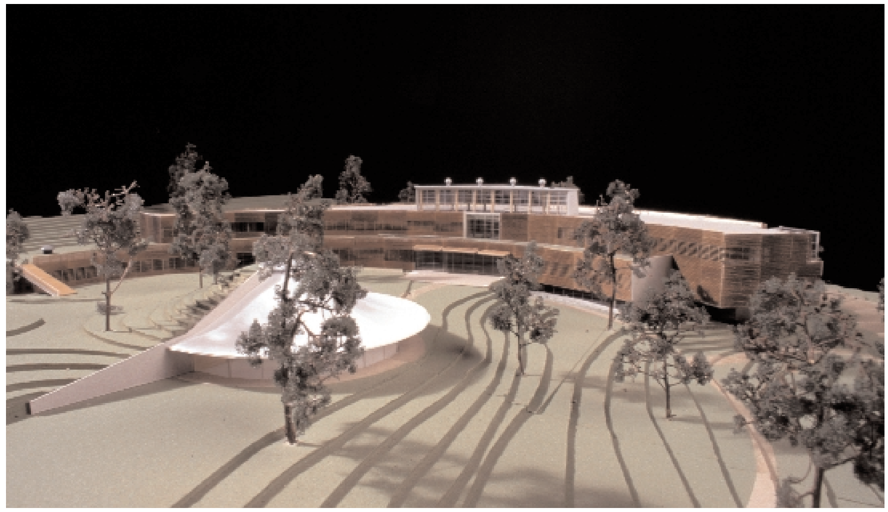

Use of EcoSmart™ Concrete

In Nicola Valley Institute of Technology
Merritt, BC

March 30, 2001

BUSBY + ASSOCIATES ARCHITECTS

TABLE OF CONTENTS

1.0 INTRODUCTION

This report was commissioned by the Greater Vancouver Regional District (GVRD) as part of their 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 the Nicola Valley Institute of Technology (NVIT) /University College of the Cariboo (UCC) Shared Campus, located in the City of Merritt, British Columbia, as a mean of furthering awareness and understanding of EcoSmart™ concrete and the benefits and challenges of the technology.

EcoSmart™ concrete is produced by replacing cement with a maximum percentage of supplementary cementing materials (SCMs) such as natural pozzolans, blast furnace slag and flyash. In this project, the SCM used was flyash, a by-product from coal-fired power plants. The environmental benefits of using flyash are significant because replacing one tonne of cement with one tonne of flyash offsets industrial CO_2 emissions by approximately one tonne.

1.1 HIGHLIGHTS

- **Aesthetic Appeal** -Incorporating fly ash in the concrete mix measurably improved the finish quality and aesthetic appeal of the finished quality cast-in-place concrete. The resulting concrete had a warm color, smoother and denser finish satisfying the architect's aesthetic expectations at no extra cost.

- **Environmental Impact** - The cement manufacturing industry in the GVRD currently produces approximately 2 million tonnes of CO_2 annually. The opportunity to reduce the concrete industry's contributions to greenhouse gases through the reduction in cement consumption is enormous. For this project, the decision to use flyash in replacement of 180,000 kilograms of cement, resulted in the reduction of approximately 180 tonnes of CO_2 emissions.

- **Long-term Strength** - Concrete test reports show that strength development in EcoSmart™ concrete is somewhat slower than that of a conventional concrete mix. However, over time EcoSmart™ concrete generally achieves higher compressive strengths.

- **Challenges** - Using a high percentage of flyash in a majority of the building concrete components presented a significant challenge because of the longer set-up times required during cold weather placing temperatures.

2.0 THE PROJECT

2.1 PROJECT STATISTICS

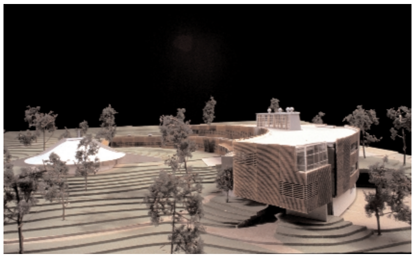

FIGURE 2.1.1
MODEL PHOTO

- Design 1999
- Floor to floor height 3.5 m
- Construction 2000-2001
- Number of Storeys 2.5
- Site Area 17.5 Ha
- Cost $7.0 M
- Building Area 4519 sq.m.

