EcoSmart's AP2K 2007 Assessment & Dissemination Project
Notes on Discussions in SCM Consultative Meetings Across Canada, March 2007

City: Winnipeg
Date: March 6, 2007: 9:00am-10:00am
Meeting: Manitoba Infrastructure and Transportation (MIT)
Attendance: See separate list

Current specifications:

- Median barriers, slabs, curbs etc: Minimum 360 kg/m^3 Type GU Cement for a 30 MPa at 28 days, 0.40 maximum w/c concrete (effectively precludes use of fly ash).
- Overlay slabs, shoulder barriers, abutment etc: Type 10E-silica fume silica fume portland cement, and shall not contain fly ash.

Concerns:

- Delay in setting times
    - based on experience with local materials, the use of 15% fly ash makes no difference in setting time.
- Quality and availability of fly ash
    - Manitoba Infrastructure and Transportation did have a previous bad experience with fly ash from SaskPower, which gave rise to a negative perception of fly ash. This, however, is no longer the case.
    - In the short term fly ash is sustainable, as there is 4 Mt fly ash produced in Canada. In the long term, however, coal fired power plants are large GHG emitters and future environmental regulations may reduce availability of fly ash.
- Manitoba Infrastructure and Transportation considers a road project as a complete package and is concerned with the performance of the concrete and the entire road. As such, it would to have warranty for durability: scaling, cracks, etc.

Steps toward increasing SCMs use:

- Manitoba Infrastructure and Transportation (Paving division) is now proposing 15% fly ash use for all concrete (curbs and roads). This proposal is now with the Specifications Committee. 15% has been used in curbs in the past and this positive experience is being used to promote its use in roads.
- According to Manitoba Infrastructure and Transportation representatives, the main reason for the specification changes is the cost. They expect to have cheaper concrete that performs equally to conventional concrete.
- Manitoba Infrastructure and Transportation would be willing to do a small scale demonstration project to further increase the maximum fly ash content permissible by the specifications.
- Manitoba Infrastructure and Transportation would consider performance specifications instead of prescriptive requirements if the contractor / supplier will provide a warranty on performance.
    - The Ready Mix (ready-mix) representative responded that in this instance, the producer will probably stop at 25% or 30%, but warranty bond is doable. Quality Assurance/Control (QA/QC) is key to performance concrete.

Conclusions

Manitoba Infrastructure and Transportation (Paving division) has taken a step in the right direction in proposing 15% fly ash in all concrete once formal specification committee approval is obtained; this a major change in the last 25 years. In the future, Manitoba Infrastructure and Transportation could go further: specify a higher proportion, adopt a cement replacement optimization strategy or develop performance specifications.

City: Winnipeg
Date: March 6, 2007: 11:00am-12:30pm
Meeting: City of Winnipeg
Attendance: See separate list

Current City specifications

- Fly ash is not permitted in curb, gutters, sidewalks, walkways, swales, medians from September 30 to May 15.
- From May 16 to September 30: no more than 10% of the specified minimum cement content may be replaced with fly ash.
- The use of blended cement is not permitted.
- The bridge branch of the city is allowing only up to 10% fly ash use.

Concerns

- SCMs supply:
    - There are 3 fly ash suppliers: Boundary Dam (SaskPower), Atikokan (Ontario), and fly ash from North Dakota, USA. The Atikokan supply is considered the best.
    - At times, there has been some difficulty to find in locating fly ash suppliers. It is believed that the suppliers in the US would like to keep it for own market. In June 2006, they experienced some fly ash shortage.
    - GGBFS (Slag) is available, but more expensive than fly ash.
- Quality assurance on site:
    - Performance of concrete regarding water being added to the truck and the need for QA at the construction site. Slump variability is a concern, and so there is a need for a communication truck/batch operation when adding water.
- Familiarity/experience with new product:
    - The city is not permitting the use of blended cement simply because they have no experience with the use of blended cement. If blended cement comes to the market, the product might be included in the specifications.

