Use of EcoSmart™ Concrete

In York University Computer Science Building
Toronto, Ontario

April, 2001

Busby + Associates Architects

TABLE OF CONTENTS

1.0 INTRODUCTION

This report was commissioned by the GVRD Ecomart Steering Committee as part of the EcoSmart™ Concrete Project. The EcoSmart™ Concrete Project is funded by the Federal Climate Change Action Fund-TEAM Program as well as private industry and other government partners. The scope of this study is to record the impacts of using EcoSmart™ concrete in the construction of York University Computer Science Building in Toronto Ontario as a means of furthering awareness and understanding of EcoSmart™ concrete and the benefits and challenges of the technology.

1.1 DEFINITIONS

EcoSmart™ concrete is produced by replacing cement with a maximum percentage of supplementary cementing materials (SCMs) such ash natural pozzolans, blast furnace slag and flyash. In this project, the SCM used was flyash, a by-product from coal-fired power plants. Two classifications of flyash are produced, according to the type of coal used. Anthracite and bituminous coal produces flyash classified as Type F. Type C flyash is produced by burning lignite or sub-bituminous coal. Of these, Class C flyash can undergo a hydration reaction due to its high lime content. For sulfate environments, only Type F flyash will be permitted.

1.2 HIGHLIGHTS

- **Aesthetic Appeal –** Incorporating fly ash in the concrete mix produced a high quality, warm color, smoother and denser finished concrete satisfying the architect's aesthetic expectations at no extra cost**.**

- **Environmental Impact –** The concrete manufactured for the York University Computer Science building reduced CO2 by approximately 50% over a conventional, all-cement concrete mix.

- **Strength Development** - Contrary to the slower setting times predicted for EcoSmart™ concrete use, the EcoSmart™ concrete mix used in York University on average, cured faster than a typical all cement mix. The concrete was finished and cured successfully at -10°C under normal winter construction practices.

- **Workability** - The high volume fly ash mixes were found to be easier to place, pump and vibrate than conventional mixes. Even with less water in the mix, the mechanical properties of the fly ash enhanced the slump and flow of the concrete making the mix more workable.

- **Future Use** - The contractors concluded that in another project similar to York University, they would feel confident setting a goal of at least 50% fly ash content for the EcoSmart™ concrete mix. The project team encourages the future use of EcoSmart™ concrete for the simplicity of the technology, low initial cost, high durability and high environmental friendliness of the product.

FIGURE 1.0.1
MODEL PHOTO

2.0 THE PROJECT

2.1 PROJECT STATISTICS

Design	1998-1999
Construction	2000-2001
Floor to floor height	3.5 m
Number of Storeys	3
Cost	$17.5 M
Building Area	9,500sq.m
Concrete Used	5,000 c.m

2.2 PROJECT TEAM

Client	York University, *Toronto, ON.*
Architect	Busby + Associates Architects, *Vancouver, B.C.*
	Van Nostrand di Castri Architects, *Toronto, ON.*
Structural Engineer	Yolles Partnership, *Toronto, ON.*
Mechanical Engineer	Keen Engineering, *North Vancouver, B.C.*
Electrical Engineer	Carinci Burt Rogers, *Toronto, ON.*
Environmental Consultants	RWDI , *Toronto, ON.*
Costing Consultant	Hanscomb Consultats, *Toronto, ON.*
Contractor	Ellis Don Construction, *Toronto, ON.*
Material Engineer	Davroc & Associates, *Brampton, ON.*
Ready-Mix Supplier	Ontario Ready-Mix, *Etobicoke, ON.*
Concrete Placer	Forma-Con Construction, *Toronto,ON.*
Cement Supplier	Essroc Italcementi Group, *Mississauga, ON.*
Flyash Supplier	Lafarge Canada, *Stoney Creek, ON.*