2.2 PROJECT TEAM

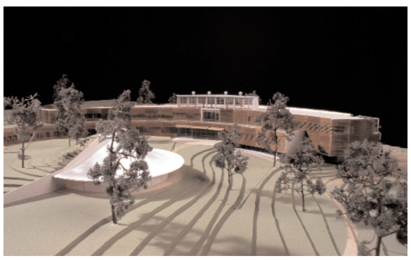

FIGURE 2.1.2
MODEL PHOTO

- Project Manager/Client University College of the Cariboo, *Merritt, BC*
- Steering Committee Nicola Valley Institute of Technology, *Merritt, BC*
- Architect Busby + Associates Architects, *Vancouver, BC*
- Structural Engineer Equilibrium Consulting, *Vancouver, BC*
- Mechanical Engineer Keen Engineering, *North Vancouver, BC*
- Electrical Engineer Reid Crowther, *Vancouver, BC*
- Civil Engineer TRUE Engineering, *Kelowna, BC*
- Landscape TRUE Engineering, *Kelowna, BC*
- Contractor Swagger Construction, *Abbotsford, BC*
- Material Engineer AMEC Earth & Environmental, *Kamloops, BC*
- Ready-Mix Supplier Norgaard Ready-Mix, *Merritt, BC*
- Cement Supplier Tilbury Cement Ltd., *Delta, BC*
- Flyash Supplier Lafarge Sundance, *Alberta*

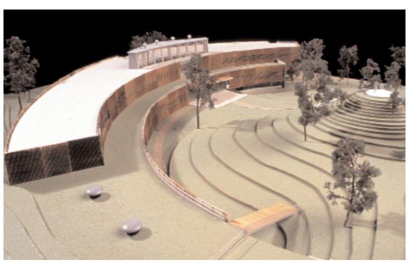

FIGURE 2.1.3
MODEL PHOTO

2.3 OVERVIEW

The NVIT/UCC Shared Campus is Canada's first post-secondary facility shared by both First Nations and non-native institutes. It is funded by the Province of British Columbia, and located on a 17.5-hectare site on the north side of the City of Merritt, in the interior of British Columbia.

This first building on the new campus, is designed to reflect the cultural values of the aboriginal community, and provide state of the art learning spaces. The 4,519 sq.m building includes classrooms, elder's room, faculty offices, social spaces, computer and science labs, bookstore, cafeteria, and library.

The energy target established with the client for the proposed facility was to exceed ASHRAE 90.1 standards for energy performance by 50%. Exposed thermal mass to offset peak heating and cooling loads, careful siting of the building within an existing sloped landscape, natural ventilation, and solar control are the primary strategies used to achieve the energy targets without adding cost to the Provincial budget of $1280 per sq.m. Futhermore, building materials were carefully selected for low embodied energy, site and ecology conservation and reduced construction waste including the specification of high volume fly ash for the majority of the building's concrete elements. These sustainable features incorporated into the building reflect Busby + Associates Architects' commitment to environmental sustainability, energy conservation, reduced negative global impact and conscious recycling of materials.

3.0 ECOSMART™ CONCRETE USAGE

FIGURE 3.0.1
SITE AREA

The primary materials used at NVIT were concrete and wood, due to their local availability and cultural significance. Yellow cedar was chosen for the exterior envelope because of its durability and lack of need for a chemical preservative treatment. Poured-in-place concrete with recycled fly-ash content was used for all concrete components of the building. Due to the aesthetic appeal of the concrete, all of the interior floor slabs, stairs, retaining walls, main floor exterior soffits and columns were exposed. Concrete supply was readily available from two local batch plants in Merritt and approximately 2300 cu. m. of concrete was used during construction. Type F flyash was obtained from Lafarge in Alberta. Approximately 82 cu. m of flyash was supplied in bulk quantities to avoid the intensive labor associated with the use of fly ash delivered in bags.

3.1 GOALS

In addition to contributing to a very strong "green" agenda, the specification of fly ash was encouraged by Busby and Associates Architects since it makes for a warmer and lighter coloured "architectural" concrete with a smoother finished surface. Equilibrium Engineering recommended fly ash mixes for its higher compressive strength and increased durability of the concrete due to the lower level of mixing water in the wet mix. EcoSmart™ concrete mix costs marginally less than a conventional cement mix, and more importantly, its intrinsic features such as better workability and better "pumpability" makes it an advantageous concrete product. Additionally, fly ash use provides sulfate resistance which is considered an advantage in the Thompson Nicola Region where sulfate ions are found in the soil and ground water.