Steps to increase SCMs use

- The City of Winnipeg is experimenting with a change to 25% fly ash in city roads and sidewalks due to a cement shortage. They are limiting fly ash use by time of year, but for practical applications all paving is done in the time period where fly ash use is acceptable. No major differences in scaling were found with the increase of fly ash content. The City of Winnipeg feels comfortable increasing fly ash content to 25%.
- City of Winnipeg has also looked at practice and experiences in US jurisdictions. In Wisconsin, where up to 30% fly ash is used, no problems have occurred. In Minnesota and North Dakota, it is common to find 25%-30% fly ash replacement.
- In 2006, The City planned for 6 projects that would employ 25% fly ash ; 3 of which have been completed. They were undertaken with Lafarge towards the end of the year. This was done in order to increase their confidence in concrete incorporating 25% fly ash.
- Winnipeg soil contains sulfate with an exposure S1, Type 50 cement is usually required for underground concrete. Type 50 could be replaced by Type 10 and 25% fly ash. Some plants in Canada replace Type 50 with Type 10 and 25-30% interground fly ash.

- The City is also not opposed to discussions on performance based concrete based on CSA specifications
- According to the city representatives, the main reason for planning to change their specifications by allowing the use of more fly ash is the fact that in Minnesota, up to 30% fly ash is being used without any problems.

Conclusions

The City of Winnipeg has done lot of progress with regard to fly ash in recent years, increasing fly ash use from 10% to 25% and planning to incorporate these changes in their specification once the field results of the six planned projects with the concrete suppliers are convincing. Similar examples in the US are supporting The City's belief that higher replacement levels could be achieved. City of Winnipeg is favorable to performance specifications on the condition that good QA/QC by the supplier is implemented.

City: Winnipeg
Date: March 6, 2007: 2:00pm-3:30pm
Meeting: Wardrop (Consultant)
Attendance: See separate list

Concerns

- Stripping strength and strength design:
  - There was a discussion regarding strength development and specifications at 1 day and 28 days. It was noted that many engineers in BC specify 56 days instead of 28 days.
  - From a practical point of view, the strength that counts is stripping strength. All the other strengths will derive from that including strength at 28 days or 56 days.
  - The best measure is an in-situ test that reflects true condition of concrete.
- Performance specifications:
  - It would seem that some concrete suppliers do not know how to handle performance specifications and answer by giving mix design information when performance specifications are required. There is a need for better control from the RMC regarding who is capable to handle performance specification, as some smaller RMC may be less equipped.
  - It would be ideal to have a few (5 to 6) standard mixes as exist for steel or wood, resulting in more standardization. This will make it easier for a designer to select from a handbook, as is done with the blue steel design manual or wood design manual.
  - Wardrop has experienced difficulty in suppliers providing the required information for them to approve mixes, etc.

Recommendations for SCMs increase

- Wardrop is familiar with fly ash concrete, but would prefer a few standard mixes from which to choose.
  - Wardrop is favourable to performance specifications although it is concerned that not all Ready Mix suppliers are prepared to design mixes on that basis.

Conclusions

Although Wardrop is accepting of the use of SCMs, there are concerns with regard to inconsistency or lack of knowledge among some ready-mix suppliers. A suggestion is to create several standard mixes.

City: Calgary
Date: March 7, 2007: 7:30am-9:00am
Meeting: Stantec Consultants
Attendance: See separate list

Position and concerns

- Stantec is outspoken on issues of encouraging contractors to become more positive about use of fly ash.
- Finishing and curing of fly ash concrete
- Policy barrier: It was pointed out that when dealing with municipal governments as well as private developers, there are a lot of negative comments on use of fly ash and misconceptions.

Steps and recommendations for SCMs increase

- There is a need to inform or educate labourers on how to properly use concrete with high replacement of PC with SCMs. Such efforts will eliminate misconceptions or rumors of bad experiences, especially as one or two bad experiences can create false impressions regarding the use of SCMs. Placers and finishers can have a large influence on the concrete. Curing is a large part of using fly ash concrete, and must be used responsibly.
- Inland Cement is introducing a blended cement, HSb. It is high sulphate resistant and incorporates approximately 30% fly ash.

Conclusions
Stantec recognizes the benefits of using SCMs and encourages them with contractors. Better education and information, especially for labourers, will help eliminate curing issues and overcome negative attitudes based on one or two bad experiences.

City: Edmonton
Date: March 8, 2007: 11:00am
Meeting: Stantec Consultants
Attendance: See separate list

Concerns:

- Delay in setting times and strength gain.
- Bad experience with delamination and scaling of fly ash concrete used in parkade.
- Finishing fly ash concrete.
- Cost related to delay in strength gain, and extra QC (ex. Given that 56-d strength is specified by CSA, this will require additional cylinders and increase the cost to the contractor; the owner must be aware of this)
- Conservative specifications by cities and Ministry of transportation.

