ECOSMART™ CONCRETE PROJECT

A Concrete Contribution to the Environment™

MOUNTAIN EQUIPMENT CO-OP

MONTREAL STORE

USING ECOSMART CONCRETE IN THE QUEBEC CONTEXT

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TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

LIST OF FIGURES

LIST OF TABLES

1.0 EXECUTIVE SUMMARY

FIGURE F1.1
SALVAGED WOOD IN ENTRANCE CANOPY

The Mountain Equipment Co-op Montreal store is the Co-op's 8th retail store and the third (after the Ottawa and Winnipeg stores) to comply with Natural Resources Canada's C2000 Green Building Standard. It is the first C2000 compliant retail building in Quebec.

The goals established by the project team at the beginning of the project were:

- To make of the store a visible statement of MEC's environmental commitment;
- To facilitate the store's success in a very competitive outdoor equipment retail culture;
- To redefine the 'big box' retail model;
- To further the case for environmentally sustainable buildings in Montreal and Quebec;
- To integrate all of the above in a distinctive architectural form.

The decision to use EcoSmart™ concrete was made in conformity with the project's environmental objectives. The team was aware of projects in other provinces, mainly in British Columbia, where a 50% SCM concrete mix was readily available at little or no cost premium. MEC's own Ottawa store used concrete where Portland cement was replaced with slag at the 50% level.

The team was surprised to discover that the use of EcoSmart™ concrete in the MEC Montreal store would be a challenge. Early enquiries resulted in more questions than answers. Local concrete suppliers initially informed our structural engineers in June 2002 that the maximum SCM mix that they would provide was 27%. By the end of July, the unofficial portrait of EcoSmart™ concrete availability in Montreal was brighter in terms of SCM percentage available but definitely bleak in terms of cost. At the fourth Design Charrette the structural engineers presented the following summary of fly-ash premiums, based on their research:

Regular concrete: +/- $120 / m^3
With 27% fly-ash content: +/- $135 / m^3
With 50% fly-ash content: +/- $184 / m^3

Cost effectiveness being one of the main arguments of using EcoSmart™ concrete elsewhere in Canada, the architects were disappointed and perplexed by the premium cost in Montreal. Efforts to negotiate lower costs were not successful.

The EcoSmart™ Partnership was very supportive in pushing for answers in and an understanding of the Quebec context. EcoSmart™ commissioned this report after the construction was well underway and most of the concrete already poured to document this first experience in trying to use 50% SCM concrete in the Quebec context.

Although this report refers mainly to the Lafarge product used in the MEC project, the context described applies to the other major concrete suppliers in Quebec. Demix Concrete, a subsidiary of the St. Laurence Cement Group Inc., offers an EcoSmart™ concrete based on a preblended cement mix with 22% fly ash and 5% silica fume. Lafarge would not provide an SCM replacement level greater than that available in their Tercem 3000™ cement. Demix Concrete offered a mix with 50% fly ash but this option was not investigated further due to the very high cost premium. The cost premium for HVSCM (high volume supplementary cementing material) concrete is related to the limited availability of SCM's in Quebec, other than silica fume.

2.0 INTRODUCTION

FIGURE F2.1
VIEW FROM THE WEST

The Mandate: The project mandate was to build a new two-storey, 4,180-m^2 retail store for Mountain Equipment Co-op (MEC) in conformance with the client's stringent Green Building Guidelines.

The Client: MEC is a retail consumer co-operative "driven by member's needs and values rather than the financial drive to maximize profit"(1). Since its founding in 1971, MEC has held to a vision based on social and environmental responsibility that has made it a leader in promoting sustainability, social equity, and community enhancement.

In its business operations, MEC has created a 'Green Building Program' to guide its building construction projects in an environmentally responsible manner.

3.0 THE PROJECT

3.1 PROJECT OVERVIEW

The new MEC store is located in a 'big box' shopping complex at the intersection of autoroutes 15 and the Metropolitain in Montreal. The development island where MEC is sited also accommodates a bank and a donut shop that were designed after the MEC store. The specific nature of the site and land agreement (the store was developed by MEC as a tenant) meant that the site planning and building volume had to meet the requirements of the landlord as well as of MEC.

The challenge for the team was to apply the MEC store concept and meet the program's environmental objectives in a commercial context characterized by 'big box' retailing. This was a unique opportunity to redefine the 'big box' retail model and further the case for sustainable buildings in Quebec.

(1) MEC website

FIGURE F3.1
LIGHT AND VENTILATION 'GILLS'

Environmental Features:

- The site storm water retention system accommodates 4 times the maximum capacity required by municipal regulations and allows the retained water to be released gradually back to the water table instead of returned to the overburdened municipal infrastructure as is currently the practice in Montreal;
- The landscape strategy differs substantially from the 'maximum building / maximum parking' model of the rest of the commercial complex: more landscaped area around the building and in the parking area, use of indigenous, drought resistant species and a green roof above the one-storey café by the store entrance;
- Water conservation strategies: roof rain water captured in underground cistern and used for irrigation and flushing toilets; low flow plumbing fixtures and waterless urinals;
- Radiant heating and cooling with geothermal as the main energy source;
- Natural day lighting through clerestory windows, a central light monitor and strategically placed, high performance curtain wall glazing at the entrance and behind the climbing wall.
- Natural ventilation through the use of underground tunnels and controlled louvers integrated into the central light monitor (operable windows were not appropriate for the site or the store layout and are limited to the staff lunch room);
- High level of insulation in an airtight building envelope (walls insulated to R35, roof to R40, foundations to R17/R24.5 slab to R10 and glazing to R3.4 and R5);
- Use of salvaged materials (this proved to be a significant challenge in Montreal): BC fir from a distillery was used for the main staircase, entrance canopy, curved roof mill deck, soffits and interior fit-up; salvaged steel was used for the climbing wall structure and excavated materials including boulders were used in the landscaping;
- No materials or equipment containing CFC's or HCFC's;
- Use of low VOC content, non-toxic, and high recycled content materials;
- Use of EcoSmart™ concrete;
- Use of R407 refrigerant (the 'greenest' refrigerant commercially available in Quebec);
- A waste management plan was implemented to divert 60% of non-hazardous solid construction waste from landfill sites. This target is ambitious in the current Quebec context but reflects the goal established by RecycQuebec, who partnered with the project team to use the Montreal MEC store as a case study towards the provincial waste management road map.

One of the results of the building's environmental features is a minimum 50% reduction of energy consumption compared to that of a similar building as modeled with the Model National Energy Code for Buildings.

FIGURE F3.2
'GILLS' FROM OUTSIDE

FIGURE F3.3
MATERIALS SUMMARY

3.2 PROJECT TEAM

Client / Tenant:	Mountain Equipment Co-op
Building owner:	Fiducie Immobilière MCM
Architect:	MTF Architects (Studio MMA, Atelier d'architecture Lyse M. Tremblay, architect Duschenes & Fish, architects)
Construction Manager:	Broccolini Construction Inc.
Civil Engineer:	Vinci Consultants
Structural Engineer:	Saia Deslauriers Kadanoff Leconte Brisebois Blais
Mechanical, Electrical and Energy Engineering:	Pageau Morel and Associates Inc.
Landscape Architects:	Williams Asselin Ackaoui and Associates Inc.
Waste Management:	Jacques Whitford Environment Limited
Materials Engineering:	Inspec-Sol Inc.
Cement Supplier:	Lafarge
Concrete Supplier:	Lafarge
Structural Concrete Placer:	Coffrage Multiformes Inc.
Concrete Finisher: (Also placer of slab on grade)	ACF
Site Concrete Placer:	Pavage Maska

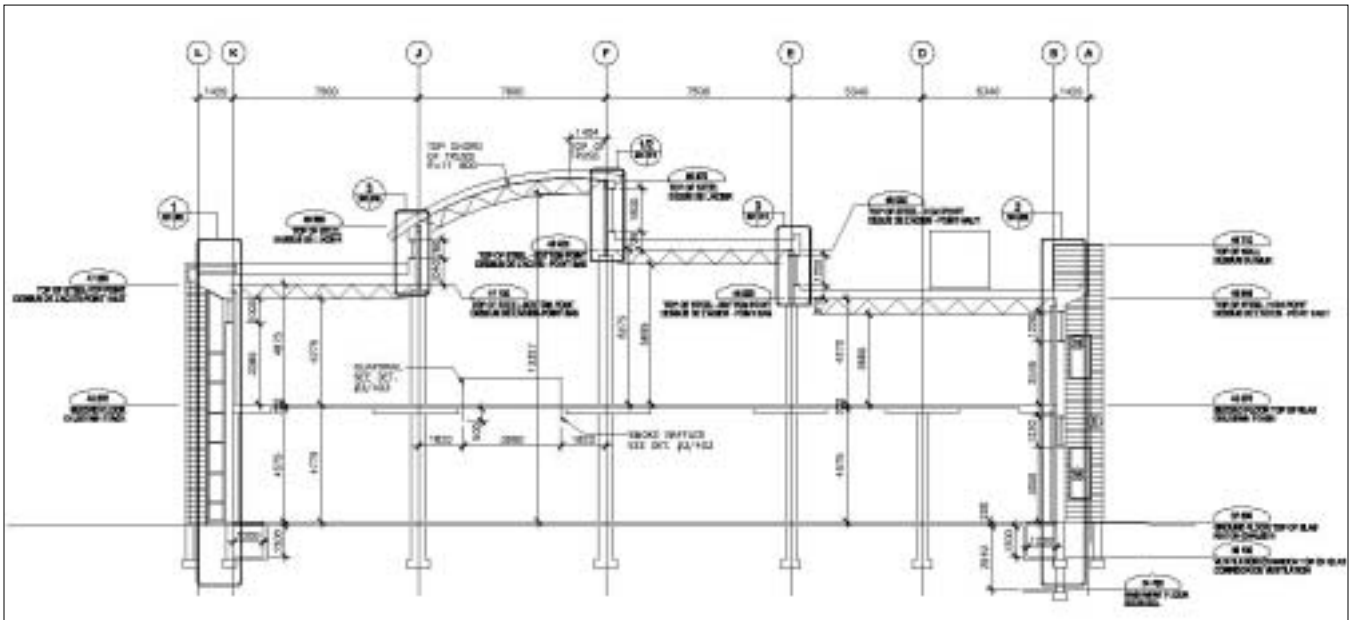


FIGURE F3.4
BUILDING CROSS SECTION

3.3 PROJECT DETAILS

Project development:
Whole systems approach using an Integrated Design Process (IDP)

Project delivery method:
Fast track / Construction Management

Project start:	April 2002
Construction period:	October 2002 – May 2003
Project cost:	± $5,500,000
Building area:	4,180 m^2
Number of storeys:	2

Floor to ceiling heights:

Ground floor (slab to slab):	4.58 m
Second floor (slab to u/s of joists):	4.28 m
At floor cut-out (slab to u/s of joists):	13.38 m

FIGURE F3.5
BOARD FORMED SHEAR WALL BEHIND CASH AREA

Concrete elements:

- Foundation walls (double walls along most of perimeter to create ventilation tunnels)
- Light weight insulating concrete under slab on grade (ISO Remblais by Lafarge): -100 mm
- Slab on grade: 200 mm thick with radiant tubing
- Structural slab: 200 mm thick with radiant tubing
- Perimeter columns, gr. floor, retail: 400 mm dia.
- Perimeter columns, gr. floor, back of store: 250 mm x 500 mm
- Central columns, ground and second floor: 600 mm dia.
- Plastic form liners used for the retail area round columns to produce a smooth shiny finish for the exposed concrete: Poly Newform by Givesco Inc.
- Concrete hardener / sealer for slabs in store: Ashford formula
- Concrete hardener / sealer for slabs in café: RetroPlate by Advanced Floor Products

4.0 USE OF ECOSMART™ CONCRETE

4.1 GOALS

The building structure is concrete and steel. Concrete was chosen to provide the necessary thermal mass for effective radiant heating and cooling.

The project team's commitment to environmental sustainability made the Montreal MEC store an obvious candidate for an EcoSmart™ collaboration. Reducing the CO_2 signature of the concrete used in the building became integrated into the project goals during the design phase.

Based on the EcoSmart™ literature and MEC's previous experience with their Ottawa store (50% slag content), the team set as its goal to use concrete with 50% SCM's. Initially, the intention was to use fly ash for its aesthetic qualities (warmer colour and smoother finish).

FIGURE F4.1
CONSTRUCTION NOV. 8TH. 2002

The premium cost of SCM concrete seriously threatened its integration into the project. The estimated extra cost to the project was estimated as follows prior to bidding:

27% SCM concrete (slag): $15,000
50% SCM concrete (fly ash): $64,000

The goal of using a 50% mix was abandoned for budget reasons but MEC agreed to invest the extra money for the 27% mix.

When the concrete bids were in, the decision was made to use concrete made with Lafarge's Tercem 3000™ blended cement (a blend of 20-25% blast furnace slag, 4-6% silica fume and 69-76% Portland cement). The premium cost for this concrete was $20 / m^3, which represents 11.3% of the total concrete cost.