3.2 CONCRETE REQUIREMENTS

Component	Min 28/56 Day Strength mPa	Max Slump mm	Fly Ash Content %	Max Size Aggregate mm	Air Content %	Exp. Class.
Foundations, Footings	30	80	50	20	5-6	F2
Walls Above Grade	25	80	50	20	-	F2
Columns	30	80	50	20	5-8	F2
Suspended Slabs, Beams	25	70	33	20	4-7	-
Exterior Slab on Grade *	32	70	20 max	20	5-8	C2
Interior Slab on Grade	25	70	50	20	-	F2

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

TABLE 3.2.1
CONCRETE REQUIREMENTS

3.3 TYPICAL CONCRETE MIX DESIGNS

The ball bearing effect of the fly ash enhances the slump and increases the flow of concrete allowing water/cementitious (w/c) ratios of .3 and less. With this low level of water in the mix, the concrete can form a dense well-sealed matrix increasing the durability of the concrete. Curiously, the design mixes for NVIT used w/c ratios ranging from .44 to .55 . This range is well above the predicted .3 ratio and is almost the same as the w/c ratios used for cement-only mixes. The cement-testing engineer determined the design mixes to be acceptable for its intended application, exposure classification and compressive strength requirement.

Component	Units kg/m3	NVIT	Cement Only Mix
water/cementitious ratio		0.45	0.50
fly ash/cementitious ratio		0.50	0
Recommended 56 day strength	mPa	30	30 @ 28D

TABLE 3.3.1
FOUNDATIONS, FOOTINGS & OTHER CONCRETE IN DIRECT CONTACT WITH SOILS

Component	Units kg/m3	NVIT	Cement Only Mix
water/cementitious ratio		0.54	0.54
fly ash/cementitious ratio		0.50	0
Recommended 56 day strength	mPa	25	25 @ 28D

TABLE 3.3.2
WALLS ABOVE GRADE

Component	Units kg/m3	NVIT	Cement Only Mix
water/cementitious ratio		0.44	0.48
fly ash/cementitious ratio		0.50	0
Recommended 56 day strength	mPa	30	30 @ 28D

TABLE 3.3.3
COLUMNS

Component	Units kg/m3	NVIT	Cement Only Mix
water/cementitious ratio		0.55	0.55
fly ash/cementitious ratio		0.33	0
Recommended 28 day strength	mPa	25	25

TABLE 3.3.4
SUSPENDED SLABS, BEAMS & CURBS

Component	Units kg/m3	NVIT	Cement Only Mix
water/cementitious ratio		0.45	0.45
fly ash/cementitious ratio		0.19	0
Recommended 56 day strength	mPa	32	32 @ 28D

TABLE 3.3.5
EXTERIOR SOG'S & OTHER CONCRETE EXPOSED TO DE-ICING SALTS

NOTE - High flyash contents are not recommended in areas with contact to de-icing agents (i.e. sidewalks, curbs, gutters) due to being prone to "flaking"

Component	Units kg/m3	NVIT	Cement Only Mix
water/cementitious ratio		0.55	0.55
fly ash/cementitious ratio		0.50*	0
56 day strength	mPa	25	25 @ 28D

*This ratio was later relaxed to .20 due to nearly frozen subgrade during the time of concrete placing.

TABLE 3.3.6
INTERIOR SOG


FIGURE 3.3.1
SUSPENDED CONRETE SLABS

3.4 CONCRETE TEST DATA

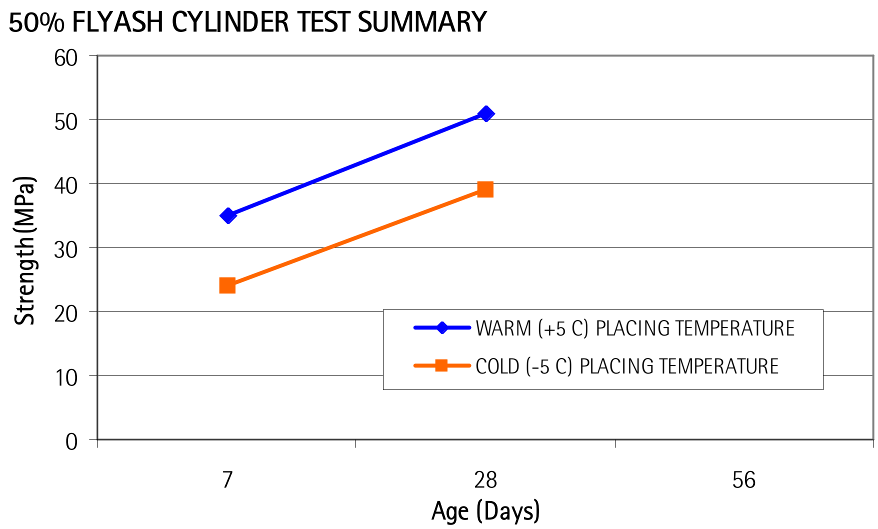

FIGURE 3.4.1
During winter construction the high flyash content lowers the heat of hydration resulting in longer initial curing periods to achieve a specified strength.