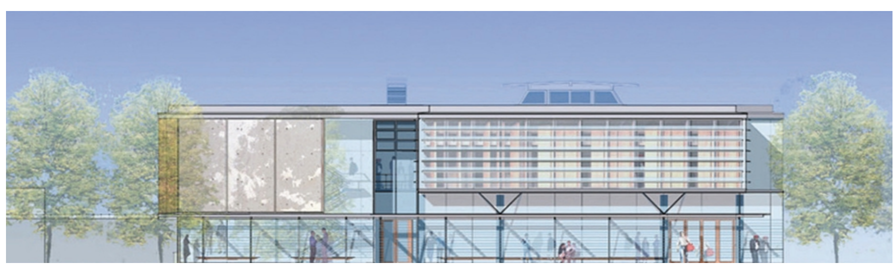

FIGURE 2.0.1
SOUTH ELEVATION

FIGURE 2.0.2
WEST ELEVATION

2.3 OVERVIEW

York University is a 1970's era campus that has grown to become one of Canada's larger universities, with over 45,000 students. Responding to a surge in enrolment pressure, in 1998 they commissioned Busby + Associates Architects, in joint venture with Van Nostrand Dicastri Architects, to design a new dedicated Computer Science facility.

York University directed the team to design a warm, open and welcoming facility that would be simple and flexible enough to accommodate unpredictable changing technology. York's commitment to environmental sustainability led to a further directive: the development of the first "green" university building in Ontario. Busby & Associates Architects had at this time an extensive portfolio of "green" projects in the West Coast. This project provided the opportunity to demonstrate that a "green" approach is valid in a cold weather climate.

The "green" design elements are both simple and complex. The fundamental approach is to design a "cold" climate, highly insulated building that capitalizes on solar gain and heat absorption in an exposed structure. The building must also have the capability of performing as a naturally ventilated "tropical" structure. The hot climate design incorporates a central atrium to capture heat stratification opportunities, thermal "chimneys" on the roof, and a large component of operable perimeter glazing that maximizes free cooling in spring and fall and night time "flushing" in the summer. The result is energy consumption calculated to be less than 50% of comparable buildings.

In addition to a very aggressive operating energy conservation agenda, building materials were also carefully selected for low embodied energy and reduced construction waste which included the specification of high volume fly ash for the majority of the building's concrete elements. Overall, features of the building reflect the design team's commitment to environmental sustainability, energy conservation, reduced negative global impact and conscious recycling of materials.

3.0 ECOSMART™ CONCRETE USAGE

EcoSmart™ concrete using recycled fly-ash was used for all cast-in-place concrete components of the building. Exposed thermal mass to offset peak heating and cooling loads required that all interior floor slabs, ceilings, stairs and 95% of interior walls and columns to be exposed concrete.

FIGURE 2.3.1
BUILDING SECTION

Although the project specified the use of flyash, the concrete industry in Ontario was not as supportive in its application. It is worth mentioning that the cement industry in Ontario has a significant investment in marketing slag. The Stoney Creek grinding facility is a product of a joint venture by the 3 cement majors in the area: Lafarge, St. Lawrence and Blue Circle. It is in their commercial interest to promote slag over flyash. The concrete manufacturer Lafarge Canada was not interested in providing concrete with 50% flyash because the project was not large enough. But Toronto-based Ontario Ready-Mix was interested and successfully obtained flyash from Lafarge Great Lakes in Atikokan, Thunder Bay. Approximately 385 cu. m. of Type C fly-ash was supplied in bulk quantities to avoid the intensive labor associated with the use of fly ash delivered in bags. Approximately 5000 cu. m. of concrete was used during construction. The decision to use flyash in replacement of 50% cement averaged for all cast-in-place concrete used in this project, resulted in the reduction of approximately 850 tonnes of CO2 emissions.

3.1 GOALS

The environmental impact of cement manufacture is significant; each tonne of cement produced releases .9 tonnes of CO2 into the environment. About 50-60 million tons of flyash are generated per year of which about 10% is consumed by the cement and concrete industry. Overall, only about 27% of the flyash produced by the combustion of coal is currently reused or recycled, while the remainder is disposed in landfills. A great potential exists to reduce the concrete industry's contributions to greenhouse gases and alleviate a flyash disposal problem through the reduction in cement consumption.