Recommendations for SCMs increase:

- It was put forward that the use of SCMs is very abstract in the CSA. It is unclear what the benefits are and so it was suggested to relate CSA into LEED for fly ash usage. It was further pointed out that benefits should be stated in CSA if fly ash is the right choice.
- Educating finishers to deal with fly ash concrete.
- The comfort level of contractors seems to be a key factor. Industry must be brought to attention.

Conclusions

Barriers include resistance of SCM use by the municipal and provincial government, delays in strength gain and finishing difficulties. The main recommendations are better education, especially for finishers and contractors, and improved communication on fly ash benefits.

City: Edmonton
Date: March 8, 2007: 2:00pm
Meeting: City of Edmonton
Attendance: See separate list

City current specifications:

- Fly ash is not permitted in curb, gutters, sidewalks, walkways, swales, medians…etc from September 30 to May 15.
- From May 16 to September 30: no more than 10% of the specified minimum cement content may be replaced with fly ash. The rational for the 10% is a study conducted in the early 1980s by R.M. Hardy. It concluded that 10% FA replaced produces the exact same performance out of concrete.
- In most of the structures designed by the city of Edmonton, minimum 28-d compressive strength of 30 MPa, maximum w/cm of 0.45, and minimum cement content of 335 kg/m^3 in Spring and Fall, and 302 kg/m^3 in Summer is specified.

Concerns:

- Slower strength gain, especially in cold weather.
  Because of budget issues, the concrete is most of the time poured until early November.
- Leachability of heavy metals from fly ash.

Position:

- There is a big push for the City of Edmonton to get on track with environmental objectives; the City of Edmonton is 14001 compliant.
- Representative from the city sit on an expert work group on climate change for roads, buildings, and bridges. This group was formed at the beginning of September 2006, and its goal is to prepare a course at the university level to educate engineers on climate change.

Steps/Recommendations for SCMs increase

- There is openness to changing specifications if data shows that fly ash concrete is good or better than conventional concrete.
- There is openness for test sections/demonstration projects.
- There is also openness in using the blended cement promoted by Inland Cement (incorporates 25-20% fly ash) provided that back up data shows it is good.

Conclusions

Although there are several barriers to SCM use, the City of Edmonton is willing to use fly ash and change specifications if data from tests show that it is as good as currently used concrete.

City: Toronto
Date: March 19, 2007: 9:00-11:00am
Meeting: City of Toronto
Attendance: See separate list

Current Specifications (sidewalks, curbs, gutter…etc)

- Slag cement up to 50%; fly ash up to 25%; silica fume up to 10%; a mixture of slag cement and fly ash up to 50% except that the amount of fly ash shall not exceed 25%.
- The minimum total cementing materials content shall be 355 kg/m^3.
- If SCMs are to be used, certification and documentation signed by a professional engineer, stating that the quality and durability of the concrete with SCMs will equal or exceed those of the concrete without SCMs. Specific documentation relating to deicer chemical scaling resistance and rate of strength gain shall also be submitted.

Current practices

- City of Toronto is following a hybrid system with some prescriptive specifications.
- City of Toronto does not work directly with ready-mix but hires contractors who hire ready-mix.
- Now City of Toronto is following Ontario Provincial Standards Section (OPSS), based on CSA A23.1.
- City of Toronto always uses curing compound (never burlaps), calcium chloride (never Magnesium chloride).
- City of Toronto changed salting mix for sidewalks from 20% salt 80% sand to 80% salt / 20% sand.

Concerns

- Scaling:

  City of Toronto has a very bad case of scaling in sidewalks (mainly for concrete cast in 2002). City of Toronto has a court case with some contractors regarding bad scaling. However, there is no apparent correlation between SCM use and scaling, but according to the city representatives, the concrete produced 20 years ago (presumably without SCMs) perform way better than the concrete used in sidewalks recently (presumably using SCMs).

- Performance specifications:
  - Contractors are not prepared to provide 50 year warranty.
  - City of Toronto does not have control on mixes, as contractors decide the amount of SCMs.
  - City of Toronto has no data on mixes. Suppliers are not able to supply data and batches are not consistent based on field testing. Meanwhile, materials should be plant specific; they are not and City of Toronto has no control.
- Scheduling issues:
  - Because of budgeting process (budget available in April), construction can rarely start before September. Often the contractor will still pour concrete in December using concrete mixtures approved and developed for spring/summer weather.
  - Fast concrete installation may reduce quality of concrete
  - Often salt may be applied too early when concrete has not matured enough.
- SCM source:

- City of Toronto is not confident about SCMs. It does not know where it comes from. There is also confusion between Type C and F. It is unsure how type affects the quality of concrete.