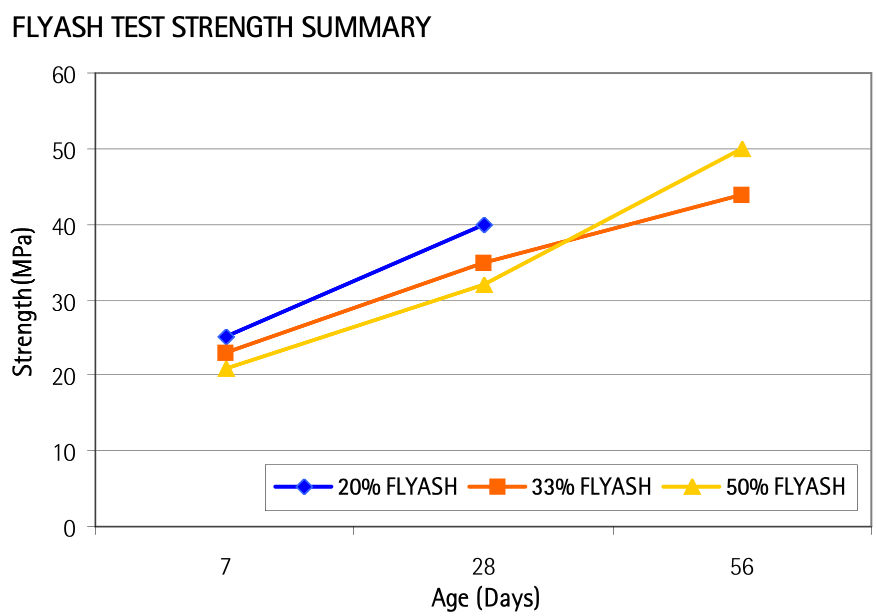

FIGURE 3.4.2
Strength development in EcoSmart™ concrete is somewhat slower than that of lower flyash concrete mixes, but generally achieves higher compressive strength over time.

Refer to Appendix A for Concrete Test Results.

FIGURE 3.5.1
SLAB CONCRETE PLACING IN JANUARY

FIGURE 3.6.1
CONCRETE FINISHERS AT WORK

"The concrete behavior of mixes with 50% fly ash caught us by surprise. We were wondering why it wasn't setting up. I am now on my 5th crew, the first 4 quit after having placing difficulties."
Craig Wittman
Swagger Construction Ltd.

3.5 CHRONOLOGY

The start of construction scheduled for August 2000, was delayed until October due a delay in the tendering process. The foundations and footings were poured in late October, and the first pour of columns and walls above grade occured in November. Suspended slabs were poured from late December right into early January. Roof slabs were completed by mid-March 2001.

3.6 WINTER CONCRETING

- **Cost Implications**: : Because of the three month delay in start of construction, the contractor was faced with wintertime pouring conditions. Larger mass elements such as foundations were poured in late October where the average temperature was around 2°C, followed by thinner elements such as slabs placed later in December at temperatures as low as -15°C. During winter construction, the high flyash content lowers the heat of hydration resulting in slow concrete set up times. Temporary hoarding and heating were required to assist in curing thinner elements attributing to an increase in cost for fuel and labor of about 25%. Accelerators added to reduce set times became added an cost . Additionally, finishing costs increased by 10% due to less bleed water rising to the surface which prevented finishers from accessing the slab as quickly due to slower strength gain.

"The thinner slab which was to be placed against a nearly frozen subgrade could have been structurally jeopardized without a relaxation in the fly ash".
Eric Karsh
Equilibrium Engineering

- **Flyash Relaxation**: It is clearly stated in the specifications that the fundamental design intent for this project is to use EcoSmart™ concrete. It is also clearly stated that "*Should the Contractor require earlier strength gains for their own construction sequencing, this can be achieved by increasing the overall cement ratio, not by reducing the flyash content.*" The engineer and architect only made one exception to this clause by approving a request by the contractor to reduce flyash content for the interior slab on grade from 50% to 20%.

"Knowing what we know now, we would factor in the increased cost associated with the use of fly ash in our next bid for a project, but that would very well mean that we might not get the job."
Craig Wittman
Swagger Construction

- **Competitive Advantage**: The contractor understands the aesthetic and structural advantages provided by the use of EcoSmart™ concrete. However, for wintertime construction at this time, Craig Wittman of Swagger Construction does not look at it as an economic advantage despite its lower material cost.

