Use of Ecosmart Concrete
In Residential Construction

A Case Study of

Ardencraig

355 West 11th Avenue

Vancouver, B.C. Canada

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1.0 EXECUTIVE SUMMARY

Ardencraig is a heritage-style redevelopment project that was completed in September 2000 by Chesterman Property Group Inc. in Vancouver. Chesterman converted an existing single family residence built in 1910 into four strata-titled townhouse units, three in the converted home and a new coach house infill residence in the rear yard.

Ardencraig, amongst several other sustainable initiatives, is an example of the residential use of EC concrete. The principal investigations are the environmental and business impacts of its use. In terms of environmental impacts, Ardencraig is a case study of a sustainably built, market-driven housing project. Since less than 10% of houses in Canada are designed specifically for the individual homeowner in order for housing to become a more sustainable industry more sustainable practices and materials need to be adopted in speculative development. Along side of the environmental impacts the following business impacts are addressed: cost, scheduling, availability, approvals (or possible related delays), and the perceptions of the buying public. This report has relevance for the individual homeowner and the development industry,

While this report focuses on the use of Ecosmart Concrete (EC) in Ardencraig, the decision to use it should also be viewed in the larger context of the project's environmental goals.

DEFINITIONS:

In this report we use the term Ecosmart Concrete to refer to concrete that is produced by replacing cement with a maximum percentage of supplementary cementing materials (SCMs) determined by construction requirements.

Supplementary cementing materials (SCMs) (i.e. pozzolans and cementitious hydraulic slags) are used to partially replace cement in concrete. They are often added to concrete to make the mixtures more economical, reduce permeability, increase strength, or influence other properties. Typical examples include natural pozzolans (like volcanic ash), fly ash, ground granulated blast furnace slag, rice husk ash, and silica fume.

In this project the supplementary cementing material was flyash.

2.0 INTRODUCTION

The subject of this study is a four unit residential project located in the City Hall area of Vancouver. The project, Ardencraig, is a heritage-style redevelopment project developed by Chesterman Property Group. In 2000, Chesterman converted an existing single-family residence into four strata-titled townhouse units, three in the converted home and a new coach house in-fill residence on the rear yard. The existing building was a two and one half storey with full basement, single-family house built in1910. It sits on a 50' by 122' lot, zoned RT-6. This zoning allows for multi-unit dwellings and an infill dwelling when the original building is retained and a "heritage" style is adopted. The project involved retaining the existing building structure in its present location, expanding the building slightly to the east and north and adding a two-story "coach house" infill unit. The original house was completely upgraded and renovated to create three strata-titled townhouse units of between 970 square feet and 1475 square feet. Ardencraig is located at 355 West 11th Avenue, Vancouver.

Chesterman's vision in Ardencraig was to identify and incorporate a wide range of resource conservation, energy conservation and healthy building measures within the project. The design and construction methods undertaken were meant to minimize the impact of the project on the environment, and are known as "green" or "sustainable" approaches. The project is a market experiment and an example of producing high-quality housing through remodeling and infill in an environmentally sustainable way. There are few, if any, similar examples with this emphasis that have been successfully developed and sold in the market area of Greater Vancouver.

The following companies were involved in this project:

Owner/Developer:	Chesterman Property Group Inc.
Architect:	Allan Diamond Architect
Environmental Consultants	Chris Mattock David Rousseau Urban Ecology Heather Tremain

	Wave Design + Media
Structural Engineer:	Jeff Allester
Construction Manager:	Armin Gottschling Timberland Homes
Concrete Placer:	Rolf Susi and Son Concrete
Ready-Mix supplier:	Rempel Brothers Concrete

Original Building

After Renovation

3.0 OBJECTIVE

The object of this report is to assess and study the environmental aspects of the use of EC and the implications on cost, physical implementation and public perception.

3.1 Environmental aspect

The production of Portland cement is a large contributor to the world's overall carbon dioxide production. Carbon dioxide is a "greenhouse" gas and thus contributes to global warming. In the Lower Mainland cement production contributes 12.5% of the overall C02 produced in the region. Additionally, the making of one tonne of cement consumes approximately 4-5 GJ of energy.

Flyash is a waste product of coal-fired power plants. The province of Alberta and the state of Washington currently employ coal-fired plants and therefore producing large quantities of flyash. Normally 75 to 80% of the flyash produced goes to landfills.

For projects that aim to be more sustainable, EC is an excellent material since flyash material, which would otherwise be sent to landfill, may be substituted for Portland cement in a concrete mix. The net result is a decrease in waste materials and a reduction in greenhouse gas emissions. Bill McDonough, a visionary green architect envisages a time when there is no such thing as waste – where the waste of one form of production becomes the raw materials of another. EC is an excellent example of this possibility.

Although EC is relatively new to the Vancouver it has been used for a long period of time in Europe.

3.2 Business and logistical implications

In this section we will deal primarily with the issues related to finances, scheduling, eco-image and marketing.