Steps to increase SCM use

- City of Toronto needs more field data and is prepared to do some field test (demonstration with increased % of SCM). City of Toronto is wiling to undertake demonstration project with various type of concrete mixes if it could get support from producers.
- City of Toronto approves one mix for the entire season. It is proposed to have 2 seasons' mixes. City of Toronto agreed, but the management team is still skeptical because there is pressure from the ready-mix concrete association to go for performance specifications. In this case, the specifications can no longer be prescriptive.
- City of Toronto could implement a city-wide policy not to apply salt before January on recently built sidewalks.

Suggestions/recommendations

- Review field finishing procedures.
- When the curing compound is added, extend curing time.
- Drop water-to-cementing ratio (current w/cm=0.40 or 0.45 for sidewalks)
- Educate contractors and enforce finishing and curing methods.
- A user manual for contractors and education program for finishers is needed.
- City of Toronto might recommend to delay the first salt spraying on fresh concrete until January

Conclusions

City of Toronto is well aware of increased sensitivity of SCM concrete to scaling and understands the issue is not only with the material but also construction practice, W/Cm ratio, bleed control, and finishing method (slip form being superior). As a result of the meeting, City of Toronto would want to implement a 2-season mix specification instead of the current one-fits-all. Support data is needed to increase SCMs acceptance.

City: Toronto
Date: March 19, 2007: 1:00pm-2:30pm
Meeting: Ontario Ministry of Transportation
Attendance: See separate list

Current specifications

- Up to 70% GGBFS and 40% fly ash is allowed by OPSS 1820 for circular concrete pipe, and by OPSS 1351 for precast reinforced concrete components, maintenance holes, catch basins etc.
- Up to 40% GGBFS is allowed by MTO (118SO3) in dry cast culverts.
- Up to 25% fly ash or slag is allowed in MTO's high performance concrete.
- For conventional concrete in highway structures, MTO does not allow the use of OPSS 1350 dated November 2006, but the one dated January 1995, which limits GGBFS to 25% and fly ash to 10%.
- For concrete exposed to De-icing chemicals, MTO specifies a mass loss of not more than 0.8 kg/m^2 of concrete slabs subjected to 50 cycles of freeze/thaw according to ASTM C 672.

Current practices

- Ministry of Transportation does not design concrete mixes and does not mandate SCMs.
- Ministry of Transportation works with contractors and they decide whether to use or not SCMs.

Concerns

- Environmental exposure (scaling):
  - De-icing salt is an issue.
  - Sometimes salting is done 18 days after placing concrete.
  - Despite specifications, not much SCM is used in Northern Ontario. The industry is far from using the top limits specified by MTO due to concerns related to environmental exposure.
  - Ministry of Transportation concrete is exposed very quickly after casting.

Steps to increase SCM use

- Ministry of Transportation has presently a hybrid system performance/prescriptive but is willing to adopt 100% performance if the contractor is prepared to give 5 years' warranty on performance and scaling resistance.
- How to guarantee concrete quality and good practice: proxy such as shrinkage and curing. These are introduced in coming specifications.
- The Ministry is open to examining data showing concrete with 25% fly ash performing satisfactorily for scaling resistance following the Ministry specifications in order to increase the 10% fly ash limit specified for conventional concrete. The slag content in dry cast culverts was increased to 40% based on lab work. This shows that the Ministry of Transportation is open to changing the specified SCMs content if data is available.

Conclusions

The Ministry of Transportation is promoting SCM but few projects (particularly in the North) are taking advantage of it and the percentage of SCMs used are significantly lower than the top limits currently specified. Ministry of Transportation is not against performance specifications but need a better

guarantee mechanism and also better performance lab-tests. The Ministry of Transportation is open to look at scaling resistance data of concrete incorporating 25% fly ash in order to increase the 10% fly ash limit specified for conventional concrete.

City: Toronto
Date: March 19, 2007: 3:00pm-4:00pm
Meeting: Trow
Attendance: See separate list

Current specifications

- Specifications do not allow SCM in parking slabs.
- Most of Trow's clients follow Ministry of Transportation specifications.

Concerns

- Fly ash availability: the source in Thunder Bay, ON is closing.
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- Some placers do not want to work with SCM concrete. There is a fear of increased setting time.
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- Flooring contractors do no want to use SCM, because of the lack of bleed water.

Conclusions
Trow does not seem to be extremely supportive of SCM and see more issue with it than benefits.