4.0 CONCLUSION

4.1 CURRENT PRACTICE

In the Thompson Nicola region, concrete mixes typically consists of 20 to 25% fly-ash. It is considered high enough to protect the concrete from sulfates, but at the same time low enough to achieve faster strength development than EcoSmart™ concrete. From a structural point of view, flyash use in concrete achieves higher compressive strengths over a longer period of curing time. Because of this, EcoSmart™ concrete mixes are often specified for large mass projects such as dams and other industrial installations where early age strength is not needed. EcoSmart™ concrete use for architectural work is currently in a "ground-breaking" stage.

4.2 LESSONS LEARNED

The data collected for this project shows that the cold weather concreting done between late December and February of this year did not lend itself easily to larger (50% specified for most elements) replacement volumes of flyash without increased costs such as increased use of admixtures, hoarding and heating as well as finishing delays. As expected, large mass elements such as footings were not seen as difficult, compared to pouring flatwork and thinner elements which are subject to chilling as they are exposed at the top and/or bottom during curing. For future wintertime projects, Busby + Associates Architects is considering leniency with the relaxation of fly-ash content when ambient temperatures fall below 5°C. It can be argued that adding temporary heating as well as increasing cement material (flyash and cement) to decrease curing times would be counterproductive to the main goal of reducing emissions. Although the experience with EcoSmart™ concrete in this project could have been more positive, the original goal of almost 40% flyash replacement of cement averaged for the entire placement of concrete was reached. A large amount of cement was avoided and the project team benefited from the incresed knowledge.

4.3 COMPARATIVE STUDY

It is worth noting that the York University Computer Science Building in Toronto, another project by Busby + Associates Architects underwent construction during the same time which specified the use of 50% flyash in most elements. Contrary to the challenges faced by the concrete placers at Nicola Valley Institute of Technology, the concrete was finished and cured successfully at -10°C under normal winter construction practices. On average, the concrete placers found the concrete mix actually cured faster than normal concrete.

The successful use of EcoSmart™ concrete in York could be attributed to (1) the contractor had 15 years experience with concrete mix designs incorporating fly ash, (2) York used Type C flyash instead of Type F used in NVIT; the higher calcium contents of Type C flyash are able to provide primary cementing action increasing the speed of early strength development; (3) the high alkaline found in Ontario cement with a PH of 12 to 13.5 also contributes to EcoSmart™ concrete's early strength development.

4.4 SUMMERTIME ADVANTAGE

During hot weather, the high flyash content will lower the hydration temperatures of the concrete resulting in a lower potential for thermal associated problems. However during the summer months in Merritt, 30 mile per hour winds and low humidity causes rapid dehydration and crusting of concrete surfaces. A contractor can remedy this situation by the use of a spray compound that creates a membrane preventing dehydration. Currently, this is an additional cost absorbed by the contractor and does not encourage increased use of EcoSmart™ concrete even during warmer months.

4.5 FUTURE ACCEPTANCE

At this time use of EcoSmart™ concrete presents challenges to the construction industry starting with the concrete placer's lack of experience with the material, and its behavior particularly during colder temperatures. Presently, contractors, do not factor in the additional costs and scheduling considerations when bidding on jobs with EcoSmart™ concrete. Discussions with contractors and suppliers indicates a potentially lengthy learning curve. More experience with EcoSmart™ concrete could lead to better concrete mix designs that would achieve the maximum percentage of supplementary cementing material. Thus lowering the environmental impact of CO^2 emissions for a given outside temperature and construction requirements.

In the meantime, structural engineers have to revise their specifications from a 28-day strength to a 56-day strength to reflect EcoSmart™ concrete mixes' slower curing time to reach maximum strength. As well, the owner and contractor have to be informed about potential costs and/or delays that may arise from the use of EcoSmart™ concrete and agree upon strategies to deal with these issues.

4.6 SUMMARY

EcoSmart™ concrete use provides the opportunity to reduce greenhouse gas emissions, alleviate a flyash disposal problem, save natural resources and produce a high quality product. Despite the challenges ahead, a few recent projects using EcoSmart™ concrete show that supplementary cementing materials (SCMs) such as flyash contribute to tremendous ecological, aesthetic and structural benefits easily outweighing current obstacles and will continue to gain popularity in the future for use in advanced and sustainable architectural projects.