Consistent with the "green" agenda specified for this project, the design team of Busby + Associates in joint venture with Van Nostrand di Castri Architects specified the use of 50% flyash replacement for all cast-in-place concrete. Although flyash offers environmental advantages, it also improves the performance and quality of concrete. Flyash affects the plastic properties of concrete by improving workability, reducing water demand, reducing segregation and bleeding, and lowering heat of hydration. Flyash increases strength, reduces permeability, reduces corrosion of reinforcing steel, increases sulphate resistance, and reduces alkali-aggregate reaction. Additionally, the non technical benefits of high volume flyash also includes less cost than cement, more attractive colour and denser finish concrete.

3.2 CONCRETE REQUIREMENTS

FIGURE 3.0.1
CONSTRUCTION, JUNE, 2000

Component	Min 28/56 Day Strength mPa	Max Slump mm	Fly Ash Content %	Max Size Aggregate mm	Air Content %	Exp. Class.
Footings	25	80	50	20		
Foundation Walls/Shear Walls	30	80	50	20		
Foundation Walls exposed to freezing & thawing	30	80	50	20	4-7	F2
Walls Above Grade	25	80	50	20	-	
Columns	30	80	50	20		
Columns exposed to freezing & thawing	30	80	50	20	4-7	F2
Suspended Slabs, Beams	25	80	50	20		-
Exterior Slab on Grade *	32	70	0	20	5-8	C2
Interior Slab on Grade	25	40	50	20	-	

** & other concrete exposed to de-icing salts including adjacent walls & footings*

TABLE 3.2.1
CONCRETE REQUIREMENTS

3.3 TYPICAL CONCRETE MIX DESIGNS

Component	Units kg/m3	York
Stone (20mm)	kg/m3	1110
Sand	kg/m3	830
Cement	kg/m3	170
Fly Ash	kg/m3	170
Total Cementitious	kg/m3	340
Water	l/m3	135
water/cementitious ratio		0.40
fly ash/cementitious ratio		0.50
Slump	mm	80
Water Reducer	ml/per 100 kg	250
Recommended 56 day strength	mPa	30

TABLE 3.3.1
30 MPA 50% FLYASH / 50% CEMENT MIX

Component	Units kg/m3	York
Stone (20mm)	kg/m3	1090
Sand	kg/m3	780
Cement	kg/m3	320
Fly Ash	kg/m3	0
Total Cementitious	kg/m3	320
Water	l/m3	142
water/cementitious ratio		0.44
fly ash/cementitious ratio		0.00
Slump	mm	80
Air		6-8 %
Water Reducer	ml/per 100 kg	250
Recommended 56 day strength	mPa	32

TABLE 3.3.2
32 MPA 6% AIR

Component	Units kg/m3	York
Stone (20mm)	kg/m3	1130
Sand	kg/m3	855
Cement	kg/m3	150
Fly Ash	kg/m3	150
Total Cementitious	kg/m3	300
Water	l/m3	135
water/cementitious ratio		0.45
fly ash/cementitious ratio		0.50
Slump	mm	80
Water Reducer	ml/per 100 kg	250
Recommended 28 day strength	mPa	25

TABLE 3.3.3
25MPA 50% FLYASH / 50% CEMENT

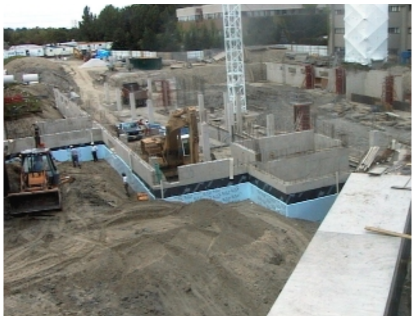

FIGURE3.0.2
CONSTRUCTION, JULY, 2000

Component	Units kg/m3	York
Stone (20mm)	kg/m3	1130
Sand	kg/m3	922
Cement	kg/m3	120
Fly Ash	kg/m3	120
Total Cementitious	kg/m3	240
Water	l/m3	135
water/cementitious ratio		0.56
fly ash/cementitious ratio		0.50
Slump	mm	80
Water Reducer	ml/per 100 kg	250
Recommended 28 day strength	mPa	20