City: Ottawa
Date: March 20, 2007: 9:00am-10:30am
Meeting: City of Ottawa
Attendance: See separate list

Current Specifications

- Public Works and Services refers to Ontario Provincial Standard Specifications (OPSS). OPSS limits SCMs to 25% of the total cementing materials.
- City of Ottawa is currently reviewing the last version of OPSS 1350, which allow the use of high volume SCMs into concrete.
- HPC and sulphate resistant concrete applications utilize higher SCM contents.
- Most other works refer to CSA concrete specifications

Concerns

- Performance specifications:
  - The issue with SCMs is that the mix content is unknown, and the concrete performance has not been proven.
- Past experience
  - The EOBC created a negative image of fly ash that still persists today.
- Fly ash quality
  - City of Ottawa is comfortable with slag but less so with fly ash. A key is how to improve the quality of fly ash and whether or not CSA standards will suffice.
- Scaling
  - Premature scaling is also an issue in Ottawa.
  - For City of Ottawa scaling issue is more related to curing than finishing and no correlation was found with the use of slag.
- Curing
  - Curing is an important item but is not a separate item in tender documents. City of Ottawa is not open to curing as a separate contract item because they want to be able to ask the contractor to remove the concrete if it is not cured properly.

Recommendations

- A solution to performance specification issue is the CSA.
- Contractors should be educated about the specifications.
- To ensure good performance, the contractor needs to be told that there will be an audit. City of Ottawa spot checks concrete plants (cement, SCM and aggregates)
- Blended cement is the most practical way to go.

Conclusions

City of Ottawa is not against SCM, particularly BFS. However, the barrier for fly ash is its quality and the quality control for fly ash concrete. City of Ottawa is open to blended cement.

City: Ottawa
Date: March 20, 2007: 1:00pm-2:30pm
Meeting: CPCI (Canadian Precast / Prestressed Concrete Institute)
Attendance: See separate list

Concerns

- The industry does not use too much fly ash because of:
  - setting time,
  - potential color inconsistencies, and
  - fear of increased cost related to setting time and esthetics.
- There is also a need for technical help, as A23.1 does not help with precast.
- It was suggested that there is resistance from those involved in the construction of bridges to use HPC (high performance concrete), which requires the use of SCMs.

Steps to increase SCM use

- The CPCI belongs to the Cement Sustainability Committee and National Capital Green Building Council.
- Pre-cast concrete is used to speed-up construction and to reduce time lost and emissions related to traffic jams caused by construction.
- Design life is going up.

Conclusions

There is commonly a resistance within industry to using fly ash and high performance concrete. Further technical help is needed for precast. The good news is that pre-cast concrete can speed up construction and design life is going up.

City: Québec
Date: March 21, 2007: 10:00am
Meeting: Ministère des Transports du Québec
Attendance: See separate list

Current specifications:

- Ternary cement type GUb-F/SF or GUb-S/SF can be used in normal concrete, except that the total weight of the supplementary cementing materials shall not exceed 30% of the total weight of the cementing materials.
- The use of ternary cements is not permitted from October 15th to March 31st.
- For shotcrete used with either wet or dry process, the use of blended cement type GUb-SF, GUb-F/SF or GUb-S/SF is permitted.

Advantages of SCMs use

- Reduced chloride ion permeability
- Stability of air entrainment network
- Increase in the paste volume (because of the lower relative density of SCMs)
- Ease of pumping

Barriers and concerns

- Lower resistance to scaling
- Compressive strength development is slower, particularly in the fall.
- The requirements of CSA standards are not stringent for SCM concrete in particular for the W/C maximum limit of concrete exposed to deicing salts
- For precast concrete, ternary cement is little used because of the reduced compression strength. They use GUb-SF cement.
- Ternary cement is not used in shotcrete with dry-process (although permitted according to the specifications) due to reduced adherence compared to that made with silica fume blended cement.
- The Ministère des Transports du Québec recommends the use of blended cement containing SCMs but does not allow the use of SCMs as a separate ingredient at the concrete batching plant because of concerns regarding quality control and SCMs.

Steps/recommendations to the increased use of SCMs

- The Ministère des Transports du Québec studies the possibility of using ternary cements during winter with the following modifications: extending the curing period to 14 days (with a steady temperature) with a drying period of 7 days after a wet cure of 7 days.
- A penalty system for concrete curing with water and a bonus system for the protection of cement from cold weather (this is actually applied by the Ministry).
- Sharing experience with other ministry of transportation.
- Encouraging the use of blended cements over the use of SCMs as a separate ingredient at the concrete batching plant.