AGRA Earth & Environmental

CONCRETE TEST CYLINDER REPORT

TO: Attention: Phil Hanmer
University College of the Cariboo
900 McGill Road - Box 3010
Kamloops, B.C. V2C 5N3

OFFICE: Kamloops
PROJECT NO: KX12488
CLIENT:
COPIES TO: Swagger Construction
Norgaard Merritt
Equilibrium Consultants

<PROJECT NVIT - MERRITT >

SET NO. 1 NO. OF CYLINDERS: 3 DATE RECEIVED: 23-Oct-00 DATE CAST: 19 Oct 00

LABORATORY IDENTIFICATION NUMBER	FIELD OR SAMPLE NUMBER	DATE TESTED	AGE AT TEST (DAYS)	COMPREHENSIVE STRENGTH (MPa)	TYPE OF FRACTURE **
413	1 A	26-Oct	7	24.1	
414	1 B	16-Nov	28	38.1	
415	1 C	16 Nov	28	39.7	

SPEC. STRENGTH	30 MPa	CONCRETE TEMP.	14 °C	SLUMP	135 mm
CEMENT TYPE		AIR TEMP.	3 °C	AIR CONTENT	1.9 %
CEMENT CONTENT	kg/m³	CAST TIME	10:00	DENSITY	
AGGREGATE SIZE	20 mm	CAST BY	JC	PLASTIC	
ADMIXTURE		MOLD TYPE	100 x 200	HARDENED	
SUPPLIER	Norgaard	INITIAL CURING TEMP: MAX.	°C	MIN.	°C
MIX NO.	1	LOCATION:	Footing - Basement Area		
TRUCK NO.	17				
TICKET NO.	16815	COMMENTS:			
BATCH TIME	8:55				
LOAD VOLUME	6.4 m³				
CUMULATIVE VOL.	6.4 m³				

A B C D E F

**TYPE OF FRACTURE REQ'D WHEN CYLINDER FAILS TO MEET SPECIFIED 28 DAY STRENGTH.

NOTES:
1. Portions of test performed by AGRA Earth & Environmental were in accordance with CSA Can A23.2 unless otherwise noted.
2. Cylinders are nominal [illegible] Dia. X 300 mm long unless otherwise noted.

AGRA Earth & Environmental
PER:

Reporting of these test results constitutes a testing service only.
Engineering interpretation or evaluation of the test results is provided only on written request.

amec Earth & Environmental

CONCRETE TEST CYLINDER REPORT

TO: Attention: Phil Hanmer
University College of the Cariboo
900 McGill Road - Box 3010
Kamloops, B.C. V2C 5N3

OFFICE: Kamloops
PROJECT NO: KX12488
CLIENT:
COPIES TO: Swagger Construction
Norgaard Merritt
Equilibrium Consultants
Busby and Associates

<PROJECT NVIT - MERRITT >

SET NO. 6 NO. OF CYLINDERS 3 DATE RECEIVED: 17-Nov-00 DATE CAST: 10-Nov-00

LABORATORY IDENTIFICATION NUMBER	FIELD OR SAMPLE NUMBER	DATE TESTED	AGE AT TEST (DAYS)	COMPREHENSIVE STRENGTH (MPa)	TYPE OF FRACTURE**
469	6 A	17-Nov	7	25.8	
470	6 B	08-Dec	28	39.2	
471	6 C	08-Dec	28	39.2	

SPEC. STRENGTH	32 MPa	CONCRETE TEMP.	19 °C	SLUMP	150 mm
CEMENT TYPE		AIR TEMP.	-1 °C	AIR CONTENT	5.5 %
CEMENT CONTENT	kg/m³	CAST TIME	11:55	DENSITY	
AGGREGATE SIZE	20 mm	CAST BY	JC	PLASTIC	
ADMIXTURE		MOLD TYPE	100 x 200	HARDENED	
SUPPLIER	Norgaard	INITIAL CURING TEMP: MAX.	°C	MIN	°C
MIX NO.	1	LOCATION	Foundation Walls: SW Upper Section		
TRUCK NO.	27				
TICKET NO.	18511	COMMENTS:			
BATCH TIME	11:35				
LOAD VOLUME	6.0 m³				
CUMULATIVE VOL.	6.0 m³				

A B C D E F

**TYPE OF FRACTURE REQ'D WHEN CYLINDER FAILS TO MEET SPECIFIED 28 DAY STRENGTH.

NOTES:
1. Portions of test performed by AGRA Earth & Environmental were in accordance with CSA Can A23.2 unless otherwise noted.
2. Cylinders are nominal 150mm Dia. X 300 mm long unless otherwise noted.