4.2 CHRONOLOGY AND SITE CONDITIONS

Construction started in October 2002 and was completed in May 2003. The scheduling of the project suffered significant delays due to abnormally cold winter conditions. The concrete elements for the project were completed as follows:

FIGURE F4.2
FORMWORK FOR STRUCTURAL SLAB
NOV. 29TH, 2002

Foundation walls and ventilation tunnels (incl. Basement slab): (See figure F4.1)
October 15th - November 19th, 2002
Average ambient air temperature: -2.1°C to 5.8°C
Site conditions: Protected with tarps and heated to between 13°C and 20°C

Structural slab above basement:
November 26, 2002
Average ambient air temperature: -1.3°C
Site conditions: Temporary enclosure and heated to 18°C

Ground floor columns and shear walls:
December 10th and 11th, 2002
Average ambient air temperature: -1.2°C and –1.9°C
Site conditions: Temporary enclosure and heated to between 21°C and 22°C

Structural slab (see figures F4.2 and F4.3):
December 13th and 18th, 2002
Average ambient air temperature: 1.6°C and –8.2°C
Site conditions: Temporary enclosure and heated to between 19°C and 24°C

FIGURE F4.3
STRUCTURAL SLAB 2ND POUR
DEC. 18TH, 2002

Second floor columns and shear walls:
January 10, 2003
Average ambient air temperature: –13.5°C
Site conditions: The second floor was never temporarily enclosed. The only heating was from below.

Under slab insulating concrete:
January 28, 2003
Average ambient air temperature: –19.2°C
Site conditions: Temporary enclosure and heated to between 19°C and 21°C

FIGURE F4.4
GROUND FLOOR SLAB POUR
(ABOVE RADIANT PIPES)

Ground floor slab on grade (see figure F4.4):

February 19, 2003
Average ambient air temperature: –2.7°C
Site conditions: Temporary enclosure and heated to between 19°C and 21°C

Site curbs:

April 29, 2003
Average ambient air temperature: 10.8°C

Winter conditions:

Winter conditions for concrete work in Montreal start on November 1st and end on March 14th. Generally, regardless of the actual temperatures, projects will pay a winter conditions premium during this period. For the MEC project the concrete surcharge for winter handling was $6 / m^3. This premium is typical for winter conditions and not related to the use of Tercem 3000™

4.3 CONCRETE USE IN STRUCTURE

Concrete quantities used:

Foundation walls (including ventilation tunnel walls):	730 m^3
Insulating concrete*:	173 m^3
Slab on grade:	272 m^3
Structural slab:	481 m^3
Columns and shear walls:	146 m^3
Site work:	98.5 m^3

** Note: All concrete with Tercem 3000™ cement except for under-slab insulating concrete which was ISO Remblai™ from Lafarge*

4.4 CONCRETE REQUIREMENTS

Element	Min. 28 Day Strength MPa	Max. Slump mm	Air %	Slag %	Silica Fume %
Footings	25	80		20 -25	4 - 6
Found. walls	25	80		20 -25	4 - 6
Shear walls	30	80		20 -25	4 - 6
Slab on grade	25	80		20 -25	4 - 6
Structural Slab	30	80		20 -25	4 - 6
Columns and beams	30	80		20 -25	4 - 6
Curbs, sidewalks and ext. walls	35	30	5 - 8	20 -25	4 - 6

TABLE T4.1
CONCRETE REQUIREMENTS PER ELEMENT

4.5 FINDINGS

Background Technical Information

The EcoSmart™ concrete used in this project used Lafarge's ternary composite cement, Tercem 3000™. The exact concrete mix designs used for the project are included in Annex D, together with typical standard concrete mixes as a comparison. The following technical information comes mainly from the technical bulletin for Tercem 3000™ (copy included in Annex A).

Portland Cement: The Portland cement clinker used in the manufacture of Tercem 3000™ is also used for the production of normal Portland cement.

Silica Fume: the silica fume used in Tercem 3000™ comes from the condensation of SiO vapour produced in an electric arc furnace during the production of silicon metal and ferrosilicon alloys. It complies with the requirements of CSA A3000-98 A23.5 *Supplementary Cementing Materials* for a Type SF material. The silica fume used in Tercem 3000™ comes from different sources in Quebec.

Silica fume is composed of very small (about 100 times finer than the average cement particle) spherical particles, which are composed almost entirely of amorphous silica (typically $>$ 90% SiO_2). This makes the silica fume a highly reactive pozzolan. It will react with the calcium hydroxide released during the hydration of Portland cement, to produce calcium-silicate-hydrates, C-S-H, similar to those produced by Portland cement. The production of the additional C-S-H leads to increased strength and reduced porosity and permeability in the hardened material. Furthermore, the hydration products produced are capable of absorbing a substantial quantity of alkalis thereby reducing the amount available for deleterious reaction with certain types of aggregate.

As a result of these benefits concrete produced with silica fume has enhanced strength and durability compared with normal concrete.

Slag: The slag used in the production of Tercem 3000™ complies with the requirements of CSA A3000-98 A23.5 *Supplementary Cementing Materials* for a Type S material. The slag originates from blast furnaces used in the manufacture of iron. To make the product suitable for use in concrete, the molten slag is rapidly cooled by pelletization prior to intergrinding. This produces a glassy (amorphous) material that is predominantly composed of silicates and alumino-silicates of calcium (and to a lesser extent magnesium). Ground granulated (iron) blast furnace slag is a latent hydraulic material that produces hydrates that are similar to Portland cement. Slag has been used as a cementitious material in concrete for more than 100 years. It is well established that its use can improve many of the properties of concrete ultimately leading to improved long-term strength and durability.

The benefits of using this cement in concrete are listed as follows by Lafarge:

- Improved compressive strength
- Lower permeability
- Improved rheology and pumpability
- Reduced concrete bleeding
- Improved finishability
- Enhanced durability

Moreover, it is documented that concrete produced with Tercem 3000™ cement shows the same setting behaviour as concrete produced with Type 10 cement made from the same Portland cement clinker. The use of Tercem 3000™ reduces bleeding which usually enables finishing operations to be carried out earlier.

Design Benefits Associated with Using EcoSmart™ Concrete

The use of EcoSmart™ concrete remained in question until fairly late in the design phase of the project. As a result, the structural engineers designed the concrete structural elements for standard concrete.

The final decision to use EcoSmart™ concrete was based on two conflicting criteria:

1. The environmental objective of lowering CO2 production
2. The cost premium that the client was willing to pay for EcoSmart™ concrete.

The Tercem 3000™ concrete that was used on the project is essentially an 'off the shelf' mix distributed by Lafarge. In Quebec, SCM's are added in blended cement mixes at replacement levels that are predetermined by the cement companies. The ready-mixed concrete plants are generally not equipped to handle additional cementing materials on site and therefore will not offer concrete containing an SCM replacement level other than that provided in the blended cement.

Quebec's main energy source is hydroelectric and the steel plants remaining in the province do not produce SCM quality blast furnace slag. This means no local source of slag or fly ash. The lack of availability of SCM material in Quebec makes the cost of these materials and of adding them at the ready-mixed plants prohibitive. Even the cost of silica fume, which is available in Quebec, has climbed in recent years due to increased demand and limited supply.

The structural engineers were asked to examine the possibility of optimizing the use of Tercem 3000™ concrete after the fact; they concluded that there would have been no significant cost savings in the context of this project in designing with the Tercem 3000™ in mind (see Annex B).

Concrete Strength Achieved

The test results for the concrete tested are shown in Annex C. The results show that the concrete strength achieved at 28 days is above the specified requirements. In some cases the actual strengths at 28 days exceeded the requirements by as much as 20 MPa. In other cases the specified 28 day strengths were met or exceeded at 7 days.

Sub Trade Experience

The decision to document the use of EcoSmart™ concrete on the MEC project was made after most of the concrete was poured and the crews had left the site. This created a situation that disfavoured detailed observations from the trades.

FIGURE F4.5
BOARD FORMED CONCRETE WALL

Both the building concrete placer and finisher reported no difference perceived in working with the SCM concrete compared to a standard concrete mix.

The site work placer, Pavage Maska, reported an overall satisfaction with the handling of the Tercem 3000™ concrete, which they used for the first time. The only difference they noted was that the Tercem was more 'sticky' than the standard Type 10 cemet concrete. This sub trade expressed a willingness to work with the Tercem 3000™ mix in the future but also pessimism about getting the opportunity given the premium cost.

There was no perceived difference in curing time although the Tercem 3000™ concrete can be up to 10% slower to set in very cold temperatures. The structural slab was poured on December 18th and the formwork was left in place over the holidays. The ground floor was temporarily enclosed and heated during this time; the second floor structural slab was heated from below. The work benefited from mild temperatures and rain over the holidays.

FIGURE F4.6
ROUND COLUMNS WITH LINERS

Appearance

All the concrete elements were left exposed and define the material aesthetic of the building interior. There was no noticeable difference in the colour of the slag concrete. The walls of the elevator shaft were formed with boards for added texture (see figure F4.5) and plastic form liners were used for the freestanding round columns to give them a polished granite-like sheen (see figure F4.6).

Finishing

Notwithstanding the advertised superior finishing and workability characteristics of Tercem 3000™ concrete, the quality of the final finishing is disappointing in some respects.

The liners of the central round columns were removed prematurely from the top half of the columns on the second floor and the shine was subsequently dulled by exposure through several winter months (see figure F4.7). Some columns are excessively honeycombed and have bug holes due to inadequate vibrating during the pour (see figure F4.8).

FIGURE F4.7
DULLED SHINE ON TOP OF COLUMNS

The slab on grade and structural slabs have excessive shrinkage and some structural cracks. Where these have been repaired, the surfaces are not uniform.

The structural engineers originally specified wire mesh for the slab on grade and then accepted a proposal by the construction manager to replace this with steel fibres. Before the pour and after consultation with Lafarge, the steel fibres were also removed. These changes were made for cost-cutting and scheduling reasons.

FIGURE F4.8
HONEYCOMBED COLUMN

The structural engineers are of the opinion that the shrinkage cracks are a direct result of the removal of the wire mesh and steel fibres from the slab. Certain concrete representatives and the construction manager believe that the cracks are mostly due to inadequate and tardy saw cuts by the finishers.

The nature of other concrete deficiencies on this project suggests that the problems cited above are mostly the result of quality control by the finishing sub trade and not due to the nature of the concrete used.

Once again, the fast-track nature of the project needs to be taken into account when evaluating this quality control. The concrete work was a major element on the critical path of the project schedule and was delayed by both weather and the complications of laying down the radiant tubing. In some cases, the pours had to happen at night to meet the schedule.

Perception

The building has already received a considerable amount of positive press coverage and will undoubtedly continue to do so; this is in keeping with the MEC tradition and reflects a growing interest in green buildings in Quebec.

Public feedback on the look of the building has also been very positive with most people commenting favourably on the mix of materials and the use of exposed concrete.

Understanding the store's environmental strategies further enhances the enthusiasm of MEC employees and members.

The use of EcoSmart™ concrete in the project will be explained, along with the other environmental store features in a large information panel located by the store entrance.

5.0 CONCLUSION

5.1 CURRENT PRACTICE

FIGURE F5.1
LAFARGE CEMENT PLANT
ST-CONSTANT

The EcoSmart™ concrete used for the MEC store used blended cement developed, tested and distributed by Lafarge. The SCM's were not added to the concrete mix, but interground into the cement. The drawback of this Quebec situation is that there is restricted opportunity to use a higher percentage of SCM's than what is available from 'off the shelf' cement mixes. The advantage is that the trades involved do not feel like they are taking a risk with an untried product. For the MEC project this advantage, however, had the drawback that the people involved in the concrete work paid less attention to the process of using an EcoSmart™ concrete than would have been desired for the benefit of recording it.

Lafarge developed the Tercem 3000™ blended hydraulic cement for concrete requiring additional strength and durability. Among the advantages and benefits listed in the Lafarge literature on this product (see Annex A) there is no mention of the environmental benefits of using blast furnace slag as a supplementary cementing material in the cement mix.

FIGURE F5.2
KILN AT ST-CONSTANT PLANT

Although the statistics on the sales of Tercem 3000™ are confidential, they have increased significantly since the formula was launched in March 2001. The product has so far been targeted mostly at structural engineers.

According to concrete industry representatives, the costs of transporting SCM material from distant sources makes it unlikely that increased demand will lower the cost premium of using EcoSmart™ concrete in Quebec; it remains to be seen whether increased demand for lower prices will have that effect.

5.2 BENEFITS AND IMPACTS

The pressure from the MEC project team (and from EcoSmart™ team members) to increase the availability and affordability of high SCM concrete in Quebec has had some positive results:

- Lafarge is planning to shift its marketing strategy to target architects and other professionals that are concerned with the environment by promoting the environmental benefits of Tercem 3000™;
- The MEC project has raised the visibility of EcoSmart™ concrete in Quebec and has initiated the debate, if not answered the question, on what is a reasonable environmental objective for its use in the Quebec context;
- The demand for EcoSmart™ concrete for a high profile project like MEC has been a catalyst for competition among concrete suppliers that may change the industry's attitude and practice for future projects.

5.3 FUTURE ACCEPTANCE

FIGURE F5.3
VIEW OF STORE FROM THE NORTHWEST

The perception among many of the project participants of using EcoSmart™ concrete in the context of the MEC Montreal store was that it is a costly 'green' initiative feasible only when the client is willing to pay for it.

Acceptance of high SCM concrete mixes in Quebec is presently limited by high costs. In order for this situation to change either the costs have to come down or the reduction of CO_2 and the use of EcoSmart™ concrete has to be presented as a basic objective in building project briefs and the premium cost integrated into the budget at the outset.

As long as using EcoSmart™ concrete is seen as an environmental option in Quebec, it will remain one of the first features to be cut or minimized for budgetary reasons.