Conclusions

The Ministère des Transports du Québec uses SCMs through binary and ternary cements. Representatives form the ministry are in general happy with their experience with blended cements use, they are open to share their experience with other Ministry of transportation, and they are open to use more of this type of blended cement once the above issues and concerns are solved. .

City: Montreal
Date: March 22, 2007: 10:00am
Meeting: Hydro-Québec
Attendance: See separate list

Current specifications:

- The use of hydraulic cement type LH-HQ (20M) is mandatory for mass concrete (the use of SCMs is not permitted for this application).
- The use of SCMs is permitted for other applications such as repair and rehabilitation.

Concerns

- A sourcing problem as FA is not available in Quebec.
- The properties of concrete can be very variable, according to its source.
- The installation of an additional silo also is a logistical and economic issue.
- SCMs reduce early age strength.
- Studies with ternary cement brought about scaling problems (it should be mentioned that the concrete with ternary cement was not designed for scaling resistance, the w/c was around 0.50).
- A representative of the Association Béton Québec has emphasized the issue of cost of transport (as SCMs are unavailable in Quebec) as well as the variable quality of SCMs (FA) seen in the colour difference.
- Hydro-Québec calls into question the quality control of SCMs.
- Concerns over SCM concrete needing extensive curing.
- These concretes are further subject to plastic shrinkage and cracking and an applied mist application at this stage is required (mainly for concrete incorporating silica fume).
- Problems with setting time and form removal.
- It was commented that using SCMs may also encourage the use of coal fired power plants.

Conclusions

Hydro-Québec has a range of concerns with the use of SCMs and is hesitant to use higher amounts in concrete. However, representatives from HQ are ready to explore the use of 10% (slag or fly ash) in mass concrete for which they were allowing none.

City: Montreal
Date: March 22, 2007: 1:30pm
Meeting: Ville de Montréal
Attendance: See separate list

Current specifications

- For HPC (50 MPa and higher with E/L of 0.37 maximum), blended cement type GUb-SF, GUb-F/SF or GUb-S/SF is specified.
- Concrete for sidewalks and gutters: Acombination of 70 to 80% of Type GU cement and 20 to 30% GUb-S/SF or GUb-F/SF blended cement is specified. In Fall (starting from October 15), cement type HE is specified. It is also specified for this type of concrete a maximum Coulomb value of 1500 at 28 days, and a maximum scaling residue of 500 g/m^2 after 56 cycles of freeze/thaw following the BNQ NQ 2621-900 test procedure. The rational of the above combination of cement Type GU with blended cements is based on studies that show concrete made with a combination of more than 30% of blended cement performing unsatisfactory with regard to scaling resistance (mainly due to lack of bleeding and a concrete surface that is sensitive to finishing)
- In Fall it is specified that curing of concrete sidewalk and gutters must be done with a curing product and sealing solvent per ASTM C309, type 1, class B.

- The City of Montreal specifies in the case of HPC form removal at 12 to 24 hours after pouring and an immediate wet curing for 7 days. Chloride ion permeability must be at a maximum of 800 coulombs.

- The City of Montreal also specifies galvanized steel and a corrosion inhibitor to prolong the service life of infrastructure.

Barriers and concerns

- One of the disadvantages of the SCM is variable scaling resistance, depending on the content in the concrete.
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- Performance must be measurable and it is very important for the engineer to know the components of a mix formula.
- The variability of sources of SCMs is problematic with respect to quality.
- In the precast concrete pipe industries, the only cement used is GU type. The use of SCMs would be possible, but special attention must be paid to early age flexural strength because of the quick delivery to site after fabrication.

Other comments

- The City of Montreal entrusts 99% of quality control to private enterprise. The city lab conducts more specialized tests. Workers at the laboratory provide technical support regarding materials, for other City of Montreal departments. This favourable role allows them to make specific recommendations, for example, regarding SCMs. The achievements of projects are the key to success.

- A research study has begun in Montreal to limit construction time. For example, by using prefabricated components for parapets and slabs. High performance concrete (HPC) is meant for these components.
- In the case of prefabricated components, hydraulic cement with SCMs has a place.
- Performance evaluations need greater knowledge about the behaviour of materials and consequently further research.

Recommendations

- Training suppliers is an interesting approach to ensure good quality.
- MS or MSb cements are specified for the Métro or underground infrastructure with respect to sulphate attack and ternary cements may offer a good alternative.
- The use of SCMs would be possible in precast concrete pipe industries as long as special attention is paid to early age flexural strength.
- Greater materials research needed.