TABLE 3.3.4
20MPA 50% FLYASH / 50% CEMENT

3.4 CHRONOLOGY

Construction began in mid-May 2000 with outside temperatures ranging from 6°C to 10°C. Foundation walls were placed in June. Slab on grade was in place early August. Suspended slabs and walls above grade were poured between late August to December. During the peak of summer, when outside temperatures were as high as 25°C the contractors had to keep the concrete damp between 48 to 72 hours after it was poured. The roof slab was placed in mid-December during outside temperatures as low as -10°C.

3.5 FINDINGS

- QUALITY OF FLYASH - Calcium content in flyash governs its ability to provide high early strength, which aids in construction sequencing. The higher calcium contents of Type C flyash are able to provide primary cementing action as opposed to the secondary cementing action provided by Type F. The higher carbon contents in Type C flyash makes air entrainment difficult as carbon absorbs air-entraining agents. For this reason, flyash use was completely avoided for air entrained concrete mixes designed for areas subject to freezing and thawing typically an F2 Classification. As the Flyash C is a pozzolan and reacts with the CaOH in hydrated cement, efflorescence should be a non-issue as the structure matures. However, during early hardening and in thick placements where bleeding was more prevalent, the presence of efflorescence was noticed which was then washed off with a dilute acid. (Note that with the high volume flyash, bleed water becomes more evident as the initial aluminate gelling phase of the cement is reduced on a unit volume basis allowing more water that is uncombined to be free. This free water and bleeding becomes the transport mechanism for CaOH salts which became visible as described) See Appendix A for Flyash Type C Chemical Analysis.

- QUALITY OF CEMENT - C3A or TriCalcium Aluminate. is one of the 4 major Bogue constituents making up cement. High alkali or C3A common in Ontario cement was supplied for this project. Cement with a higher C3A content (above 10%) allows for a higher ultimate strength in 7 - 28 days when combined with flyash or slag.

30MPA TYPICAL
COMPRESSIVE STRENGTHS

1 Day Strength	16.2 Mpa
3 Day Strength	28.6 Mpa
7 Day Strength	36.2 Mpa
28 Day Strength	44.8 Mpa
56 Day Strength	65.2 Mpa

- STRENGTH - Strength requirements were specified by the Structural Engineer Yolles Partnership of Toronto (see Table 3.2.1). The strengths are mostly 30Mpa. In order to compensate for the slower curing associated with high volume flyash use, some applications specified 56-day strength in lieu of the normal 28-day strength. The experience in this project both from laboratory and field mixture is that the high volume flyash concrete did not show unacceptable retardation in setting time and in fact, demonstrated enough strength development to produce adequate strength in one day. A one day strength of 16 Mpa was obtained for many of the mixes. Typically, the specified strength of 30Mpa was achieved by the 7th day. According to Ellis Don, a retarder was used in hot weather, which helped in maintaining strength factors similar to results in cooler temperatures. There is a direct correlation between setting time and strength development. Eg. With all other characteristics being similar, the concrete with the slower setting time will achieve better strength development over all ages once the hydration process has begun. During hot weather, the high volume flyash mixes are more prone to strength variations without close control of concrete setting. Typically, set times were in the range of 41/2 to 6 hours. Optimizing for strength and constructability would be in the range of 6 hours.

- CONCRETE CURING - The initial concerns about flyash mixes being slow drying proved to be unfounded. Between August and September, the workers had to keep the concrete damp from between 48 to 72 hours after it was poured. Damp burlap was laid over the concrete surface to prevent water loss through evaporation. During mid-December when outside temperatures got as low as -10°C, the concrete was finished and cured successfully under normal winter construction practices without incurring additional heating and/or accelerating admixtures.