6.0 RECOMMENDATIONS

The promotion of EcoSmart™ concrete in Quebec has to take into account the Quebec context:

- The main energy source in this province is hydroelectric which means that there are no available local SCM materials (the blast furnace slag used in the Tercem 3000™ mix comes from Hamilton, Ontario). The cost of transporting this material is the major reason given by concrete suppliers for the cost premium of EcoSmart™ concrete;
- Most concrete plants do not have an extra silo for storing supplementary cementing materials such as fly ash or slag. Most SCM concrete in Quebec is made from preblended SCM cement based on an unvarying formula;
- The construction industry in Quebec is behind other areas of Canada when it comes to sustainable building practices. There is a high learning curve and status quo resistance to surmount in this province with every 'green' project.

As Canada's commitment to Kyoto becomes increasingly put in practice in buildings like the MEC Montreal store, the construction industry will invariably start to integrate sustainable practices into its culture.

In the Quebec context this process can be helped along by:

- Continuing the pressure on concrete manufacturers to both re-evaluate their policies regarding EcoSmart™ concrete and to research other, less expensive sources for SCM's;
- Promoting EcoSmart™ concrete knowledge and use amongst architects and structural engineers;
- Sensitizing clients to the importance of integrating environmental objectives into their construction projects and encouraging them to include the use of EcoSmart™ concrete as a project requirement. Major government and institutional clients are already committed to the principle of sustainable building practice, but it is important to also reach developers and private clients with this message and to insist on the integration of theory into practice;
- Publicize the efforts of projects such as MEC;
- Mandating the use of SCM in concrete as a standard rather than as an environmental option.

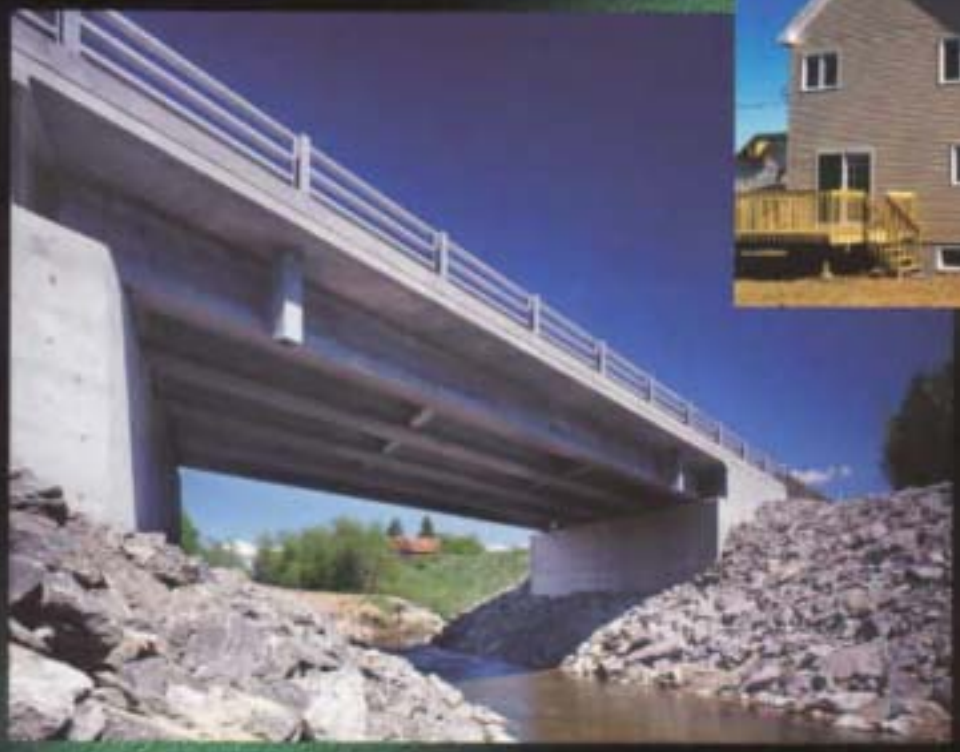
FIGURE F6.1
SOUTHEAST CORNER: GLAZED CORNER BEHIND CLIMBING WALL

ANNEX A

Publicity Brochure and Technical Bulletin for Tercem 3000™

BLENDED HYDRAULIC LAFARGE CEMENT

TERCEM 3000™

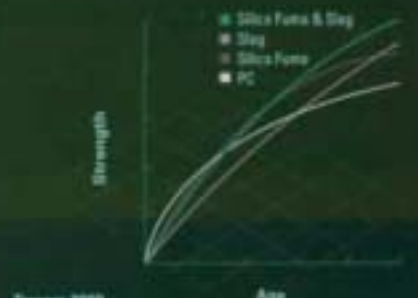


Higher Ultimate Strength
Reduction in Permeability
Improved Rheology
Better Finishability

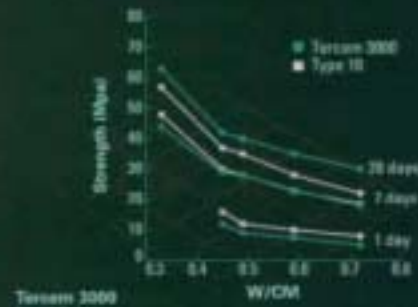
LAFARGE
NORTH AMERICA

TERCEM 3000™

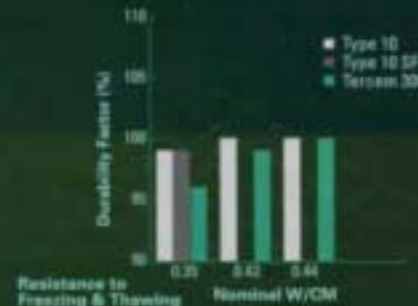
Performance Benefits For The Concrete Industry



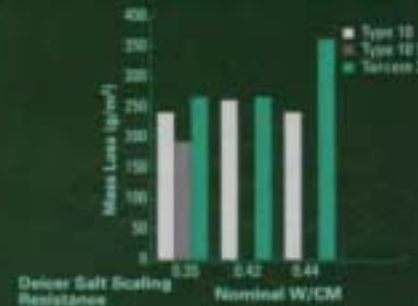
Tercem 3000



Tercem 3000



Resistance to Freezing & Thawing



Deicer Salt Scaling Resistance

Lafarge Tercem 3000, a new Ternary Composite Cement, is the ideal product when concrete requires additional strength and durability. Concrete containing this product has superior placing and finishing qualities. The precise combination of supplementary cementing materials in this portland based product results in a cement suitable for a wide variety of applications.

Tercem 3000 can be used in vertical applications and in flatwork. The improved workability with this product makes it ideal for walls, beams, columns and precast products. The product is also well adapted for use in foundations, bridges, columns,etc. In applications such as roads, sidewalks, driveways, curbs and gutters, and industrial, commercial, and institutional floors, this product provides the desired finishing characteristics in the plastic concrete, and is ideally suited for situations during warm weather. The use of Tercem 3000 gives outstanding results in roller compacted concrete. The reduced permeability in the hardened concrete results in improved durability.

Lafarge Tercem 3000 meets the applicable requirements of Canadian Standards Association (CSA) A-3000 Cementitious Materials Compendium A362 Blended Hydraulic Cement and ASTM C 1157 Standard Performance Specification for Hydraulic Cement.

This product can be used to produce quality concrete meeting design requirements for strength and durability.

Some of the criteria for high quality concrete include the selection of suitable aggregates, a proper mix designed to meet the expected exposure conditions for the structure, quality controlled concrete production, and proper placing, curing, and protection methods.

All of the requirements of the particular project specifications, CSA A 23.1, as well as the recommendations in "Design and Control of Concrete Mixtures" published by the Cement Association of Canada should be followed.

Advantages

- Improved compressive strength.
- Lower permeability.
- Improved rheology and pumpability of concrete.
- Reduced concrete bleeding.
- Improved finishability.

Specifications

1. Tercem 3000 meets the following specifications: CSA A 362 - Types 10E, 20E (moderate sulphate), 50E ASTM C 1157M - Types GU, HE, MS, HS
2. The water demand for Tercem 3000 is equivalent to Type 10 cement
3. The strength of concrete produced with Tercem 3000 is:
   - lower at 1 day
   - equivalent at 7 days
   - higher at 28 days

   compared to similar concrete produced with Type 10 cement
4. The use of Tercem 3000 significantly reduces chloride permeability compared with Type 10 cement.
5. Coulomb values at 28 days are slightly higher than those determined for similar concrete produced with Type 10E-SF cement, but are generally comparable after 56 days.
6. The expansion of concrete containing highly-reactive aggregate is reduced significantly when Tercem 3000 is used. The 2-year expansion is lower than the 0.04% maximum commonly used in specifications.
7. Excellent durability to freeze-thaw cycling was observed for air-entrained concrete produced with Tercem 3000, over a wide range of water-cementing materials ratios (W/CM).
8. Salt scaling resistance of concrete produced with Tercem3000 meets the requirements provided that W/CM < 0.45.
9. Tercem 3000 meets ASTM and CSA limits for sulphate resistant cement (Type 50E).

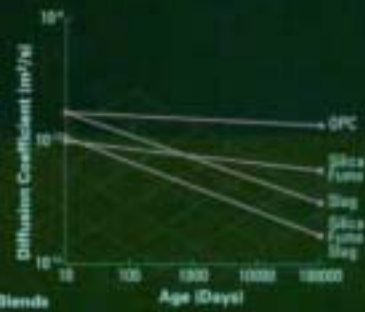
Chloride Permeability

Chloride Permeability

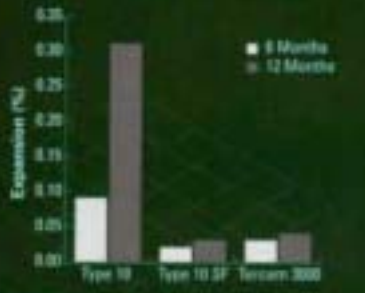
Benefits

Improvement of 28 day strengths in the order of 10% to 20% over a wide range of mix designs and W/C ratios

- ASR reduction
- Durability
- Easier finishing
- Hot weather performance
- Natural retarder
- Reduce bleeding
- Easy to pump
- Reduced segregation
- Only 1 silo required



Ternary Blends



Sulphate Resistance

LAFARGE

TERCEM 3000 Blended Hydraulic Cement

Lafarge Canada Inc. is part of the Lafarge group, one of the world's foremost producers of building materials. The group holds leading positions in each of its core businesses: Cement, Aggregates and Concrete, Roofing and Gypsum. Lafarge is committed to the advancement of the construction industry by bringing greater safety, comfort, and beauty to our everyday lives.

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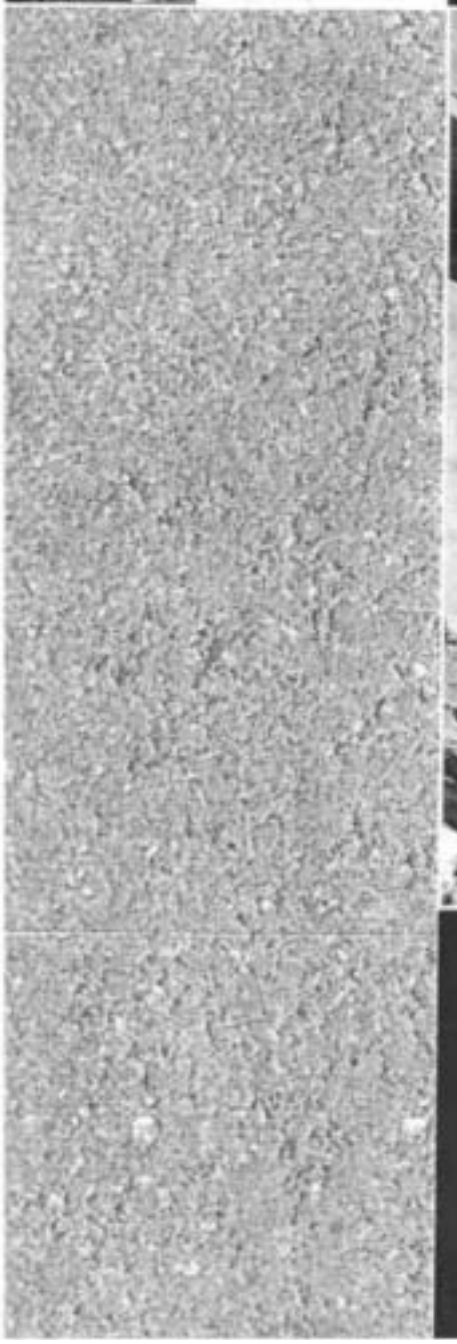
TERCEM 3000

TECHNICAL BULLETIN

Blended Cement for Performance Concretes



LAFARGE
NORTH AMERICA

Table of Contents

List of Figures:

Appendixes:

Tercem 3000™ Cement

Lafarge Tercem 3000™ cement, a new ternary composite cement, is the ideal product when concrete requires additional strength and durability. Concrete containing this product also has superior finishing qualities. Tercem 3000™ is produced by intergrinding Portland cement clinker, gypsum, silica fume and pelletized blast-furnace slag. The proportions of supplementary cementing materials are in the range of 4 to 6% silica fume and 20 to 25% slag; a typical chemical analysis is shown in Table 1. The precise proportions are optimized for performance and to produce a cement suitable for a wide variety of applications. The benefits of using Tercem 3000 in concrete include:

- Improved compressive strength
- Lower permeability
- Improved rheology and pumpability
- Reduced concrete bleeding
- Improved finishability
- Enhanced durability

The principle use for Tercem 3000™ is in concrete flatwork. In applications such as roads, sidewalks, driveways, curbs and gutters, and industrial, commercial, and institutional floors this product provides the desired finishing characteristics in the plastic concrete and is ideally suited for situations during warm weather. The reduced permeability in the hardened concrete results in improved durability. Other uses for this product include foundation walls, precast concrete products, and roller-compacted concrete. Tercem 3000, easier to place and finish due to its improved rheology, reduces bleeding and has excellent slipforming qualities. During periods of excessive evaporation precautions should be taken to protect the concrete surface from rapid evaporation.