In making use of new materials there are many potentials concerns and drawbacks. In this project we tried to address the potentials cost concerns of the developer by pricing materials in comparison with the standard material in order to determine the benefit. From the owners perspective 'green' materials were the preferred choice as long as the costs were comparative. In some cases in the project the cost comparison was set aside because there was a desire to use a more environmentally sound approach (e.g. heat recovery ventilation system in the building.) The developer has positioned himself as a creator of 'green' buildings and thus feels it is important to build consistent with that positioning.

The use of new materials can bring with it a set of concerns for many of the players within a project. The owners concerns regarding the use of EC was multi-faceted. There was a concern about the cost impact of the use of a new material, the overall environmental impact of the material was certainly a concern with this project as was the resulting strength and durability of the concrete.

The construction manager on the project was interested in the new materials and approaches to building but maintained a healthy skepticism throughout the project. His concerns were related to the ability of crews to adapt to a new approach and the impact on labour costs and quality of work. His principal commitment was to creating a quality project that would be attractive to buyers and durable over time. With the use of EC concrete his specific concern was its impact on scheduling.

Jeff Allester, the structural engineer was chiefly concerned with the strength of the concrete that could be achieved. Building code officials were not concerned with the use of EC provided that the structural engineer was prepared to approve its use. Rolf Susi and

Son, the concrete placers, were concerned with the workability of the concrete and its curing time.

Because of the scale of the project, the architect was involved in the project only until the building permit was approved. He was not involved in the decision to use EC, a decision that was not made until just prior to the commencement of construction.

4.0 DETAILED REPORT

In November 1998 Chesterman Property Group purchased the property at 355 West 11th Avenue, Vancouver with a view to doing a renovation and infill project. Not long after purchasing the project, the principal of Chesterman, Robert Brown was in contact with people promoting alternative building products such as straw board. Based on this contact and new insights into forest management in BC, Brown began to question the source and impact of materials used in construction and began thinking about the use of alternatives that have a more benign impact. It was not, however, until early 1999 that the concept to make Ardencraig a true test of applying principles of resource efficiency, energy efficiency and healthy housing took shape. In July 1999, after having receiving a development permit Chesterman set about transforming Ardencraig into such a project.

One of the approaches was to create a 'Green Team'. The "Green Team" was assembled to set environmental and health goals and priorities for Ardencraig. For the Green Team we drew upon people who were working in the environmental arena – but not necessarily in green building. We looked to them to give us direct "on the ground" opinion on the most important environmental issues that we might impact through Ardencraig.

Members of the Green Team were:
Robert Brown; Heather Tremain; Bruce Haden, architect; Perry Abbey, former contractor, ethical investment advisor; Nicole Rycroft, Friends of Clayoquot Sound; Gil Yaron; Armin Gottschling, contractor; and Nancy Bradshaw, socially conscious retailer (and Brown's life partner);

As a result of the Green Team input the following goals were set for the project:

1) No old growth wood was to be used in the project
2) Minimize energy requirements of the building including consideration of embodied energy and ongoing building operation by creating an efficient building envelope, efficient heating equipment
3) Reducing our impact on green house gas emissions
4) Create a healthy indoor environment – focusing on air and water quality
5) Minimizing our impact on resource use and reducing waste
6) Minimize the use of potable water throughout the project and reduce storm water runoff.

Chesterman took an initial period of three months to research and investigate alternative materials and practices. This information was necessary to complete certain aspects of the Building Permit drawings. This time was spent seeking out alternative products and approaches, costing these alternatives and locating local suppliers. Locating suppliers was often the most difficult task. Many of the green and healthy materials are manufactured in the US and are therefore costly with a weak Canadian dollar, or they must be shipped a great distance, which we wanted to avoid. The other challenge with products is that many of the new products are produced by small innovative companies but are not widely available or distributed.

At this point we were open to any product that had a positive environmental impact and it was during this period that we became aware of EC through an article in the Vancouver Courier about the Liu Centre for Global Studies at UBC. Initially we contacted the GVRD to learn more about the use of EC. Following that we contacted Ocean Concrete and Rempel Brothers Concrete to discuss the availability, use and cost of EC.

4.1 Reasons for application

EC was used in Ardencraig as a way to fulfill the environmental goals that had been set for the project. EC clearly made sense environmentally so we reviewed it in terms of the cost implications to the project and its ease of use.

In terms of ease of use, we found after some searching that two concrete companies in Vancouver had some experience with the mixing and pouring of EC John Rutherford, Lab Manager of Ocean Concrete was extremely helpful and assuring in term of Ocean's interest and research into the use of EC. In addition Rempel Brothers outlined their past experience in the manufacture of EC. The construction manager has worked with Rempel before and was quite satisfied with them as a supplier. The structural engineer on the project was open to the use of a new material – and was willing to approve its use, subject to the review of the specifications.

It is important to note that in projects where the goal is to do innovative work particularly, sustainable building, that consultant's willingness to look at alternative materials and approaches is critical to its success.

4.2 Ecosmart Concrete Application

In the project we made use of EC in every concrete application: footings, foundations, exterior decks and porches, stairs, retaining walls and concrete topping for the radiant floor heating system. With the exception of the porch surfaces and stairs the concrete was not exposed.