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Earth & Environmental

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University College of the Cariboo
900 McGill Road - Box 3010
Kamloops, B.C. V2C 5N3

OFFICE: Kamloops
PROJECT NO: KX12488
CLIENT:
COPIES TO: Swagger Construction
Norgaard - Merritt
Equilibrium Consultants
Busby and Associates

<PROJECT NVIT - MERRITT >
SET NO. 9 NO. OF CYLINDERS: 3 DATE RECEIVED: 28 Nov-00 DATE CAST: 27-Nov-00

LABORATORY IDENTIFICATION NUMBER	FIELD OR SAMPLE NUMBER	DATE TESTED	AGE AT TEST (DAYS)	COMPREHENSIVE STRENGTH (MPa)	TYPE OF FRACTURE**
504	9 A	04-Dec	7	12.9	
505	9 B	28-Dec	31	30.6	
506	9 C	22 Jan	56	36.5	

SPEC. STRENGTH 25 MPa
CEMENT TYPE
CEMENT CONTENT kg/m³
AGGREGATE SIZE mm
ADMIXTURE Plasticizer
SUPPLIER Norgaard
MIX NO
TRUCK NO. 9
TICKET NO. 18535
BATCH TIME 11.05
LOAD VOLUME 6.0 m³
CUMULATIVE VOL 24.0 m³

CONCRETE TEMP 15 °C
AIR TEMP. -1 °C
CAST TIME 11.45
CAST BY JC
MOLD TYPE 100 x 200
INITIAL CURING TEMP. MAX. °C MIN. °C

SLUMP 170 mm
AIR CONTENT 3.0 %
DENSITY
PLASTIC
HARDENED

LOCATION: NE mid section

COMMENTS:

A B C D E F

**TYPE OF FRACTURE REQ'D WHEN CYLINDER FAILS TO MEET SPECIFIED 28 DAY STRENGTH.

NOTES:
1. Process of test performed by AMEC Earth & Environmental were in accordance with CSA Can A23.2 unless otherwise noted.
2. Cylinders are nominal 150mm Dia. X 300 mm long unless otherwise noted.

PER:

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Earth & Environmental

CONCRETE TEST CYLINDER REPORT

TO: Attention: Phil Hanmer
University College of the Cariboo
900 McGill Road - Box 3010
Kamloops, B.C. V2C 5N3

OFFICE: Kamloops
PROJECT NO: KX12488
CLIENT:
COPIES TO: Swagger Construction
Norgaard - Merritt
Equilibrium Consultants
Busby and Associates

<PROJECT NVIT - MERRITT >
SET NO. 17 NO. OF CYLINDERS 6 DATE RECEIVED: 22-Dec-00 DATE CAST: 21-Dec-00

LABORATORY IDENTIFICATION NUMBER	FIELD OR SAMPLE NUMBER	DATE TESTED	AGE AT TEST (DAYS)	COMPREHENSIVE STRENGTH (MPa)	TYPE OF FRACTURE**
567	17 A	28-Dec	7	26.3	
568	17 B	18-Jan	28	37.0	
569	17 C	18-Jan	28	39.7	
570	17 D	15 Feb	56	42.4	
571	17 E *	09-Jan	19	26.8	
572	17 F *				

SPEC. STRENGTH 25 MPa
CEMENT TYPE
CEMENT CONTENT kg/m³
AGGREGATE SIZE 20 mm
ADMIXTURE 33% Flyash, 2% RB1000
SUPPLIER Norgaard
MIX NO
TRUCK NO. 20
TICKET NO. 18127
BATCH TIME 8:06
LOAD VOLUME 6.0 m³
CUMULATIVE VOL 12.0 m³

CONCRETE TEMP. 16 °C
AIR TEMP. -9 °C
CAST TIME 8:35
CAST BY JC
MOLD TYPE 100 x 200
INITIAL CURING TEMP. MAX. °C MIN. °C

SLUMP 110 mm
AIR CONTENT 4.3 %
DENSITY
PLASTIC
HARDENED

LOCATION: 1st Floor: Suspended Slab: Gridline A30

COMMENTS: *Field Cured Cylinders

A B C D E F

**TYPE OF FRACTURE REQ'D WHEN CYLINDER FAILS TO MEET SPECIFIED 28 DAY STRENGTH.

NOTES:
1. Process of test performed by AMEC Earth & Environmental were in accordance with CSA Can A23.2 unless otherwise noted.
2. Cylinders are nominal 150mm Dia. X 300 mm long unless otherwise noted.