Tercem 3000™ meets the requirements in CSA A3000-98 A362 Blended Hydraulic Cement for the following types of ternary blended cement (see Appendix 1):

- Type 10E-S/SF
- Type 20E-S/SF
- Type 50E-S/SF

This means that Tercem 3000™ provides equivalent performance to Type 10 Normal Portland cement, Type 20 Moderate Portland cement and Type 50 Sulphate-resistant Portland cement.

Tercem 3000™ also meets the requirements in ASTM C 1157M-97 Standard Performance Specification for Blended Hydraulic Cement for the following types (see Appendix 2):

- Type GU – Blended hydraulic cement for general construction (general use)
- Type HE – High Early Strength
- Type MS – Moderate Sulfate Resistance
- Type HS – High Sulfate Resistance

Table 1

Typical Chemical Analysis of Portland Cement and Blended Hydraulic Cements

	Type 10	Tercem 3000™
SiO_2	20.2	26.3
Al_2O_3	4.7	5.6
Fe_2O_3	2.1	1.9
CaO	63.3	56.2
MgO	2.8	4.8
Na_2Oe	0.87	0.89
SO_3	3.3	2.9
LOI	1.9	0.7
Blaine (m^2/kg)	380	580
S.G.	3.15	3.07
C_3S	61	–
C_2S	12	–
C_3A	9	–
C_4AF	6	–

1. Cementitious Components

1.1 Portland Cement

The Portland cement clinker used in the manufacture of Tercem 3000™ is also used for the production of normal Portland cement. The same clinker is also used in the manufacture of Lafarge SF™ cement, which meets the requirements of CSA A3000-98 A362 Blended Hydraulic Cement for Type 10E-SF. Chemical analyses for Type 10 and Tercem 3000™ are shown in Table 1.

1.2 Silica Fume

The silica fume used in Tercem 3000™ comes from the condensation of SiO vapour produced in an electric arc furnace during the production of silicon metal and ferrosilicon alloys. It complies with the requirements of CSA A3000-98 A23.5 *Supplementary Cementing Materials* for a Type SF material. In its natural state, silica fume is an extremely fine powder with particles having an average diameter of about 0.1 μm. For easier handling and to ensure a uniform feed in the grinding mill the silica fume is pelletized with water. This process is most efficient for producing a homogenous blended cement of constant quality and with good handling characteristics. During the intergrinding process, the heat generated in the mill drives off the moisture returning the pelletized silica fume to its original fineness.

Silica fume is composed of very small (about 100 times finer than the average cement particle) spherical particles, which are composed almost entirely of amorphous silica (typically > 90% SiO_2). This makes the silica fume a highly reactive pozzolan. It will react with the calcium hydroxide, $Ca(OH)_2$, released during the hydration of Portland cement, to produce calcium-silicate-hydrates, C-S-H, similar to those produced by Portland cement. The production of the additional C-S-H leads to increased strength and reduced porosity and permeability in the hardened material. Furthermore, the hydration products produced are capable of absorbing a substantial quantity of alkalis thereby reducing the amount available for deleterious reaction with certain types of aggregate.

As a result of these benefits concrete produced with silica fume has enhanced strength and durability compared with normal concrete.

The properties of silica fume and silica fume concrete are documented in the ACI Committee 234 Report "Guide For the Use of Silica Fume in Concrete."

1.3 Slag

The slag used in the production of Tercem 3000™ complies with the requirements of CSA A3000-98 A23.5 *Supplementary Cementing Materials* for a Type S material. The slag originates from blast furnaces used in the manufacture of iron. To make the product suitable for use in concrete, the molten slag is rapidly cooled by pelletization prior to intergrinding. This produces a glassy (amorphous) material that is predominantly composed of silicates and alumino-silicates of calcium (and to a lesser extent magnesium). Ground granulated (iron) blast furnace slag is a latent hydraulic material that produces hydrates that are similar to Portland cement.

Slag has been used as a cementitious material in concrete for more than 100 years. It is well established that its use can improve many of the properties of concrete ultimately leading to improved long-term strength and durability.

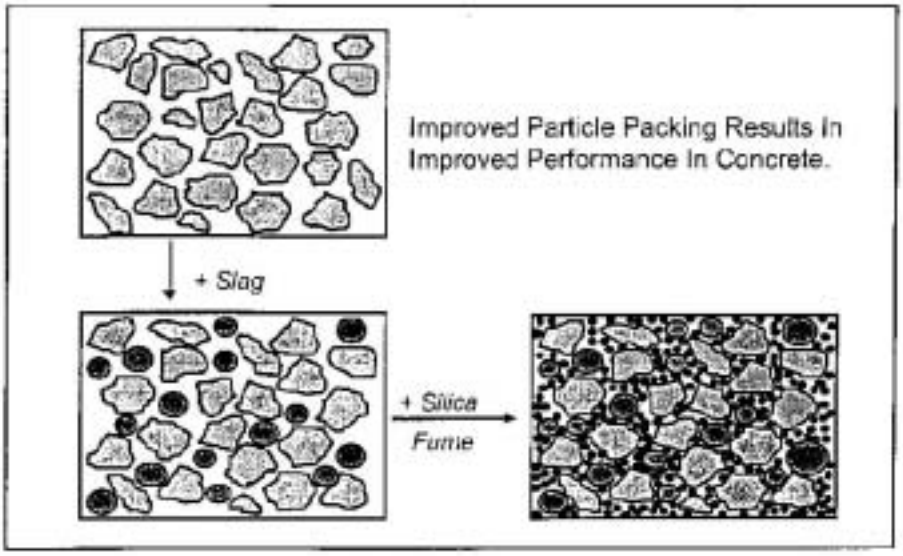
The properties of slag and slag concrete are documented in the ACI Committee 233 Report "Ground Granulated Blast-Furnace Slag as a Cementitious Constituent in Concrete and Mortar."

2. Benefits of Ternary Blended Cement

The production of a cement blend incorporating two supplementary cementing materials (SCM's), such as silica fume and slag, can result in synergistic effects because of the different nature of the SCM's. For example, the following benefits have been observed when silica fume and slag are used in combination with Portland cement:

- The resulting particle size distribution leads to an improved particle packing of the cement.
- Silica fume compensates for the comparatively low early-strength of concrete with slag.
- Slag increases long-term strength development of silica fume concrete.
- Slag improves the finishing properties of silica fume concrete. (i.e. reduces stickiness)
- Silica fume reduces the normally high levels of slag required for sulphate resistance and ASR mitigation.
- Slag can reduce the heat of hydration of silica fume concrete.
- Very high resistance to chloride ion penetration can be obtained with combinations of silica fume and slag.

The benefits associated with the use of ternary blends has made Tercem 3000™ the first choice for the production of a wide range of concretes including high-performance concrete.



3. Properties of Fresh Concrete

3.1 Workability and Cohesion

Concrete containing Tercem 3000™ has the similar water demand as an equivalent concrete produced using Type 10 Normal Portland cement; i.e. the same water content is required for a given slump. However, the use of Tercem 3000 increases the cohesiveness of the mix resulting in reduced segregation and bleeding.

3.2 Pumpability

The pumpability of concrete has been found to be significantly improved when using Tercem 3000™ cement as the presence of silica fume and slag have a lubricating effect (reducing pump pressures by up to 50%) while reducing the risk of segregation during pumping.

3.3 Time of Setting

Concrete produced with Tercem 3000™ cement shows the same setting behaviour as concrete produced with Type 10 cement made from the same Portland cement clinker. Also, the use of Tercem 3000™ reduces bleeding, which usually enables finishing operations to be carried out earlier.

3.4 Air Entrainment

Air contents (and spacing factors) of concrete made with Tercem 3000™ should be the same as normal Portland cement concrete for similar exposures. Small adjustments in the dosage of air-entraining admixtures may be required when changing the type of cement used for concrete production.

3.5 Compatibility with Admixtures

Tercem 3000™ cement is compatible with most conventional admixtures such as water reducers, superplasticizers, retarders, accelerators, air entrainers, and other types of admixtures. To obtain optimum performance with these admixtures, slight adjustments in the dose rate may be required. Technical representatives of Lafarge or the admixture supplier can provide advice in this regard.

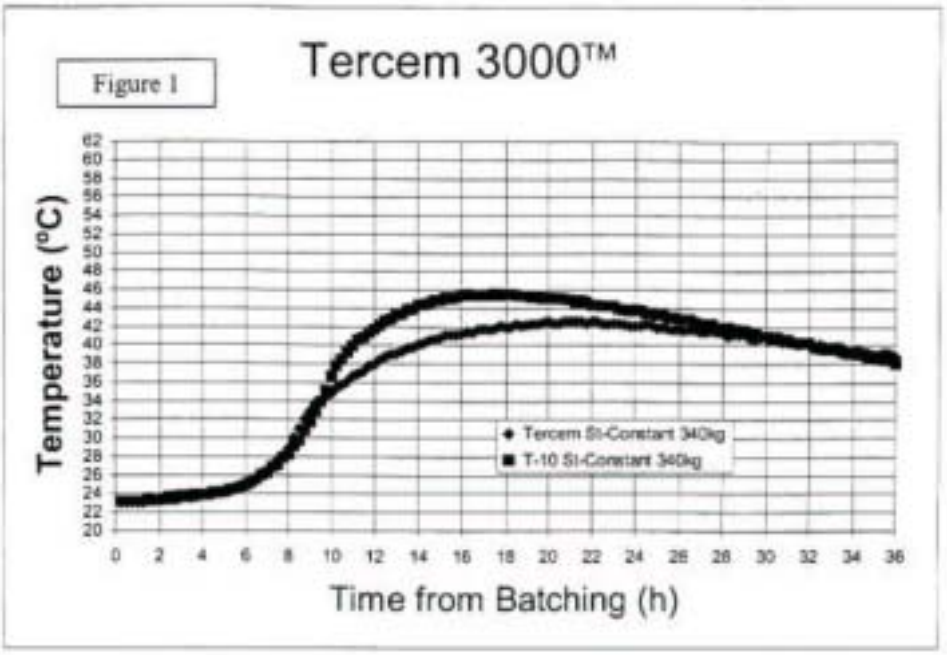
3.6 Plastic Shrinkage

The potential for plastic shrinkage of concrete containing Tercem 3000™ cement is similar to that for concrete with Type 10 cement.

3.7 Hydration Temperatures

For a given cementitious material content, concrete made with Tercem 3000™ cement produces the same or slightly less heat than concrete made with a Type 10 cement produced from the same clinker (Figure 1). Further reductions in temperature rise can be achieved by partial replacement of Tercem 3000™ with fly ash or slag at the concrete production facility.

Figure 1

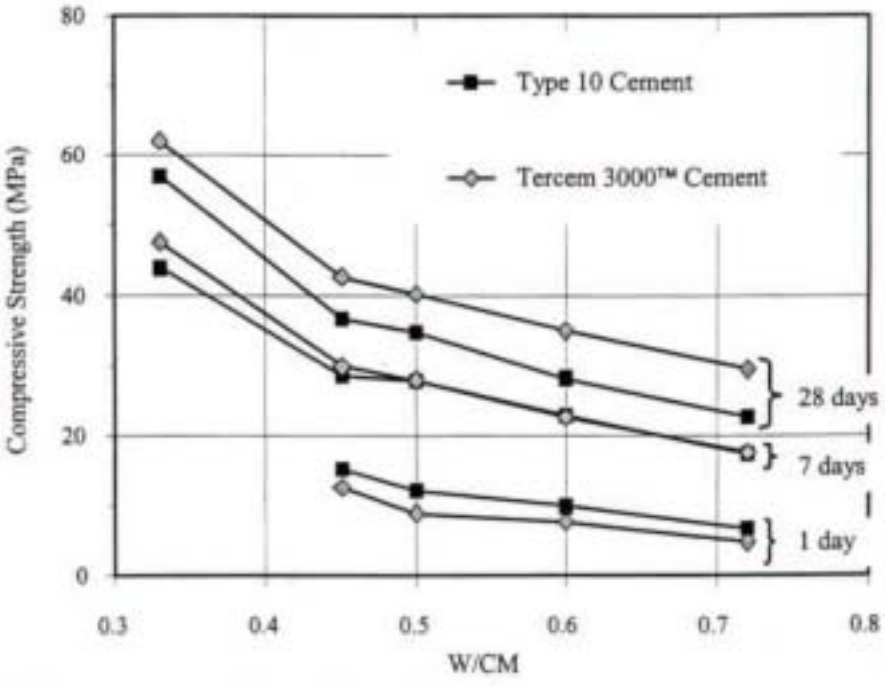


4. Properties of Hardened Concrete

4.1 Compressive Strength

Concrete produced with Tercem 3000™ cement has a higher compressive strength at 28 days (and beyond) compared with concrete produced with the same quantity of ordinary Type 10 Portland cement and the same water to cement ratio (W/CM). The early age strength (e.g. at 1 day) may be slightly lower in the concrete produced with Tercem 3000™ cement because of the incorporation of slag. Figure 2 shows strength results for a range of concrete mixes (W/CM between 0.33 and 0.72) at different ages. For normal strength concrete, the use of Tercem 3000™ cement typically results in a 10 to 20% increase in the 28-day compressive strength compared with Type 10 cement.