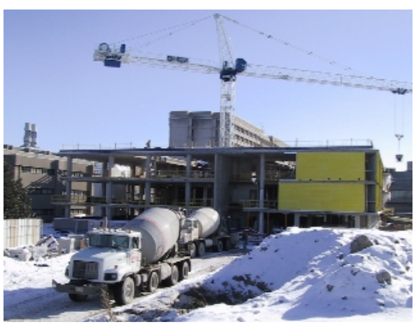

FIGURE 3.5.1
CONSTRUCTION, DECEMBER, 2000

- DURABILITY - Flyash increases concrete durability by allowing an optimally low level of mixing water to the wet mix. In this project, the water/cementitious ratio for a typical 30Mpa mix was limited to .40. This low level of water in the mix created a denser and more impermeable matrix.

FIGURE 3.5.2
CONSTRUCTION, JANUARY, 2001

- WORKABILITY - Despite low water content in the wet mix, the concrete placers found the EcoSmart™ concrete mix to be more workable, and compacted better than conventional concrete mixes reducing the necessity to utilize a slump enhancing admixture. The concrete was moist cured on all flatwork for 3 days and forms left in place on vertical work. No effort was done to overdesign the concrete forms because of fluidity. Setting times were within 1 -2 hours of normal concrete and slump was in the range of 100 -120 vs 80 - 100 mm. Flyash works as plasticizers for cement. Flyash particles get absorbed on the surface of cement grains and act as very powerful dispersants to the cement particles. This increases responsiveness of the mix during pumping, placing and vibration.

- FINISHING - Due to the lower water content, less bleed water rose to the surface than expected for a typical concrete mix. Finishers not being able to rely on bleed water, used a high pressure power washer to mist the air and keep the sheen on the surface. A delay in schedule was avoided due to the adjustment in finishing technique.

- APPEARANCE - The architectural concrete finish was lighter and warmer coloured with fewer bug holes and honeycombing resulting in a denser & smoother surface concrete. The concrete placers found the concrete surface to be more predictable and consistent from the forms, requiring less patching thus avoiding color variations.

- ECONOMICS - No detrimental cost effects were experienced in this project from scheduling delays, increased labor and/or material cost. On the contrary, flyash costs about half the price of cement and is readily available. As well, the labour required to place flyash concrete proved to be less than conventional concrete due to its workability.

- PERCEPTION - At the onset of the construction process, Ellis Don Construction, prepared the trades' people (suppliers, placers, finishers) about the potential negative impacts of high flyash use such as slow curing time. Discussions were held regarding potential adjustments to handling, placing, vibrating and finishing EcoSmart™ concrete mixes. Needless to say, the experience of working with EcoSmart™ concrete turned out to be better than what everyone expected.

4.0 CONCLUSION

The experience in this project was very positive. The original goal of 50% flyash replacement for the majority placement of cast-in-place concrete was reached resulting in the reduction of approximately 850 tonnes of CO2 emissions. The use of EcoSmart™ concrete provided a stronger more attractive finished product, excellent workability and did not disrupt the project schedule. Overall, the project team gained invaluable experience from the use of EcoSmart™ concrete and feels confident in setting a flyash goal of at least 50% for similar projects in the future.

5.0 ACKNOWLEDGEMENTS

The author would like to thank Lloyd Keller of Ellis Don Construction, Gordon Graham of Forma-Con Constructions, Jimmy Scaccia of Ontario Ready Mix Ltd. and Walter Bettio of Van Nostrand di Castri for their cooperation in the completion of this report and for advancing the concept of EcoSmart™ concrete at the York University Computer Science Building.