4.3 Details of Concrete

The specific mix of the EC was prepared by Rempel Brothers. Rempel has chosen not to disclose the design mix. Strength of the concrete varies from 25-30 MPA (see chart below) All mixes were 50 % flyash, 50% cement. In keeping with the environmental objectives of the project the forms were rental, thereby reused.

Date (all dates are 2000)	**Volume** (cubic metres)	**Location**	**Specified Strength**
January 25	34	House Foundation	25 MPA 56 day
February 14	2	Footings for Coach House	" "
February 23	18	Footings	" "
March 21	2	Footings	" "
April 11	15	Basement floor	" "
May 2	18	Radiant floor, crawl space & garage	" "
May 19	1.5	Footings (stairs up to porches)	" "
June 28	6	Porches and stairs	30 MPA
July 25	3.4	Stairs	25 MPA
Total	99.9		

The weather for all outdoor areas was dry with the exception of the first pour.

4.4 Decision Makers

The Owner/Developer was the driving force behind use of EC. In collaboration with the Construction Manager they selected Rempel Brothers as the concrete supplier and Rolf Susi and Sons as the concrete placers. The structural engineers reviewed the specifications provided by Rempel. As the required strength of concrete would be provided he approved the use of EC.

Although the construction manager had initial concerns about scheduling there was no negative impact on the schedule. Despite a slower curing rate, the schedule was not

slowed enough to cause a delay. The forms for the pouring of the foundation of the main house remained on for one week. The main house had been raised and this period allowed time for the framing of the basement level to be completed. After one week the concrete had cured to sufficient strength for the original house structure to be set down on the new framing and foundations.

4.6 Cost factors

As part of the investigation into "green" materials one of the significant factors we analyzed was cost. For each alternative material we looked at its cost in comparison to the standard material used. With EC we found the cost of materials to be approx 5% greater than the cost of the standard concrete mix. The labour and pouring costs were very comparable. While the placement cost was no greater Rolf Susi and Son indicated that in hindsight they would charge a higher amount to compensate for the longer setting time and the slightly more difficult finishing workability of the concrete.
It should be noted that the difference in workability of the concrete was more noticeable in the earlier pours when the weather was colder. There was little or difference between a EC pour and standard concrete pour later in spring and summer, in terms of workability. No special equipment was required for the EC pour.

4.5 Perceptions

Ardencraig received generous amounts of publicity for a project of its size. Publications included Vancouver Sun, Business in Vancouver, Georgia Strait, Courier and Shared Vision. There was an interest and willingness on the part of the print media to write articles highlighting the environmental and healthy aspects of the project.

According to the real estate agent, Kurt Laurent, there were over 400 people who visited the project while it was for sale, a phenomenal number in comparison to other comparable projects. Laurent estimates that 75-80% of the people who attended open houses came to see the project because of the environmental features mentioned in the articles above. When visitors were interested in more detailed information Laurent would

mention the use of EC in the project and the connection to C02 emissions. No one he spoke to was aware of the impact of cement production on green house gas emission.

The first sale of a unit happened before the project was completed. Part of that purchasers' decision was based on the environmental impacts of the project. The following is a quote from one of the owners.

> "The reason I was so eager to buy a suite at Ardencraig was that for a long time I had wanted to live in a home that reflected my values. Ardencraig offered the chance to live in one of the older character homes I'd admired in the area with an approach to renovation that was environmentally responsible and aesthetically appealing, with attention to detail and quality."

All of the remaining suites were sold shortly after the completion of the project. This was exceptional, considering the poor real estate market at the time. Each of the owners was drawn, at least in part, to the project because of the sustainable aspects of the project.

The CMHC provided funding for a research study on Ardencraig. Although that report has not yet been completed the general findings in a small survey of visitors to the project was that location and design or aesthetics were the most important attractive features of the project followed by the measure taken to ensure healthy interior spaces. Environmental features ranked third. The general public saw these features, as an added value, but were unwilling to forgo locational and aesthetic considerations in exchange for such features

5. CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER PROJECTS

The creation and maintenance of building employ approx. 40% of the world's physical and energy resources. These statistics demonstrate the profound impact that buildings have on the environment. The building industry along with other industries is challenged to reduce its overall impact. The two largest obstacles that the building industry faces is knowledge of new products, materials and approaches and finding those materials at reasonable cost.

The specific barrier to overcome in small-scale residential projects is thinking that a small project does not have an impact. When one multiplies the impact by the number of housing starts per year – it is clear that there is the potential for a large benefit.

In summary, the use of EC at Ardencraig when compared to use of a regular concrete mix was close to being cost comparative, provided equal or stronger finished concrete, had adequate workability, was supported by the structural engineer, and did not disrupt the project schedule. Given the significant benefits for the environment through reduced greenhouse gas emissions, landfill waste, and energy usage EC is a logical and functional material to use in a project of this scale.

Having used this material in Ardencraig, Chesterman Property Group Inc. will continue to make use of it in their future projects.