Figure 2: Compressive Strength Development of Concrete



4.2 Permeability

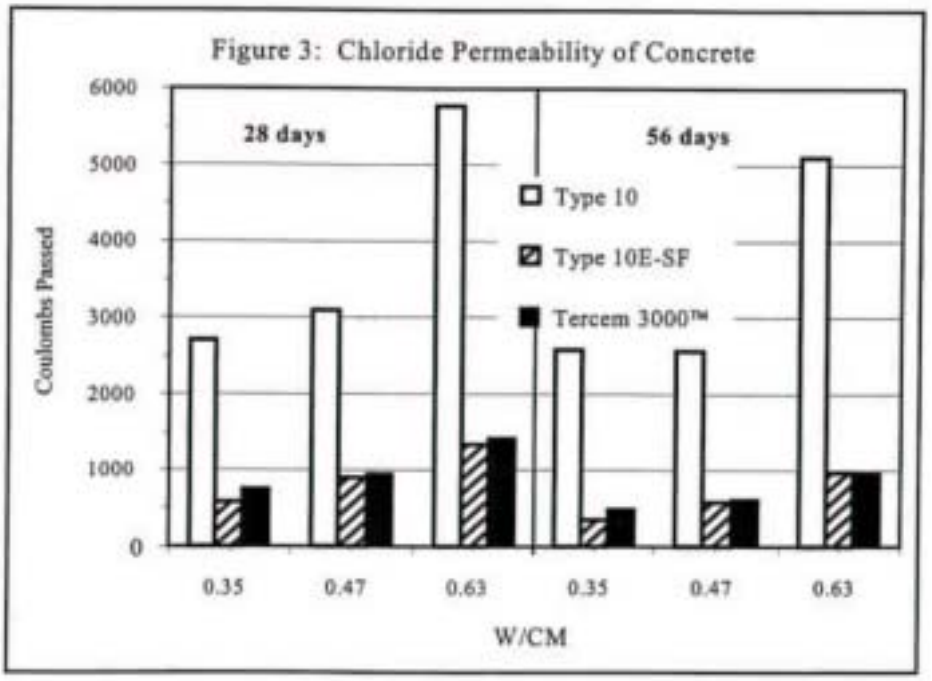
The combination of silica fume and slag produce significant reductions in the permeability of the concrete to water, gases and deleterious agents (e.g. chlorides and sulphates). These effects are attributed to the pozzolanic reaction, reduced porosity, improved quality of the interface between the cement paste and the aggregate, and reduced internal bleeding.

The permeability of concrete to chloride ions is often measured using ASTM C 1202 *Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration*, which is more commonly referred to as the Rapid Chloride Permeability or RCP Test. This test ranks the permeability of the concrete on the basis of the electrical charge passed during the six-hour test as follows:

Charge Passed (Coulombs)	Chloride Ion Penetrability
> 4,000	High
2,000 – 4,000	Moderate
1,000 – 2,000	Low
100 – 1,000	Very Low
< 100	Negligible

Figure 3 shows the results from a series of concretes of varying water to cement ratios (W/CM from 0.35 to 0.63) cast with three different cements, which were produced from the same Portland cement clinker. The use of Tercem 3000 significantly reduces the permeability compared with Type 10 Portland cement and generally produces performance that is equivalent to silica fume cement (Type 10E-SF).

Figure 3: Chloride Permeability of Concrete



5. Durability of Concrete with Tercem 3000™

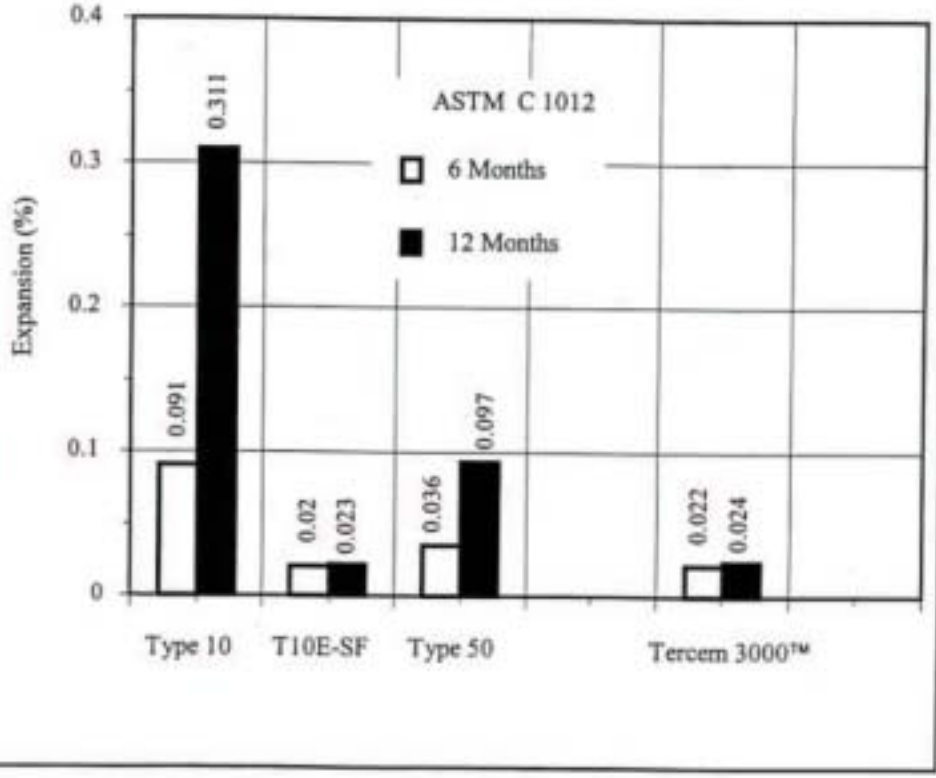
5.1 Resistance to Sulphate Attack

Tercem 3000™ cement provides excellence resistance to sulphate attack as demonstrated by its performance in ASTM C 1012 *Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.* Figure 4 shows test data for mortars cast with three different samples of Tercem 3000™ and for mortars cast with Type 10 cement and Type 10E-SF cement produced from the same clinker.

Tercem 3000™ cement shows equivalent performance to, a silica fume cement, (Type 10E-SF) with higher amounts of silica fume and meets the requirements of both the CSA Specification (CSA A3000-98 A362) and the ASTM Specification (ASTM C 1157) for high sulphate resistance.

The high sulphate resistance is attributed to the combined action of the silica fume and slag which, leads to a reduction in permeability and an increase in chemical resistance due to the consumption of calcium hydroxide by the pozzolanic reaction.

Figure 4: Results of Sulphate Resistance Tests



5.2 Resistance to Cycles of Freezing and Thawing

Laboratory testing using ASTM C 666 *Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing* indicates that air-entrained concrete produced with Tercem 3000™ cement has excellent resistance to cyclic freezing and thawing with durability factors in excess of 95% after 300 cycles. It is recommended that the minimum air contents and maximum spacing factors of the relevant CSA or ACI specifications be followed regardless of the cement type.

The scaling resistance of concrete exposed to cycles of freezing and thawing in the presence of de-icing salts is affected by both the quality of the concrete (e.g. W/CM) and the quality of the air-void system. Laboratory tests using ASTM C 672 Standard Test Method for Scaling Resistance of Concrete Surfaces to De-icing Chemicals indicate that concrete meeting the requirements of CSA A23.1 for air entrained concrete will have excellent scaling resistance when produces with Tercem 3000™ cement.

Additional testing carried out according to Norme Quebec NQ 2621-900 have also indicated an excellent scaling resistance with only 0.09 kg/m3 of material loss (limit of 0,50 kg/m3) at a cement content of 340 kg/m3.

5.3 Resistance to Alkali-Silica Reaction

The use of either, silica fume or slag, in concrete has been shown to reduce the risk of damage due to alkali-silica reaction. When these two materials are used together (i.e. in a ternary blended cement) there is a synergistic effect, with the combination showing a greater efficacy in terms of controlling expansion[1].

The ability of Tercem 3000™ to control ASR expansion has been tested using the concrete prism expansion test (CSA A23.2-14A) and the results are shown in Figures 5 and 6 for moderately reactive and highly reactive aggregates, respectively. In these tests the alkali content of the blended cement was raised to 1.25% equivalent sodium oxide (Na_2Oe) by adding NaOH to the mixing water. This is a somewhat more severe test condition than that prescribed in CSA, which only requires the Portland cement component to be raised to 1.25% Na_2Oe. Even with the additional alkali content (which results is a 12% increase in alkali over that specified in CSA), Tercem 3000 is effective in reducing expansion to below the CSA specified limit of 0.040% at 2 years with both reactive aggregates.

---

[1] Bleszynski, R.F., Thomas, M.D.A. and Hooton, R.D. "Use Of Ternary Blended Cements To Control ASR." Proceedings of the 11th International Conference on Alkali-Aggregate Reaction in Concrete, Quebec City, June 2000.

Figure 5 Expansion with Moderately-Reactive Aggregate

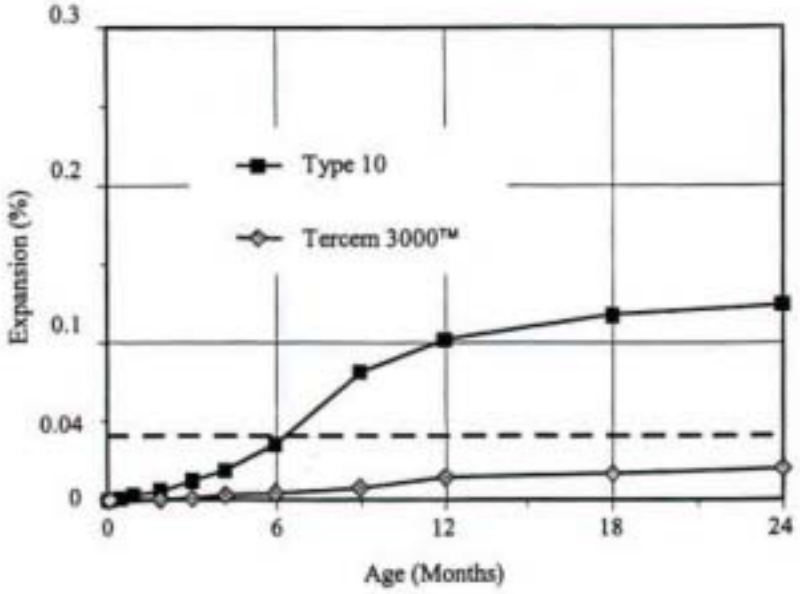
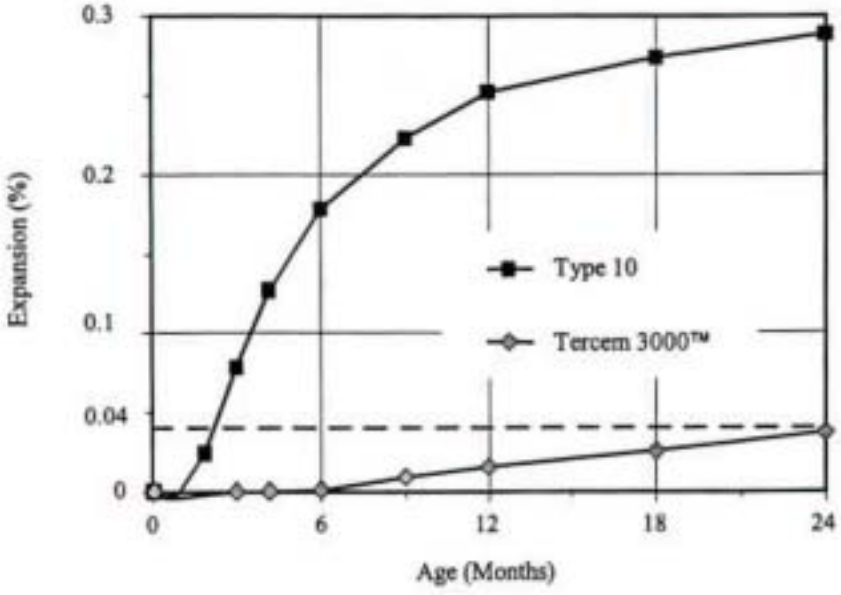


Figure 6 Expansion with Highly-Reactive Aggregate



The long-term performance of concrete containing a ternary blend of high-alkali cement, silica fume and slag in terms of controlling expansion with a highly reactive aggregate and resisting the action of salt scaling has been confirmed in a field exposure study. In this study, concrete beams and slabs produced with a highly reactive aggregate and high-alkali cement were exposed at an outdoors exposure site. After 10 years, the use of silica fume (3.5% replacement) and slag (25% replacement) was found to be the most effective measure tested in terms of controlling the expansion of beams and scaling of the slabs.

Although, Lafarge endorses the use of Tercem 3000™ cement with moderately reactive aggregates, the company does not recommend the use of Tercem 3000 with aggregates that are classified as highly reactive by the current edition of CSA A23.1, 27A - *Standard Practice to Identify Degree of Alkali-Reactivity of Aggregates and to Identify Measures to Avoid Deleterious Expansion in Concrete.* The procedures in the current edition of CSA A23.1 27A should be followed when using supplementary cementing materials (including blended cements) with potentially reactive aggregate.

