Calendar restrictions on use of flyash mixes

Wally Rooke, P.Eng.
Executive Director,
Manitoba Ready Mix Concrete Association

Concrete pavement market

- Some 80,000 to 100,000 cubic metres of concrete are placed in Winnipeg street pavements each year.

Concrete pavement market

- Paving mixes meet CSA A23.1 C-2 Exposure:
  - 32 MPa @ 28 days
  - w/cm ratio: 0.45
  - air entrained
  - low slump
- Cementitious contents
- are typically 340 kg/m^3
- Current City spec restricts flyash content to 15%

Late season paving mixes

- Decades ago, it was common to restrict the use of flyash by the calendar for pavement mixes.
- North Dakota DOT's forbidding of flyash from paving mixes after September 15 each year was typical of specifications in the 1970 & 1980's.

Late season paving mixes

- Winnipeg City Street spec, too, has had a similar calendar restraint on paving mixes since it added the 15% flyash option to its spec.

2005 Portland cement allocation

- This past autumn, by September 2005, cement supply was put on an allocation basis to concrete producers across the Prairies.

2005 Portland cement allocation

- Heavy demand for Portland cement in the autumn of 2005, combined with a late start to the paving season because of early summer rains, created a situation where many street projects in Winnipeg may not have been completed.

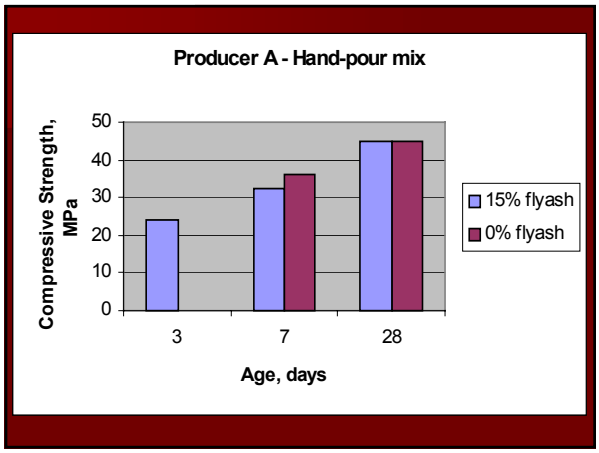
Removal of flyash restriction considered by City

- The cement shortage prompted City and industry in October to address the situation with the view to freeing up 15% of the cement in street projects by dropping, at least temporarily, the restriction on late season use of flyash.

City / industry discussion

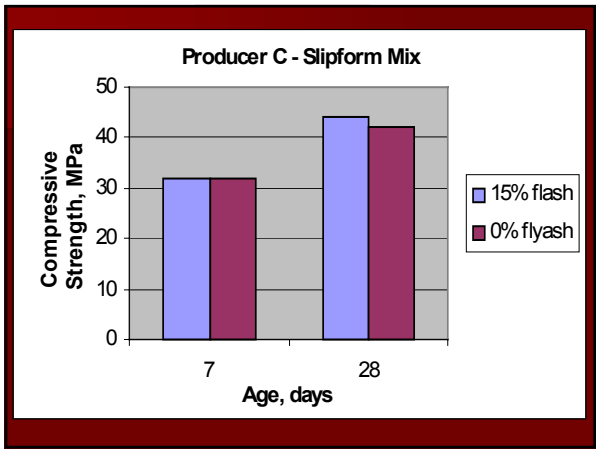
- To assure the City that 15% flyash mixes commonly used throughout the summer months would have strength development characteristics similar to 100% Portland cement mixes, MRMCA members companies provided detailed QC statistics of strength tests for both types of mixes.

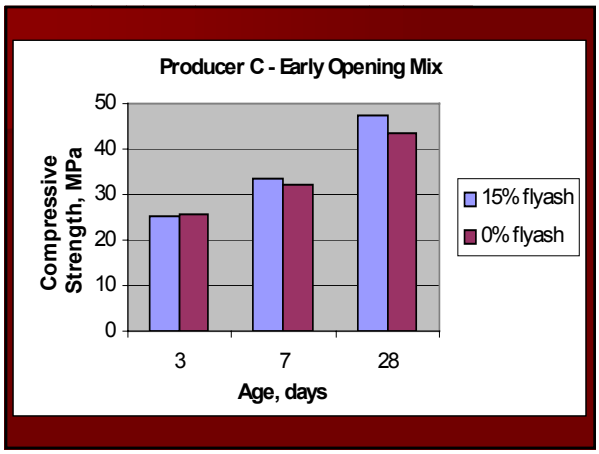

Producer A - Sidewalk mix
Compressive Strength, MPa
50
40
30
20
10
0
3
7
28
Age, days
15% flyash
0% flyash