LAFARGE
GREAT LAKES FLYASH
A joint venture of Lafarge Canada Inc. and D.B.O. Marketing Limited

Report of: Type C Fly Ash   Date: June 2000   Source: Northern Ash

CHEMICAL ANALYSIS	COMPOSITE DATE MONTH AVERAGE	CAN3-A23.5 SPECIFICATIONS
Silicon Dioxide (SiO_2)	37.1	
Aluminum Oxide (Al_2O_3)	19.4	
Iron Oxide (Fe_2O_3)	6.1	
Calcium Oxide (TCaO)	16.6	
Magnesium Oxide (MgO)	4.1	
Sulfur Trioxide (SO_3)	2.6	5.0 Maximum*
Loss on Ignition	0.3	6.0 Maximum
Na_2O Eq	8.0	

** May be exceeded if mortar expansion (A5-C17.5.5) is 0.020% maximum.*

Mortar Expansion: With 40% replacement 14 days)	N/A	

PHYSICAL ANALYSIS		
Fineness: Amount retained on 45 µM sieve (%)	13.3	34 Maximum
ax. Variation from Average (%)	N/A	5 Maximum
Relative Density	N/A	
Autoclave Expansion (%)	0.05	0.8 Maximum
Pozzolanic Activity :(With Portland Cement, 28 Days (%))	110.1	75 Minimum

This fly ash complies with the current CAN/CSA - A23.5 standard.

Certified:

CEMENT GROUP / ONTARIO
1 West Pearce St., 7th Floor, Richmond Hill, Ontario L4B 3K3
Telephone: (905) 764-5260 Fax: (905) 764-6188
Order Office: Metro Toronto (905) 764-5261 Long Distance: 1-800-263-3581

DAVROC TESTING LABORATORIES INC.

CONSULTING ENGINEERS • *Materials Testing and Inspection* • 2051 Williams Parkway, Units 20 & 21
Brampton, Ontario L6S 5T4
Telephone: (905) 792-7792
Fax: (905) 792-7829

COMPRESSIVE STRENGTH CYLINDER TEST REPORT

FILE NO. : L00-0270CM

TEST REPORT NO. : 74

CLIENT: Architects Alliance
van Nostrand DiCastri Architects Inc.
Wellman Clewes Bergman Architects Limited
317 Adelaide Street West, Suite 205
Toronto, Ontario
M5V 1P9

CONTRACTOR: Ellis-Don

PROJECT: York University
New Computer Science Building

DATE OF POUR: 24-Nov-00

ATTENTION: Mr Walker Bellio, B ES, B Arch, OAA

LAB NO.	CYLINDER NO.	DATE CAST (DD-MMM-YY)	DATE RECEIVED IN LAB (DD-MMM-YY)	MASS (Kg/m³)	CURE	DATE TESTED (DD-MMM-YY)	T.O.F.	SPECIFIED 28 DAY STRENGTH (MPa)	3 Day STRENGTH (MPa)	7 Day STRENGTH (MPa)	28 Day STRENGTH (MPa)
3502	1	24-Nov-00	27-Nov-00	2459	L	01-Dec-00		30.0		42.1	
3502	2	24-Nov-00	27-Nov-00	2483	L	22-Dec-00		30.0			
3502	3	24-Nov-00	27-Nov-00	2495	L	22-Dec-00		30.0			
3502	4	24-Nov-00	27-Nov-00	2483	F	27-Nov-00		30.0	24.4		

NOTE: SUFFIX "L" DENOTES LAB CURED - "F" DENOTES FIELD CURED. "T.O.F." DENOTES TYPE OF FRACTURE: 1 - SATISFACTORY, 2 - UNSATISFACTORY

LOCATION ON STRUCTURE: Roof slab between lines A-B and 1-6

	SLUMP (mm)	AIR (%)	TEMPERATURE (°C)		TIME		INITIAL 24 HOUR CURING TEMPERATURE (°C)		CYLINDERS CAST	
MEASURED	70	N/R	CONCRETE:	14	MIXER CHARGED:	1:52	MIN.:	18	BY:	Sukhdip
SPECIFIED	50-100	N/R	AIR:	0	CYLINDERS CAST:	2:22	MAX.:	22	OF:	Davroc

CONCRETE SUPPLIER	Ontario Ready Mix	NOMINAL SIZE OF AGGREGATE:	20 mm	WATER ADDED ON THE JOB:	N/R
PLANT NO.:	1	AIR ENTRAINING AGENT:	N/R	BY WHOSE AUTHORITY:	N/R
TRUCK NO.:	2	TYPE OF ADMIXTURE:	N/R	TYPE OF MOULD:	Plastic
LOAD NO.:	16	DRUM COUNT REVOLUTIONS:	N/R	SIZE OF MOULD:	100x200 mm