Appendix 1

Physical Requirements of Blended Hydraulic Cement in CSA A362

& Comparative Performance of Tercem 3000™

	10E	20E	30E	40E	50E	Tercem 3000™
Fineness (maximum % retained on 45 µm sieve)	24.0	24.0	24.0	24.0	24.0	10.0
Autoclave expansion (max %)	0.8	0.8	0.8	0.8	0.8	0.045
Time of Set (minutes)						
Minimum	45	60	45	90	60	125
Maximum	480	480	250	480	480	
Strength (minimum MPa)						
1 Day	–	–	13.5	–	–	11.1
3 Days	14.5	14.5	24.0	8.5	14.5	23.7
7 Days	20.0	20.0	–	–	20.0	33.7
28 Days	26.5	26.5	–	25.0	26.5	48.9
Heat of Hydration (maximum kj/kg at 7 days)	–	300§	–	275	–	319
Sulphate Resistance (% maximum exp. at 6 months)	–	0.10§	–	–	0.05	0.037

§ Requirement of either heat of hydration (or both) shall be specified at the option of the purchaser

Appendix 2

Physical Requirements of Blended Hydraulic Cement in ASTM C 1157

& Comparative Performance of Tercem 3000™

	GU	HE	MS	HS	MH	LH	Tercem 3000™
Autoclave Expansion (maximum %)	0.8	0.8	0.8	0.8	0.8	0.8	0.045
Time of Set (minutes)							
Minimum	45	45	45	45	45	45	125
Maximum	420	420	420	420	420	420	
Strength (minimum MPa)							
1 day	–	10	–	–	–	–	11.1
3 days	10	17	10	5	5	–	23.7
7 days	17	–	17	10	10	5	33.7
28 days	–	–	–	17	–	17	48.9
Heat of Hydration (maximum kj/kg)							
7 days					290	250	319
28 days					–	290	
Mortar Bar Expansion (maximum % at 14 days)	0.020	0.020	0.020	0.020	0.020	0.020	0.003
Sulfate Resistance (maximum %)							
6 months			0.10	0.05			0.037
12 months			–	0.10			

ANNEX B

Letter from SDKLBB on optimization of Tercem concrete mix

1751, rue Richardson, bureau 2153, Montréal (Québec) H3K 1G6

DAIA | DESLAURIERS | KADANOFF
LECONTE | BRISEBOIS | BLAIS

Téléphone: 514-938-9095
Télécopieur: 514-938-9470
Courriel: [illegible]

Montreal, June 9, 2003

MRS. VOULI MAMFREDIS, ARCH.
STUDIO MAA

Subject : **MOUNTAIN EQUIPMENT COOP**
TYPE OF CONCRETE
OUR FILE: 020321

Madam,

At your request, we have examined the possibility of reducing the concrete thickness of the structural element knowing in advance that Tercem Concrete Mix would be used.

Our comments are:

1- Footing size would remain the same as the dimensions are determined by the load and the capacity of the soil;

2- Perimeter foundation wall: thickness is determined by the architectural wall. The type of concrete will not change anything;

3- Tunnel and basement foundation walls are already at their minimum thickness;

4- Concrete columns were oversized to insure the lateral stability of the roof and to provide sufficient space for the truss connection;

5- The upper floor structural slab was designed with 30 PMa (same as Tercem). Very few modifications can be implemented as the thickness of the slab is governed mostly by the punching near columns and the deflection (controlled by the span);

6- The thickness of the slab on grade was chosen to accommodate the system of piping, not in relation with the type of cement.

In conclusion, Tercem Concrete Mix is a good choice for a "green building", however little or no economy could have been made in the context of this project.

Yours truly,

François Deslauriers, Eng.
/dh

ANNEX C
Concrete test results

INSPEC - SOL INC.

COMPILATION OF CONCRETE TESTS RESULTS

CLIENT:	Broccolini Construction inc. / c/ o Mr. Nick, Iwanowski, Eng., fax (514) 737-2728	**CONTRACTOR:**	Broccolini
PROJECT:	Proposed Mountain Equipment Coop Store, North-East Corner of l'Acadie Boulevard and projected Beauharnois street, Montreal, Quebec	**PROJECT No.:** 92-B-6237	**SUPPLIER:** Lafarge

SAMPLING				TESTS ON FRESH CONCRETE					COMPRESSIVE STRENGTH (MPa)							IDENTIFICATION AND LOCATION
Set No.	Date		Tech.	% Air		Slump (mm)		Temp. (°C)	Specified Strength	Field Cure	7 Days	Note	28 Days	28 Days	Note	
	Month	Day		Specified	Measured	Specified	Measured									
1	October	17	R.D.	-	6.8	80±30	80	15	25		19.3	A/E	35.5	35.0	A/E	Exterior footing, line D-E and 3-4
2	October	21	E.D.	-	6.0	80±30	130*	16	25		17.8	A/E	31.9	32.7	A/E	Exterior footing, line K and 12-13
3	October	23	R.D.	-	3.4	80±20	90	14	25		21.0	A/E	34.9	33.1	A/E	Interior footing, line F4.1, E6 et F6
4	October	25	Y.C.	-	3.1	80±20	70	16	25		23.0	A/E	32.0	32.3	A/E	Foundation wall, line C.3-E et 4-8
5	October	30	S.O.	-	1.4	80±20	80	20	25		22.8	A/E	32.5	32.9	A/E	Foundation wall (tunnel), line J.7 between 7-8
6	November	12	S.B.	-	1.5	80±20	80	19	25		18.5	A/E	32.6	32.2	A/E	Foundation wall, line J-K and 15
7	November	19	R.D.	-	2.0	80±20	90	13	25		19.8	A/E	33.9	34.6	A/E	Foundation wall, line E-J.5 and 16-19
8	November	26	O.P.	-	2.0	80±20	100	18	30		23.8	A/E	39.6	40.4	A/E	Structural Slab, line J.5 and 15.5. Elevation 37 500
9	**December**	**10**	**R.M.**	**+**	**2.8**	**80±20**	**90**	**21**	**30**		**20.1**	**B/E**	32.1	33.5	A/E	**Column, line B and 1**
10	December	11	K.B.	-	2.6	80±20	90	22	30		23.0	A/E	39.4	39.5	A/E	Column, line F and 1
11	**December**	**13**	**R.M.**	**+**	**1.8**	**80±20**	**80**	**20**	**30**		**20.1**	**B/E**	33.2	34.0	A/E	**Structural Slab, 2nd floor, line B and 11**
12	December	13	R.M.	-	1.5	80±20	80	21	30		22.4	A/E	37.5	36.5	A/E	Structural Slab, 2nd floor line E and 14
13	**December**	**13**	**R.M.**	**+**	**2.0**	**80±20**	**90**	**19**	**30**		**19.6**	**B/E**	32.1	33.5	A/E	**Structural slab, 2nd floor line J and 12**
14	December	18	E.D.	-	2.1	80±20	80	24	30		23.7	A/E	36.7	37.9	A/E	Structural slab, 2nd floor, line F-J and 12.5-13.5
15	December	18	E.D.	-	2.0	80±20	80	19	30		22.0	A/E	39.1	38.0	A/E	Structural slab, 2nd floor, line D.5-E.5 and 11.5-12.5

REMARKS:

LEGEND

CONFORMITY:
A : Conform
B : Risk of non-conformity at 28 days
C : Does not conform at 28 days

TYPE OF CURE:
D : Field
E : Laboratory

All samples were made in molds having a diameter of 100 mm and a height of 200 mm.

Distribution List:
c.c. M. François Deslauriers, ing. / SDK, fax (514) 938-9470
c.c. M. Jacques McDonald / J. McDonald inc., fax (514) 381-8886
c.c. M. Richard Pagotto, ing. / Fiducie Immobilière MCM, fax (514) 381-8886

Verified by: Claude Marchesseault, T.P. Date: January 22, 2003

Canadian Standard Association
Certified Concrete Testing Laboratory

A.C.L.E.

INSPEC - SOL INC.

COMPILATION DES ESSAIS SUR LE BÉTON DE CIMENT

CLIENT:	Broccolini Construction inc. / c/ o Mr. Nick, Iwanowski, Eng., fax (514) 737-2728		ENTREPRENEUR: Broccolini
PROJET:	Proposed Mountain Equipment Coop Store, North-Est Corner of l'Acadie Boulevard and projected Beauhamois street, Montreal, Quebec	No. PROJET: 92-B-6237	FOURNISSEUR: Lafarge

ÉCHANTILLONNAGE				ESSAIS SUR BÉTON FRAIS					RÉSISTANCE EN COMPRESSION (MPa)						IDENTIFICATION ET LOCALISATION
Série No.	Date		Tech.	% Air		Affaissement (mm)		Temp. (oC)	Résistance spécifiée	7 jours	Note	28 jours	28 jours	Note	
	Mois	Jour		Spécifié	Mesuré	Spécifié	Mesuré								
16	December	18	E.D.	-	2.0	80±20	80	23	30	21.2	A/E	35.9	34.7	A/E	Structural slab, 2nd floor, line B-B.5 and 12-13.5
17	February	19	J.A.	-	2.9	80±20/ 150*	90/130*	20	25	29.6	A/E	44.2	43.7	A/E	Slab on grade, line J-K and 12-13
18	February	19	J.A.	-	2.5	80±20/ 150*	100/150*	19	25	28.6	A/E	40.8	40.9	A/E	Slab on grade, line E-F and 11-12
19	February	19	J.A.	-	3.0	80±20/ 150*	90/140*	21	25	27.9	A/E	42.0	40.5	A/E	Slab on grade, line F-J and 6-7
20	April	29	B.S.	5@6	5.5	30	30	18	32	31.9	A/E	41.5	41.5	A/E	Parking curb (see sketch on field report dated April 29, 03)

REMARQUES:
*After addition of superplastifier

LÉGENDE

CONFORMITÉ:
A : Résistance conforme
B : Risque de non conformité à 28 jours
C : Résistance non conforme à 28 jours

Tous les échantillons ont été fabriqués dans des moules de 100 mm de diamètre et 200 mm de hauteur.

Liste de distribution:
c.c. M. François Deslauriers, ing. / SDK, fax (514) 938-9470
c.c. M. Jacques McDonald / J. McDonald inc., fax (514) 381-8886
c.c. M. Richard Pagotto, ing. / Fiducie Immobilière MCM, fax (514) 381-8886

Vérifié par: Claude Marchesseault, T.P. Date: June 2, 2003

Association Canadienne de Normalisation
Laboratoire D'Essai de Béton Certifié

A.C.L.E.

FO-058.5MF / 04-02

ANNEX D
Concrete Mix Designs

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 152535
25MPa 20mm Tercem

Plant:	203 - St.- Laurent	Submitted to:	Brocolini
Job site:	Montréal		
Usage:			
Contract No:	Mountain Equipment Coop		

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L
Cement Cement #2 Mineral add. Min. add. #2	Lafarge Canada inc. - 00001	Tercem 3000 - TERCEM	252	82.20
Sand Sand #2 Sand #3	Sablière St.-Gabriel - 00225	Sable à béton - SAND	966	356.84
Stone 20 mm Stone 14 mm	Pavage Chenail - 00004 Pavage Chenail - 00004	BC 10-20mm - 1020LIM BC 5-14mm - 514MMLIM	406 610	145.83 218.75
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	158	158.00
Volume of air				40.00
TOTAL:			2392	1001.62

ADMIXTURES (ml/100 kg)

Water Redu.	Master Builders inc. - 00002	Pozzolith 210 - POZZ210	250.00	0.63
Air Entrain.	Master Builders inc. - 00002	M.B. Micro-air - MICROAIR	27.00	0.07
Retarder (1)	Master Builders inc. - 00002	Pozzolith 100XR - 100XR	57.00	0.14
TOTAL:	**(before fibers)**			1002.46

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers		-		Slump:	80±20mm
Met. fibers		-		Air content:	20 - 5 mm = N/A
		Cost:		Water/Cement:	0.63

Remarks:

Prepared by: Michel Drouin

Date: 2003-08-20

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 252535
25MPa 20mm Tercem Pompe

Plant:	203 - St.- Laurent	Submitted to:	Brocolini
Job site:	Montréal		
Usage:			
Contract No:	Mountain Equipment Coop		

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L
Cement Cement #2 Mineral add. Min. add. #2	Lafarge Canada inc. - 00001	Tercem 3000 - TERCEM	273	88.91
Sand Sand #2 Sand #3	Sablière St.-Gabriel - 00225	Sable à béton - SAND	947	349.98
Stone 20 mm Stone 14 mm	Pavage Chenail - 00004 Pavage Chenail - 00004	BC 10-20mm - 1020LIM BC 5-14mm - 514MMLIM	399 600	143.47 215.20
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	164	164.00
Volume of air				40.00
TOTAL:			2383	1001.56

ADMIXTURES (ml/100 kg)

Water Redu. Air Entrain. Retarder (1)	Master Builders inc. - 00002 Master Builders inc. - 00002 Master Builders inc. - 00002	Pozzolith 210 - POZZ210 M.B. Micro-air - MICROAIR Pozzolith 100XR - 100XR	250.00 25.00 60.00	0.68 0.07 0.16
TOTAL:	**(before fibers)**			1002.47

(I) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers Met. fibers		- -		Slump: Air content: Water/Cement:	80±20mm 20 - 5 mm = N/A 0.60
		Cost:			

Remarks:

Prepared by: Michel Desaulniers Date: 2003-08-20

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 253025

30MPa 14mm Pompe Tercem

Plant:	203 - St.- Laurent	Submitted to:	Brocolini
Job site:	Montréal		
Usage:			
Contract No:	Mountain Equipment Coop		

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L
Cement Cement #2 Mineral add. Min. add. #2	Lafarge Canada inc. - 00001	Tercem 3000 - TERCEM	324	105.68
Sand Sand #2 Sand #3	Sablière St.-Gabriel - 00225	Sable à béton - SAND	924	341.34
Stone 14 mm	Pavage Chenail - 00004	BC 5-14mm - 514MMLIM	1031	369.74
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	172	172.00
Volume of air				15.00
TOTAL:			2451	1003.76
ADMIXTURES (ml/100 kg)				
Water Redu.	Master Builders inc. - 00002	Pozzolith 210 - POZZ210	250.00	0.81
Retarder (1)	Master Builders inc. - 00002	Pozzolith 100XR - 100XR	87.00	0.28
TOTAL:	**(before fibers)**			1004.85