Producer A - Hand-pour mix
Compressive Strength, MPa
50
40
30
20
10
0
3
7
28
Age, days
15% flyash
0% flyash

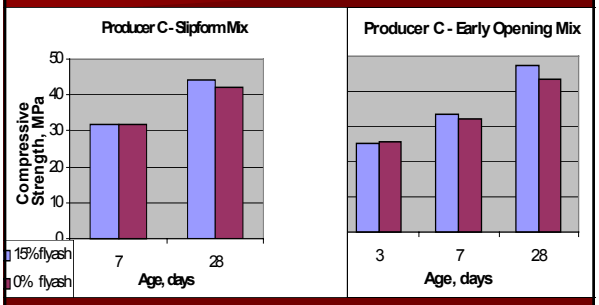

Producer B - Slipform Mix
Compressive Strength, MPa
50
40
30
20
10
0
7
28
Age, days
15% flyash
16% flyash
0% flyash


Producer C - Hand Pour mix
Compressive Strength, MPa
50
40
30
20
10
0
7
Age, days
28
15% flyash
0% ash


Producer C - Slipform Mix
Compressive Strength, MPa
50
40
30
20
10
0
7
28
Age, days
15% flash
0% flyash


Producer C - Early Opening Mix
Compressive Strength, MPa
50
40
30
20
10
0
3
7
28
Age, days
15% flyash
0% flyash

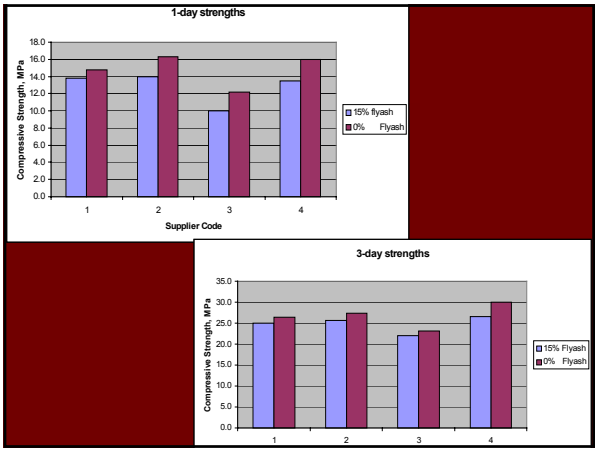
Not much to choose between early opening and standard mix



- The data from 691 Winnipeg tests demonstrated that mixes with 15% ash replacement outperform those with 100% Portland cement for all pavement mix types.
- In only one instance, with a data population of only 2 tests, was the contrary shown.

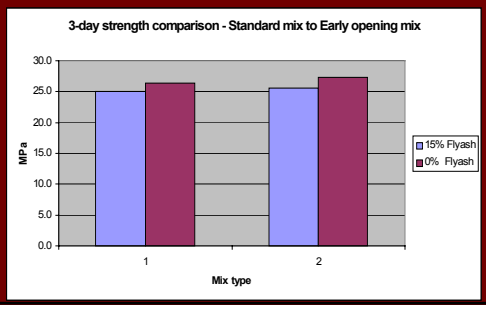
Short term tests

- To demonstrate early strengths at 1, 2 & 3 days, additional tests were performed in early October.
- A slight delay in strength development at early ages was shown @ 1 day with a maximum difference of 2.5 MPa.



Short term tests

- Even special Early-opening mix @ 3 days showed only marginal difference from standard mix.



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- As a result of this review of data, the City issued official permission to contractors and consultants to continue to use flyash in the paving mix.
- Circumstances were reviewed weekly; this permission extended to the end of October.

Future developments

- In view of this, MRMCA members will be approaching the City to alter its specification to eliminate all calendar restrictions on the use of flyash.
- Further tests are being considered to demonstrate that higher flyash contents up to 30% will show similar performance.

- Highways departments in both North Dakota and Minnesota specify from 15% to 30% flyash in paving mixes from pre-qualified plants.
- Both states previously had mid-September calendar restrictions on the use of flyash; these were dropped in the past 10 years.
- No reduction in pavement performance reported by either state.

Other jurisdictions

- 2004 statistics from the US show only Nevada does not use flyash in its pavement mixes.
- Permissible range of flyash use is 15% to 30% depending on Class of flyash and use.