PER:

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AGRA Earth & Environmental

CONCRETE TEST CYLINDER REPORT

TO: Attention: Phil Hanmer
University College of the Cariboo
900 McGill Road Box 3010
Kamloops, B.C. V2C 5N3

OFFICE: Kamloops
PROJECT NO: KX12488
CLIENT:
COPIES TO: Swagger Construction
Norgaard - Merritt
Equilibrium Consultants
Busby and Associates

<PROJECT NVIT - MERRITT >
SET NO. 2 NO. OF CYLINDERS: 3 DATE RECEIVED: 30-Oct-00 DATE CAST: 27-Oct-00

LABORATORY IDENTIFICATION NUMBER	FIELD OR SAMPLE NUMBER	DATE TESTED	AGE AT TEST (DAYS)	COMPREHENSIVE STRENGTH (MPa)	TYPE OF FRACTURE**
438	2 A	03-Nov	7	32.7	
439	2 B	24-Nov	28	43.5	
440	2 C	24-Nov	28	43.5	

SPEC. STRENGTH 32 MPa
CEMENT TYPE
CEMENT CONTENT kg/m³
AGGREGATE SIZE 20 mm
ADMIXTURE Flyash 60kg/m³
SUPPLIER Norgaard
MIX NO.
TRUCK NO. 191
TICKET NO. 17951
BATCH TIME 10:21
LOAD VOLUME 6.0 m³
CUMULATIVE VOL 6.0 m³

CONCRETE TEMP 13 °C
AIR TEMP 10 °C
CAST TIME 11:15
CAST BY DF
MOLD TYPE 3 X 6
INITIAL CURING TEMP MAX °C MIN. °C
SLUMP 80 mm
AIR CONTENT 4.2 %
DENSITY
PLASTIC
HARDENED

LOCATION: Loading Bay C3 to C4

COMMENTS:

A B C D E F

**TYPE OF FRACTURE REQ'D WHEN CYLINDER FAILS TO MEET SPECIFIED 28 DAY STRENGTH.

NOTES:
1. Performance of test performed by AGRA Earth & Environmental were in accordance with CSA Can A23.2 unless otherwise noted.
2. Cylinders are nominal 150mm Dia. X 300 mm long unless otherwise noted.

AGRA Earth & Environmental
PER

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amec Earth & Environmental

CONCRETE TEST CYLINDER REPORT

TO: Attention: Phil Hanmer
University College of the Cariboo
900 McGill Road - Box 3010
Kamloops, B.C. V2C 5N3

OFFICE: Kamloops
PROJECT NO. KX12488
CLIENT
COPIES TO: Swagger Construction
Norgaard - Merritt
Equilibrium Consultants
Busby and Associates

<PROJECT NVIT - MERRITT >
SET NO. 21 NO. OF CYLINDERS 5 DATE RECEIVED: 12-Jan-01 DATE CAST: 11-Jan-01

LABORATORY IDENTIFICATION NUMBER	FIELD OR SAMPLE NUMBER	DATE TESTED	AGE AT TEST (DAYS)	COMPREHENSIVE STRENGTH (MPa)	TYPE OF FRACTURE**
13	21 A	18-Jan	7	21.5	
14	21 B	08-Feb	28	27.1	
15	21 C	08-Feb	28	25.2	
16	21 D	08-Mar	56		
17	21 E *				

SPEC. STRENGTH 25 MPa
CEMENT TYPE
CEMENT CONTENT kg/m³
AGGREGATE SIZE 20 mm
ADMIXTURE 50% Flyash
SUPPLIER Norgaard
MIX NO.
TRUCK NO.
TICKET NO. 18206
BATCH TIME 10:30
LOAD VOLUME 6.0 m³
CUMULATIVE VOL 6.0 m³

CONCRETE TEMP 15 °C
AIR TEMP -1 °C
CAST TIME 11:30
CAST BY BS
MOLD TYPE
INITIAL CURING TEMP MAX °C MIN. °C
SLUMP 80 mm
AIR CONTENT 1.6 %
DENSITY
PLASTIC
HARDENED

LOCATION: Shear wall A30 elevator shaft & shear wall A30 - A32
Shear Wall A40.5 - R1 to R5;

COMMENTS: *Suspect field cure frozen during initial set

A B C D E F

**TYPE OF FRACTURE REQ'D WHEN CYLINDER FAILS TO MEET SPECIFIED 28 DAY STRENGTH.

NOTES:
1. Performance of test performed by AMEC Earth & Environmental were in accordance with CSA Can A23.2 unless otherwise noted.
2. Cylinders are nominal 150mm Dia. X 300 mm long unless otherwise noted.

PER:

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