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers Met. fibers		- - Cost:		Slump: 80±20mm Air content: 14 - 5 mm = 1.5±1.0% Water/Cement: 0.53

Remarks:

Prepared by: Michel Drouin Date: 2003-08-20

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 253034

30MPa 20mm Air Pompe Tercem

Plant:	203 - St.- Laurent	Submitted to:	Brocolini
Job site:	Montréal		
Usage:			
Contract No:	Mountain Equipment Coop		

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L
Cement	Lafarge Canada inc. - 00001	Tercem 3000 - TERCEM	366	119.10
Cement #2				
Mineral add.				
Min. add. #2				
Sand	Sablière St.-Gabriel - 00225	Sable à béton - SAND	862	318.71
Sand #2				
Sand #3				
Stone 20 mm	Pavage Chenail - 00004	BC 10-20mm - 1020LIM	393	141.25
Stone 14 mm	Pavage Chenail - 00004	BC 5-14mm - 514MMLIM	591	211.88
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	160	160.00
Volume of air				50.00
TOTAL:			2372	1000.94

ADMIXTURES (ml/100 kg)

Water Redu.	Master Builders inc. - 00002	Pozzolith 210 - POZZ210	250.00	0.92
Air Entrain.	Master Builders inc. - 00002	M.B. Micro-air - MICROAIR	55.00	0.20
Retarder (1)	Master Builders inc. - 00002	Pozzolith 100XR - 100XR	110.00	0.40
TOTAL:	**(before fibers)**			1002.46

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers		-		Slump:	80±20mm
Met. fibers		-		Air content:	20 - 5 mm = 6.5±1.5%
		Cost:		Water/Cement:	0.44

Remarks:

Prepared by: Michel Drouin

Date: 2003-08-20

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 253035

30MPa 20mm Pompe

Plant:	203 - St.- Laurent	Submitted to:	Brocolini
Job site:	Montréal		
Usage:			
Contract No:	Mountain Equipment Coop		

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L
Cement Cement #2 Mineral add. Min. add. #2	Lafarge Canada inc. - 00001	Tercem 3000 - TERCEM	294	95.62
Sand Sand #2 Sand #3	Sablière St.-Gabriel - 00225	Sable à béton - SAND	934	345.33
Stone 20 mm Stone 14 mm	Pavage Chenail - 00004 Pavage Chenail - 00004	BC 10-20mm - 1020LIM BC 5-14mm - 514MMLIM	423 636	152.03 228.04
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	165	165.00
Volume of air				15.00
TOTAL:			2452	1001.02

ADMIXTURES (ml/100 kg)

Water Redu.	Master Builders inc. - 00002	Pozzolith 210 - POZZ210	250.00	0.74
Retarder (1)	Master Builders inc. - 00002	Pozzolith 100XR - 100XR	70.00	0.21
TOTAL:	**(before fibers)**			1001.97

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers Met. fibers		- -	Cost:		Slump: 80±20mm Air content: 20 - 5 mm = 1.5±1.0% Water/Cement: 0.56

Remarks:

Prepared by: Michel Drouin ing. Date: 2003-08-20

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 153034
30MPa 20mm Air Tercem

Plant:	203 - St.- Laurent	Submitted to:	Brocolini
Job site:	Montréal		
Usage:			
Contract No:	Mountain Equipment Coop		

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L
Cement Cement #2 Mineral add. Min. add. #2	Lafarge Canada inc. - 00001	Tercem 3000 - TERCEM	350	114.07
Sand Sand #2 Sand #3	Sablière St.-Gabriel - 00225	Sable à béton - SAND	781	288.49
Stone 20 mm Stone 14 mm	Pavage Chenail - 00004 Pavage Chenail - 00004	BC 10-20mm - 1020LIM BC 5-14mm - 514MMLIM	432 650	155.28 232.92
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	160	160.00
Volume of air				50.00
TOTAL:			2373	1000.76

ADMIXTURES (ml/100 kg)

Water Redu.	Master Builders inc. - 00002	Pozzolith 210 - POZZ210	250.00	0.88
Air Entrain.	Master Builders inc. - 00002	M.B. Micro-air - MICROAIR	50.00	0.18
Retarder (1)	Master Builders inc. - 00002	Pozzolith 100XR - 100XR	95.00	0.33
TOTAL:	**(before fibers)**			1002.15

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers		-		Slump:	80±20mm
Met. fibers		-		Air content:	20 - 5 mm = 6.5±1.5%
		Cost:		Water/Cement:	0.46

Remarks:

Prepared by: Michel Drouin ing. Date: 2003-08-20

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 253024

30MPa 14mm Air Pompe Tercem

Plant:	203 - St.- Laurent	Submitted to:	Brocolini
Job site:	Montréal		
Usage:			
Contract No:	Mountain Equipment Coop		

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L
Cement Cement #2 Mineral add. Min. add. #2	Lafarge Canada inc. - 00001	Tercem 3000 - TERCEM	376	122.46
Sand Sand #2 Sand #3	Sablière St.-Gabriel - 00225	Sable à béton - SAND	870	321.57
Stone 14 mm	Pavage Chenail - 00004	BC 5-14mm - 514MMLIM	954	342.07
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	165	165.00
Volume of air				50.00
TOTAL:			2365	1001.10

ADMIXTURES (ml/100 kg)

Water Redu.	Master Builders inc. - 00002	Pozzolith 210 - POZZ210	250.00	0.94
Air Entrain.	Master Builders inc. - 00002	M.B. Micro-air - MICROAIR	43.00	0.16
Retarder (1)	Master Builders inc. - 00002	Pozzolith 100XR - 100XR	110.00	0.41
TOTAL:	**(before fibers)**			1002.61

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers		-		Slump:	80±20mm
Met. fibers		-		Air content:	14 - 5 mm = 6.5±1.5
		Cost:		Water/Cement:	0.44

Remarks:

Prepared by: Michel Drouin ing. Date: 2003-08-20

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 253524

35MPa 14mm Air Pompe

Plant:	203 - St.- Laurent	Submitted to:	Brocolini
Job site:	Montréal		
Usage:			
Contract No:	Mountain Equipment Coop		

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L
Cement Cement #2 Mineral add. Min. add. #2	Lafarge Canada inc. - 00001	Tercem 3000 - TERCEM	412	134.20
Sand Sand #2 Sand #3	Sablière St.-Gabriel - 00225	Sable à béton - SAND	791	292.35
Stone 14 mm	Pavage Chenail - 00004	BC 5-14mm - 514MMLIM	989	354.61
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	170	170.00
Volume of air				50.00
TOTAL:			2362	1001.16
ADMIXTURES (ml/100 kg)				
Water Redu. Air Entrain. Retarder (1)	Master Builders inc. - 00002 Master Builders inc. - 00002 Master Builders inc. - 00002	Pozzolith 210 - POZZ210 M.B. Micro-air - MICROAIR Pozzolith 100XR - 100XR	199.68 57.00 75.00	0.82 0.23 0.31
TOTAL:	**(before fibers)**			1002.52

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers Met. fibers		- -		Slump: Air content:	80±20mm 14 - 5 mm = 6.5±1.5
		Cost:		Water/Cement:	0.41

Remarks:

Prepared by: Michel Drouin

Date: 2003-08-20

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 253525

35MPa 14mm Pompe Tercem

Plant:	203 - St.- Laurent	Submitted to:	Brocolini
Job site:	Montréal		
Usage:			
Contract No:	Mountain Equipment Coop		

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L
Cement Cement #2 Mineral add. Min. add. #2	Lafarge Canada inc. - 00001	Tercem 3000 - TERCEM	361	117.43
Sand Sand #2 Sand #3	Sablière St.-Gabriel - 00225	Sable à béton - SAND	874	322.84
Stone 14 mm	Pavage Chenail - 00004	BC 5-14mm - 514MMLIM	1038	372.32
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	173	173.00
Volume of air				15.00
TOTAL:			2446	1000.59
ADMIXTURES (ml/100 kg)				
Water Redu.	Master Builders inc. - 00002	Pozzolith 210 - POZZ210	250.00	0.90
Retarder (1)	Master Builders inc. - 00002	Pozzolith 100XR - 100XR	100.00	0.36
TOTAL:	**(before fibers)**			1001.85

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers Met. fibers		- -	Cost:	Slump: Air content: Water/Cement:	80±20mm 14 - 5 mm = 1.5±1.0% 0.48

Remarks:

Prepared by: Michel Drouin ing. Date: 2003-08-20

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 353024
30MPa 14mm Air SPa Tercem

Plant:	203 - St.- Laurent	Submitted to:	Brocolini
Job site:	Montréal		
Usage:			
Contract No:	Mountain Equipment Coop		

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L
Cement Cement #2 Mineral add. Min. add. #2	Lafarge Canada inc. - 00001	Tercem 3000 - TERCEM	361	117.43
Sand Sand #2 Sand #3	Sablière St.-Gabriel - 00225	Sable à béton - SAND	802	296.26
Stone 14 mm	Pavage Chenail - 00004	BC 5-14mm - 514MMLIM	1034	370.85
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	165	165.00
Volume of air				50.00
TOTAL:			2362	999.54
ADMIXTURES (ml/100 kg)				
Water Redu.	Master Builders inc. - 00002	Pozzolith 210 - POZZ210	159.74	0.58
Air Entrain.	Master Builders inc. - 00002	M.B. Micro-air - MICROAIR	58.00	0.21
Retarder (1)	Master Builders inc. - 00002	Pozzolith 100XR - 100XR	100.00	0.36
Super-Truck	Master Builders inc. - 00002	Conchem SPN - SPN2	464.10	1.68
TOTAL:	**(before fibers)**			1002.37

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers Met. fibers		- -	Cost:		Slump: 80 =>150±30mm Air content: 14 - 5 mm = 6.5±1.5 Water/Cement: 0.46

Remarks:

Prepared by: Michel Drouin

Date: 2003-08-20

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 712049

FutureCrete 25-20 FA15kg TERC

Plant: 203 - St.- Laurent Submitted to:
Job site:
Usage:
Contract No:

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L	COST
Cement Cement #2 Mineral add. Min. add. #2	Lafarge Canada inc. - 00001	Tercem 3000 - TERCEM	299	97.30	
Sand Sand #2 Sand #3	Sablière St.-Gabriel - 00225	Sable à béton - SAND	965	356.45	
Stone 20 mm Stone 14 mm	Pavage Chenail - 00004 Pavage Chenail - 00004	BC 10-20mm - 1020LIM BC 5-14mm - 514MMLIM	522 428	187.53 153.43	
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	164	164.00	
Volume of air				40.00	
TOTAL:			2378	998.71	

ADMIXTURES (ml/100 kg)

Water Redu.	Master Builders inc. - 00002	Pozzolith 210 - POZZ210	199.68	0.60	
Air Entrain.	Master Builders inc. - 00002	M.B. Micro-air - MICROAIR	33.00	0.10	
Retarder (1)	Master Builders inc. - 00002	Pozzolith 100XR - 100XR	67.00	0.20	
Super-Plant	Master Builders inc. - 00002	Conchem SPN - SPN	310.00	0.93	
Super-Truck	Master Builders inc. - 00002	Conchem SPN - SPN2	560.30	1.68	
TOTAL:	**(before fibers)**			1002.22	

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers Met. fibers	Trefil Arbed - 00052	- Tabix 1.3/50 - 29691 Cost:	15.00	Slump: 80 =>150±30mm Air content: 20 - 5 mm = N/A Water/Cement: 0.55

Remarks:

Prepared by: Michel Desaulniers Date: 2003-10-14

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐ Total cost:

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 112535
25MPa 20mm

Plant: 203 - St.- Laurent Submitted to:
Job site:
Usage:
Contract No:

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L
Cement Cement #2 Mineral add. Min. add. #2	Lafarge Canada inc. - 00001	Ciment T-10 - TYPE10	284	90.17
Sand Sand #2 Sand #3	Sablière St.-Gabriel - 00225	Sable à béton - SAND	950	351.21
Stone 20 mm Stone 14 mm	Pavage Chenail - 00004 Pavage Chenail - 00004	BC 10-20mm - 1020LIM BC 5-14mm - 514MMLIM	401 602	143.91 215.87
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	160	160.00
Volume of air				40.00
TOTAL:			2397	1001.16

ADMIXTURES (ml/100 kg)

Water Redu.	Master Builders inc. - 00002	Pozzolith 210 - POZZ210	250.00	0.71
Air Entrain.	Master Builders inc. - 00002	M.B. Micro-air - MICROAIR	27.00	0.08
Retarder (1)	Master Builders inc. - 00002	Pozzolith 100XR - 100XR	60.00	0.17
TOTAL:	**(before fibers)**			1002.12

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers Met. fibers		- -		Slump: 80±20mm Air content: 20 - 5 mm = 1.5±1.0% Water/Cement: 0.56
		Cost:		

Remarks:

Prepared by: Michel Drouin ing. Date: 2003-08-20

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 212535

25MPa 20mm Pompe

Plant: 203 - St.- Laurent Submitted to:
Job site:
Usage:
Contract No:

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L
Cement Cement #2 Mineral add. Min. add. #2	Lafarge Canada inc. - 00001	Ciment T-10 - TYPE10	273	86.83
Sand Sand #2 Sand #3	Sablière St.-Gabriel - 00225	Sable à béton - SAND	952	351.75
Stone 20 mm Stone 14 mm	Pavage Chenail - 00004 Pavage Chenail - 00004	BC 10-20mm - 1020LIM BC 5-14mm - 514MMLIM	403 606	144.80 217.20
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	161	161.00
Volume of air				40.00
TOTAL:			2395	1001.58