Conclusions

The environmental benefits of SCMs rely on the good performance of SCM concrete. There is definitely a place for SCMs in hydraulic cement for prefabricated components. Overall, further technical research on materials would be helpful to make recommendations on the use of SCMs.

City: Halifax
Date: March 23, 2007: 8:00am-10:00am
Meeting: Breakfast organized by ARMCA
Attendance: See separate list

Concerns

- The need for faster construction, especially for multi-storey and curing time according to CSA.
- A problem with LEED was discussed. It seems that some designers ask for a magic number of 40% while CSA HVSCM1 is over 40%. A value equal to or less than 40% requires Mpa at 28 days, which requires more cementitious materials. It would appear that some designers have misconception of the LEED "fly ash rule", believing that adding fly ash will earn a LEED credit. However, LEED gives credit only for reducing the amount of OPC in the mix.
- There is also the need for extra silos.

Suggestions to increase use of fly ash

- There is a need for fly ash Quality Assurance/Quality Control.
- Following CSA 3000 is a way to keep quality constant.
- It was suggested that more people should take a prescriptive route and therefore, more responsibility.
- Performance must be measurable. A system of bonuses and penalties was also suggested to ensure performance.

Conclusions

An increase in the use of SCM has been found and overall, there does not appear to be much resistance to SCM use in the region. The actual average fly ash use in Nova Scotia is 18%. The main concerns are with regard to quality control and in clarifying standards such as LEED and CSA.

City: Halifax
Date: March 23, 2007: 12:00pm-1:00om
Meeting: Nova Scotia Department of Transportation and Public Works
Attendance: See separate list

Current specifications:

- Concrete Pavement: Low calcium (less than 10% CaO) Class F fly ash may be used at an addition rate not to exceed 15% by mass of total cementing material; minimum cementing materials content shall be 360 kg/m2, and maximum w/c of 0.45.
- Roller Compacted Concrete: The fly ash content must be less than 20%.
- Cast in Place Concrete: Fly ash and silica fume may be used, however, the department reserves the right to limit their proportion to 20% and 10%, respectively in the mix.

Concerns

- It was suggested that structural engineers are not very familiar with concrete details.
- Transportation and Public Works specifications do not align with the CSA.

Steps to increase SCM use

- Exchange experience with counterparts in New Brunswick & Newfoundland
- The department is ready to increase SCMs use if the industry is comfortable and ready to use more.

Conclusions

The Nova Scotia Department of Transportation and Public Works is generally very accepting of the use of SCMs and is ready to further increase the SCMs proportions specified if the industry is ready to do so.

City: Vancouver
Date: March 26, 2007: 8:00am-9:30am
Meeting: Breakfast Meeting with Various Industry Stakeholders
Attendance: See separate list

Current use and acceptance of SCMs

- No major restraints to the expanded use of SCMs (particularly fly ash) were identified except the historic constructability factors. Results here generally were similar to those in 2002.
- One obvious solution would be the production of blended cements. These are available in most of the world and in eastern Canada, but not in the west.
- The use of fly ash is now universally accepted. However, the replacement levels, as a percentage of cement content in concrete, are much lower that the technology would permit.
- No attendee identified any policy against the use of SCMs. However, predictably, there was the anticipated concerns about impact of higher replacements on schedule and cost.
- Most attendees stated education is needed because the plastic properties of the resulting concrete is different. Education needs to include contractors and finishers.

Driving forces to increase SCMs

- Some more senior / sophisticated owners are demanding that new construction contain the maximum practical amount of sustainability, therefore including higher fly ash contents.
- It was noted that some Municipalities are requiring a list of sustainable achievements as part of the Permit application process. These are reviewed as part of the negotiations with regard to such items as zoning.
- LEED certification is a factor but there is limited credit for fly ash.
- The tender practice of requiring a separate bid for concrete with HVFA has merit.

Supply factors

- In the long term, the environmental restraints against coal-fired power plants will reduce the availability of fly ash.

Constructability issues

- Designers suggested that the focus should be on using HVFA in those structures where it has a higher benefit such as those requiring longer service life. The example of a reservoir was given. These structures generally do not have critical formwork stripping problems. It was noted that you cannot get extended service life modeling without SCMs.
- Although there are examples of HVFA in winter construction, colder weather is a restraint.
- Benefits of reduced cracking were noted.
- Contractors suggested that hey were comfortable with upper limits of 30% and perhaps 25% for flatwork.
- Finishers want 0% fly ash.