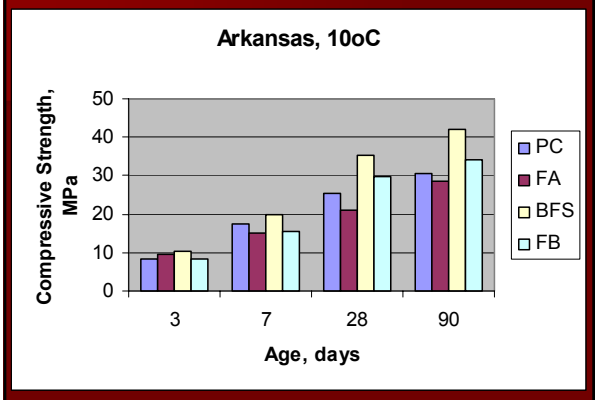
Paving in other jurisdictions

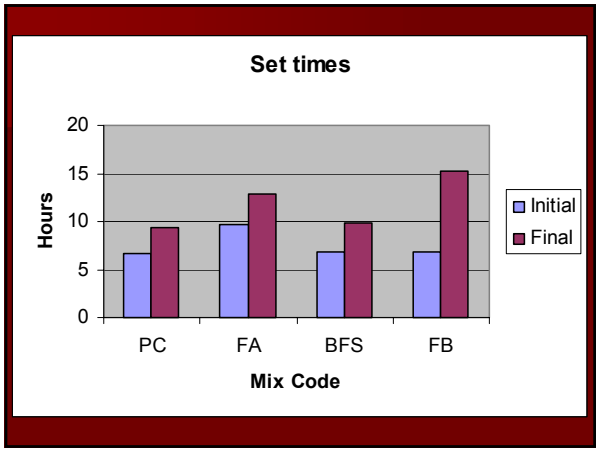
- Ternary mixes with flyash and slag reported by six states
- Blended cements specified in 41 states.
- Other applications for flyash:
  - ► Stabilized subbases with lime
  - ► Flowable or controlled density fill
  - ► Mineral filler in asphalt

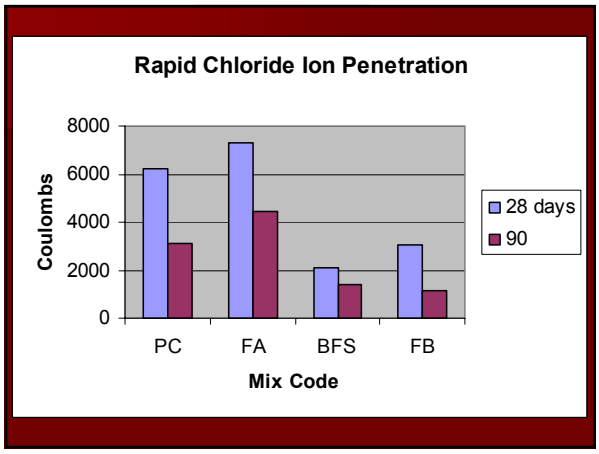
Recent research

- Control specimens, 392 kg/m^3, with only Portland cement, were compared @ three batch & cure temperatures (10^{o}C, 23^{o}C & 38^{o}C) to:
  - ► 20% Class C flyash replacement
  - ► 25% slag replacement
  - ► Blend of 20% flyash + 25% slag
- Set times, compressive strength @ 3, 7 & 28 days, Rapid chloride ion permeability, splitting tensile strengt

TRB, Jan. 2005 Hale, Bush, Russell & Freyne, U of Arkansas







Recent research

- *Under the conditions tested, results show that the addition of GGBFS (slag) at a relatively low replacement rate [25%] can improve the hardened properties for each curing regimen. This improvement was noticeable not only at later ages, but at early ages too. Mixtures containing both materials (25 %GGBFS plus 20% fly ash) performed as well and in most cases better than mixtures containing only Portland cement at all curing regimens.* TRB, Jan. 2005 Hale, Bush, Russell & Freyne U of Arkansas

Current research

- Studies (TRC 0604) currently underway in Arkansas with FHWA funding are testing ternary mixes with both slag and flyash.

  "The research results are promising. Mixtures containing both materials at cement replacement rates of 20 % (for each material) perform as well as mixtures containing only Portland cement (even at early ages)."

  Tests continue to determine strength development at temperatures below 70°F.

SCMs in Performance Specs

- COW, provincial and state specs currently do not yet specify the Performance format.
- Over time, as the situation develops towards such specs, the Producers will be required to provide statistical data to assure any Owner that mix design being used – at whatever level or blends of SCMs they may choose – meets the strength and exposure criteria stipulated in CSA A23.1.

Other applications

- If proper winter protection is provided to the works, the calendar is not a reason to limit the use of any % of any SCM in a concrete mix design.