F
- Boiling Water Submersion
1 hr at 212 °F
- Calculate Saturation
Coefficient



Saturation Coefficient

- Type M = 0.95
- Type O w/p = 0.09
- ANC 1:1 = 0.96
- ANC 1:1 w/a = 0.85
- ANC 1:1 w/p = 0.16
- ENC 1:1 w/p = 0.27
- NHL 3.5 w/p = 0.33



Conclusions

- Longer curing times increase Freeze-Thaw durability of traditional mortars
- Air entrainment increases Freeze-Thaw durability
- Polymer modified mortars performed the best to increase Freeze-Thaw durability
- Research is ongoing