Costs and supply of SCMs

- One major infrastructure project with site batch plants noted that the cost was lower with 25% fly ash. However, lower costs have not generally been experienced in ready-mixed supply.
- It was noted that transportation is a major and increasing cost factor given that BC has no domestic supply. Only one Alberta plant is on rail. Centrailia is now having to import coal so the quality can vary.
- The supplier stated that the total use of fly ash is stable or slightly down over the last few years.
- Unfortunately, the production of fly ash is lowest in the summer when the demand is the highest.

Materials engineering aspects and specifications

- The practice of the ready-mixed industry to not reveal mix designs is counter productive to the effective use of SCMs. It has resulted in the use under less that optimum conditions and resulting failures with a negative connotation with regard to SCM use.
- Some governments limit the fly ash replacement percentages but there has been recent relaxation of some of this.
- It was noted that the use of fly ash is essential in areas that have ASR susceptible aggregates.
- Specifications need to have at least 56 day acceptance.
- All specialty concrete, such as SCC, uses significant amounts of SCMs.
- The recent changes to CSA with regard to concrete supply are counterproductive with regard to increased use of HVFA.

Ready-mixed production

- Earlier, fly ash was used as a cost reducing factor, not the emphasis is more on the added performance under certain constructions.
- The industry suggested that they would be agreeable to using higher replacements but in the right place, not as a fixed amount for all concrete.

Conclusions

Generally, there are few barriers to the use of SCMs in BC but meeting participants voiced several concerns, such as the future supply of fly ash and anticipated impact of higher replacements on schedule and cost. The ready-mixed industry not revealing mix designs is seen as counter productive to the effective use of SCMs. Suggestions given included: moving toward blended cements and increasing SCM education (especially among contractors and finishers). Designers suggested that the focus should be on using HVFA in those structures where it has a higher benefit, such as those requiring longer service life.

Cities: Vancouver, Victoria and Kamloops
Date: March 26, 2007
Meeting: Conference Call with Ministry of Transportation, Government of British Columbia
Attendance: See separate list

Ministry specifications

- Basically limits the fly ash content to 15%. Focus in on bridge decks. Up to 25% permitted for substructures and mass pours.
- Require 1500 coulombs. RCP tests in some Specifications (superplasticized concrete only) – see 211K.
- Noted that up to 8% silica fume permitted in decks. Also aware that up to about 25% being used in some Design / Build projects.
- Baskin noted that fly ash's use is "…subject to the Ministry's approval, and that they may consider higher fly ash contents for a specific project.
- Ministry of Transportation intends a conservation Spec and a "…middle of the road…."position with regard to new mix design technology.
- Not familiar with Service Life models and do not use.
- They require and get mix designs. Specifically required in Specifications.

Constructability concerns

- These were the main concerns of the Ministry of Transportation. They were largely put forward by the Kamloops group. They emphasized that they work in a semi arid area and have these potential problems with fly ash concrete:
  - Inhibits bleeding and therefore creates potential plastic shrinkage problems;
  - Experienced plastic shrinkage cracking over deck rebar;
  - Late in year, experience delays in getting access to a concrete placement due to slower strength gain of fly ash concrete.
  - Particularly concerned about finishing of flatwork. Sticky.
  - Due to rheology of fly ash mixtures, difficult to hold them on sloped grades.
- One comment about the preference for no fly ash in deck concrete in Kamloops. Similar concerns with silica fume and fly ash.
- Noted that the same restraints may not exist in the Lower Mainland.

Production concerns

- The Kamloops group stated that they had reservations about the ability of the ready-mixed producers and contractors to handle the more sophisticated (high fly ash) mixes and claimed that their suppliers and contractors had limited experience and competence.
- Want to "…keep it simple…".
- Stated that there are no ASR problems in BC except "…a few pockets…". This is due to the low alkali cement.

Additional comments

- Historically, the Ministry of Transportation has been very conservative in the adoption of new technology, although there was an indication that they might be open to a demo project.

- The statement that 15% fly ash will cause problems is not supported by our experience. Similarly, many of the aggregate pits in BC are borderline ASR.

Conclusions

Concerns were raised about constructability as well as the ability of ready-mix suppliers and contractors to handle high fly ash mixes. Although the BC Ministry of Transportation has historically been very conservative in the adoption of new technology (such as SCMs), there is an indication that they might be open to a demo project.