REMARKS: Mix Code M330MP50
Ticket 77969

DISTRIBUTION:
Yolles Partnership Inc.
Attn: Mr David Gray

Ellis-Don Corporation
Attn: Mr. David Smith

Laura Dwyer
Laura Dwyer
Assistant Laboratory/Field Supervisor

Sal Fasullo, C.E.T.
Vice-President

Date Dec 4/00

Date Result 3 & 7

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TESTING LABORATORIES INC.

CONSULTING ENGINEERS • *Materials Testing and Inspection* • 2051 Williams Parkway, Units 20 & 21
Brampton, Ontario L6S 5T4
Telephone: (905) 792-7792
Fax: (905) 792-7829

COMPRESSIVE STRENGTH CYLINDER TEST REPORT

FILE NO. : L00-0270CM

TEST REPORT NO. : 68

CLIENT : Architects Alliance
van Nostrand DiCastri Architects Inc.
Wellman Clewes Bergman Architects Limited
317 Adelaide Street West, Suite 205
Toronto, Ontario
M5V 1P9

CONTRACTOR Ellis-Don

PROJECT : York University
New Computer Science Building

DATE OF POUR : 04-Nov-00

ATTENTION. Mr. Walter Bettio, B ES, B Arch, OAA

LAB NO.	CYLINDER NO.	DATE CAST (DD-MMM-YY)	DATE RECEIVED IN LAB (DD-MMM-YY)	MASS (Kg/m³)	CURE	DATE TESTED (DD-MMM-YY)	T.O.F.	SPECIFIED 28 DAY STRENGTH (MPa)	3 Day STRENGTH (MPa)	7 Day STRENGTH (MPa)	28 Day STRENGTH (MPa)
3314	1	04-Nov-00	07-Nov-00	2489	L	11-Nov-00		30.0		36.8	
3314	2	04-Nov-00	07-Nov-00	2453	L	02-Dec-00		30.0			54.0
3314	3	04-Nov-00	07-Nov-00	2465	L	02-Dec-00		30.0			52 2
3314	4	04-Nov-00	07-Nov-00	2393	F	07-Nov-00		30.0	13.1		

NOTE: SUFFIX "L" DENOTES LAB CURED - "F" DENOTES FIELD CURED "T.O.F." DENOTES TYPE OF FRACTURE 1 - SATISFACTORY 2 - UNSATISFACTORY

LOCATION ON STRUCTURE: 3rd floor slab gridline 3C

	SLUMP (mm)	AIR (%)	TEMPERATURE (°C)		TIME		INITIAL 24 HOUR CURING TEMPERATURE (°C)	CYLINDERS CAST
MEASURED	100	N/R	CONCRETE:	20	MIXER CHARGED:	9:28	MIN.: 18	BY: Jimmy
SPECIFIED	80	N/R	AIR:	12	CYLINDERS CAST:	10:23	MAX.: 21	OF: Davroc

CONCRETE SUPPLIER:	Ontario Ready Mix	NOMINAL SIZE OF AGGREGATE:	20 mm	WATER ADDED ON THE JOB:	N/R
PLANT NO.:	1	AIR ENTRAINING AGENT:	N/R	BY WHOSE AUTHORITY:	N/R
TRUCK NO.:	32	TYPE OF ADMIXTURE:	N/R	TYPE OF MOULD:	Plastic
LOAD NO.:	12	DRUM COUNT REVOLUTIONS:	N/R	SIZE OF MOULD:	100x200 mm

REMARKS: Ticket 74943

DISTRIBUTION.

Yolles Partnership Inc.
Attn: Mr. David Gray

Ellis-Don Corporation
Attn: Mr. David Smith

Laura Dwyer
Laura Dwyer
Assistant Laboratory/Field Supervisor

Sal Fasulo, C.E.T.
Vice-President

Date Result 28

Date Dec 4/00