ADMIXTURES (ml/100 kg)

Water Redu. Air Entrain. Retarder (1)	Master Builders inc. - 00002 Master Builders inc. - 00002 Master Builders inc. - 00002	Pozzolith 210 - POZZ210 M.B. Micro-air - MICROAIR Pozzolith 100XR - 100XR	250.00 25.00 60.00	0.68 0.07 0.16
TOTAL:	**(before fibers)**			1002.49

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers Met. fibers		- -		Slump: 80±20mm Air content: 20 - 5 mm = N/A Water/Cement: 0.59
		Cost:		

Remarks:

Prepared by: Michel Drouin ing. Date: 2003-08-20

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 213025

30MPa 14mm Pompe

Plant:	203 - St.- Laurent	Submitted to:	
Job site:			
Usage:			
Contract No:			

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L
Cement Cement #2 Mineral add. Min. add. #2	Lafarge Canada inc. - 00001	Ciment T-10 - TYPE10	331	105.20
Sand Sand #2 Sand #3	Sablière St.-Gabriel - 00225	Sable à béton - SAND	918	339.38
Stone 14 mm	Pavage Chenail - 00004	BC 5-14mm - 514MMLIM	1031	369.74
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	172	172.00
Volume of air				15.00
TOTAL:			2452	1001.32

ADMIXTURES (ml/100 kg)

Water Redu.	Master Builders inc. - 00002	Pozzolith 210 - POZZ210	250.00	0.83
Retarder (1)	Master Builders inc. - 00002	Pozzolith 100XR - 100XR	87.00	0.29
TOTAL:	**(before fibers)**			1002.44

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers Met. fibers		- -		Slump: 80±20mm Air content: 14 - 5 mm = 1.5±1.0% Water/Cement: 0.52
		Cost:		

Remarks:

Prepared by: Michel Drouin ing. Date: 2003-08-20

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 213035

30MPa 20mm Pompe

Plant:	203 - St.- Laurent	Submitted to:	
Job site:			
Usage:			
Contract No:			

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L
Cement	Lafarge Canada inc. - 00001	Ciment T-10 - TYPE10	315	100.19
Cement #2				
Mineral add.				
Min. add. #2				
Sand	Sablière St.-Gabriel - 00225	Sable à béton - SAND	971	358.88
Sand #2				
Sand #3				
Stone 20 mm	Pavage Chenail - 00004	BC 10-20mm - 1020LIM	404	144.94
Stone 14 mm	Pavage Chenail - 00004	BC 5-14mm - 514MMLIM	606	217.42
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	165	165.00
Volume of air				15.00
TOTAL:			2461	1001.43

ADMIXTURES (ml/100 kg)

Water Redu.	Master Builders inc. - 00002	Pozzolith 210 - POZZ210	250.00	0.79
Retarder (1)	Master Builders inc. - 00002	Pozzolith 100XR - 100XR	70.00	0.22
TOTAL:	**(before fibers)**			1002.44

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers		-		Slump: 80±20mm
Met. fibers		-		Air content: 20 - 5 mm = 1.5±1.0%
		Cost:		Water/Cement: 0.52

Remarks:

Prepared by: Michel Desaulniers Date: 2003-08-20

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 213034
30MPa 20mm Air Pompe

Plant:	203 - St.- Laurent	Submitted to:	
Job site:			
Usage:			
Contract No:			

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L
Cement Cement #2 Mineral add. Min. add. #2	Lafarge Canada inc. - 00001	Ciment T-10 - TYPE10	368	116.89
Sand Sand #2 Sand #3	Sablière St.-Gabriel - 00225	Sable à béton - SAND	856	316.21
Stone 20 mm Stone 14 mm	Pavage Chenail - 00004 Pavage Chenail - 00004	BC 10-20mm - 1020LIM BC 5-14mm - 514MMLIM	401 602	143.91 215.87
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	158	158.00
Volume of air				50.00
TOTAL:			2385	1000.88

ADMIXTURES (ml/100 kg)

Water Redu.	Master Builders inc. - 00002	Pozzolith 210 - POZZ210	250.00	0.92
Air Entrain.	Master Builders inc. - 00002	M.B. Micro-air - MICROAIR	67.00	0.25
Retarder (1)	Master Builders inc. - 00002	Pozzolith 100XR - 100XR	110.00	0.40
TOTAL:	**(before fibers)**			1002.45

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers		-		Slump: 80±20mm
Met. fibers		-		Air content: 20 - 5 mm = 6.5±1.5%
		Cost:		Water/Cement: 0.43

Remarks:

Prepared by: Michel Drouin

Date: 2003-08-20

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 113034
30MPa 20mm Air F1-C3

Plant: 203 - St.- Laurent Submitted to:
Job site:
Usage:
Contract No:

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L
Cement Cement #2 Mineral add. Min. add. #2	Lafarge Canada inc. - 00001	Ciment T-10 - TYPE10	357	113.55
Sand Sand #2 Sand #3	Sablière St.-Gabriel - 00225	Sable à béton - SAND	780	288.23
Stone 20 mm Stone 14 mm	Pavage Chenail - 00004 Pavage Chenail - 00004	BC 10-20mm - 1020LIM BC 5-14mm - 514MMLIM	434 651	155.72 233.58
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	160	160.00
Volume of air				50.00
TOTAL:			2382	1001.08

ADMIXTURES (ml/100 kg)

Water Redu. Air Entrain. Retarder (1)	Master Builders inc. - 00002 Master Builders inc. - 00002 Master Builders inc. - 00002	Pozzolith 210 - POZZ210 M.B. Micro-air - MICROAIR Pozzolith 100XR - 100XR	250.00 62.00 75.00	0.89 0.22 0.27
TOTAL:	**(before fibers)**			1002.46

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers Met. fibers		- -		Slump: 80±20mm Air content: 20 - 5 mm = 6.5±1.5%
		Cost:		Water/Cement: 0.45

Remarks:

Prepared by: Michel Drouin ing. Date: 2003-08-20

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 213024
30MPa 14mm Air Pompe

Plant: 203 - St.- Laurent Submitted to:
Job site:
Usage:
Contract No:

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L
Cement Cement #2 Mineral add. Min. add. #2	Lafarge Canada inc. - 00001	Ciment T-10 - TYPE10	383	121.90
Sand Sand #2 Sand #3	Sablière St.-Gabriel - 00225	Sable à béton - SAND	871	321.90
Stone 14 mm	Pavage Chenail - 00004	BC 5-14mm - 514MMLIM	954	342.07
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	165	165.00
Volume of air				50.00
TOTAL:			2373	1000.87
ADMIXTURES (ml/100 kg)				
Water Redu. Air Entrain. Retarder (1)	Master Builders inc. - 00002 Master Builders inc. - 00002 Master Builders inc. - 00002	Pozzolith 210 - POZZ210 M.B. Micro-air - MICROAIR Pozzolith 100XR - 100XR	250.00 52.00 110.00	0.96 0.20 0.42
TOTAL:	**(before fibers)**			1002.45

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers Met. fibers		- -		Slump: Air content: Water/Cement:	80±20mm 14 - 5 mm = 6.5±1.5 0.43
		Cost:			

Remarks:

Prepared by: Michel Drouin ing. Date: 2003-08-20

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 213524
35MPa 14mm Air Pompe

Plant:	203 - St.- Laurent	Submitted to:	
Job site:			
Usage:			
Contract No:			

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L
Cement Cement #2 Mineral add. Min. add. #2	Lafarge Canada inc. - 00001	Ciment T-10 - TYPE10	452	143.61
Sand Sand #2 Sand #3	Sablière St.-Gabriel - 00225	Sable à béton - SAND	768	283.81
Stone 14 mm	Pavage Chenail - 00004	BC 5-14mm - 514MMLIM	985	353.14
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	170	170.00
Volume of air				50.00
TOTAL:			2375	1000.56

ADMIXTURES (ml/100 kg)

Water Redu.	Master Builders inc. - 00002	Pozzolith 210 - POZZ210	250.00	1.13
Air Entrain.	Master Builders inc. - 00002	M.B. Micro-air - MICROAIR	60.00	0.27
Retarder (1)	Master Builders inc. - 00002	Pozzolith 100XR - 100XR	132.00	0.60
TOTAL:	**(before fibers)**			1002.56

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers		-		Slump:	80±20mm
Met. fibers		-		Air content:	14 - 5 mm = 6.5±1.5
		Cost:		Water/Cement:	0.38

Remarks:

Prepared by: Michel Drouin ing. Date: 2003-08-20

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 213525

35MPa 14mm Pompe

Plant:	203 - St.- Laurent	Submitted to:	
Job site:			
Usage:			
Contract No:			

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L
Cement Cement #2 Mineral add. Min. add. #2	Lafarge Canada inc. - 00001	Ciment T-10 - TYPE10	368	116.89
Sand Sand #2 Sand #3	Sablière St.-Gabriel - 00225	Sable à béton - SAND	877	324.00
Stone 14 mm	Pavage Chenail - 00004	BC 5-14mm - 514MMLIM	1038	372.32
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	173	173.00
Volume of air				15.00
TOTAL:			2456	1001.21

ADMIXTURES (ml/100 kg)

Water Redu.	Master Builders inc. - 00002	Pozzolith 210 - POZZ210	250.00	0.92
Retarder (1)	Master Builders inc. - 00002	Pozzolith 100XR - 100XR	100.00	0.37
TOTAL:	**(before fibers)**			1002.50

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers Met. fibers		- -		Slump: 80±20mm Air content: 14 - 5 mm = 1.5±1.0% Water/Cement: 0.47
		Cost:		

Remarks:

Prepared by: Michel Drouin ing. Date: 2003-08-20

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 313024
30MPa 14mm Air SPa

Plant:	203 - St.- Laurent	Submitted to:	
Job site:			
Usage:			
Contract No:			

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L
Cement Cement #2 Mineral add. Min. add. #2	Lafarge Canada inc. - 00001	Ciment T-10 - TYPE10	368	116.89
Sand Sand #2 Sand #3	Sablière St.-Gabriel - 00225	Sable à béton - SAND	799	295.22
Stone 14 mm	Pavage Chenail - 00004	BC 5-14mm - 514MMLIM	1038	372.32
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	165	165.00
Volume of air				50.00
TOTAL:			2370	999.43
ADMIXTURES (ml/100 kg)				
Water Redu.	Master Builders inc. - 00002	Pozzolith 210 - POZZ210	250.00	0.92
Air Entrain.	Master Builders inc. - 00002	M.B. Micro-air - MICROAIR	53.00	0.20
Retarder (1)	Master Builders inc. - 00002	Pozzolith 100XR - 100XR	100.00	0.37
Super-Truck	Master Builders inc. - 00002	Conchem SPN - SPN2	501.15	1.84
TOTAL:	**(before fibers)**			1002.76

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers		-		Slump:	80 =>150±30mm
Met. fibers		-		Air content:	14 - 5 mm = 6.5±1.5
		Cost:		Water/Cement:	0.45

Remarks:

Prepared by: Michel Drouin ing. Date: 2003-08-20

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐

Approved by: _____ Date: _____

LAFARGE NORTH AMERICA Lafarge Canada inc. Québec

Mix #: 712510

FutureCrete FA 25-20 15kg

Plant: 203 - St.- Laurent Submitted to:
Job site:
Usage:
Contract No:

MIX DESIGN COMPONENT (1 CUBIC METER)

COMPONENTS	SUPPLIER	TYPE / NAME	QTY kg/m³	VOLUME L	COST
Cement Cement #2 Mineral add. Min. add. #2	Lafarge Canada inc. - 00001	Ciment T-10 - TYPE10	305	96.85	
Sand Sand #2 Sand #3	Sablière St.-Gabriel - 00225	Sable à béton - SAND	967	357.20	
Stone 20 mm Stone 14 mm	Pavage Chenail - 00004 Pavage Chenail - 00004	BC 10-20mm - 1020LIM BC 5-14mm - 514MMLIM	522 428	187.53 153.43	
Water(L)	Municipal Aqueduct - 00001	Eau de gâchage du béton	164	164.00	
Volume of air				40.00	
TOTAL:			2386	999.01	

ADMIXTURES (ml/100 kg)

Water Redu.	Master Builders inc. - 00002	Pozzolith 210 - POZZ210	199.68	0.61	
Air Entrain.	Master Builders inc. - 00002	M.B. Micro-air - MICROAIR	33.00	0.10	
Retarder (1)	Master Builders inc. - 00002	Pozzolith 100XR - 100XR	67.00	0.20	
Super-Plant	Master Builders inc. - 00002	Conchem SPN - SPN	310.00	0.95	
Super-Truck	Master Builders inc. - 00002	Conchem SPN - SPN2	560.30	1.71	
TOTAL:	**(before fibers)**			1002.58	

(1) Applicable by warm weather only (> 25° C) or as per customer's request.

Synth. fibers Met. fibers	Trefil Arbed - 00052	- Tabix 1.3/50 - 29691 Cost:	15.00	Slump: 80 =>150±30mm Air content: 20 - 5 mm = N/A Water/Cement: 0.54

Remarks:

Prepared by: Michel Drouin ing. Date: 2003-10-14

PLEASE COMPLETE AND RETURN

Mix submitted by Lafarge Inc. Accepted ☐ Refused ☐ Total cost:

Approved by: _____ Date: _____