THE PRACTICE OF MANUFACTURING DURISOL NOISE BARRIER PANELS

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ABSTRACT

Durisol material is an environmentally friendly, lightweight cement-bonded wood product. Originally developed in Europe, the Durisol material has been manufactured and marketed in North America and elsewhere, for more than half a century. In this presentation, the application of Durisol material to highway noise barriers was presented, followed by a brief description of the manufacturing process. The distinctive characteristics of the Durisol material were introduced. The research work done on selected parameters was discussed in some detail. The challenges encountered in the material batching process and the steps taken to overcome them were discussed as well.

KEYWORDS

Lightweight wood-cement composites; manufacturing process; properties; highway noise barrier

INTRODUCTION

The Durisol technology was introduced from Switzerland, via license, to Canada in 1953. Today, Durisol, a division of Armtec Limited Partnership, is a wholly owned Canadian company that has provided absorptive noise barrier walls to North American markets for over 30 years. See Figure 1 for examples of walls.

Figure 3 – Durisol noise barrier panels in service

Durisol has an international presence. It has sister companies in Holland & Austria and together they have licensees in their respective spheres worldwide.
The company name stems from the trademarked Durisol material name. The Durisol material is a light-weight, Portland cement-bonded wood product. In Canada, the wood aggregate of choice is manufactured from softwood shavings although new raw materials are being investigated.

MANUFACTURING PROCESS

The manufacture of the Durisol noise barrier panels is essentially a lay-up process. The panels are generally a sandwich construction as shown in Figure 2. A conventional reinforced concrete core is faced on either side with a Durisol layer.

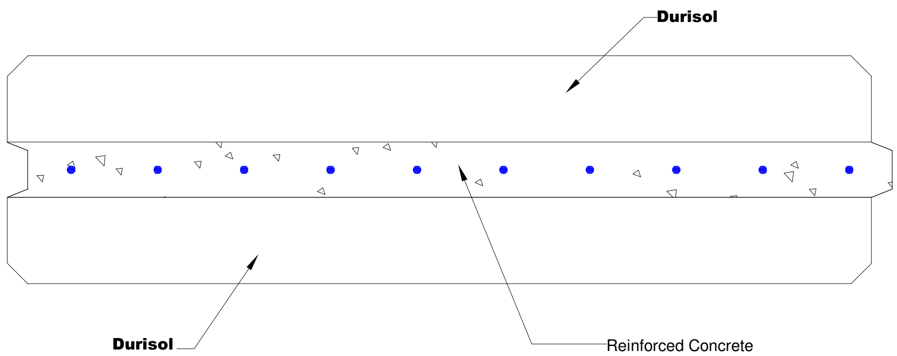

Figure 2 – A typical cross-section of a Durisol noise barrier panel

The panel is built up on an assembly line where, at the initial stations, the first layer of Durisol is packed into a form. In the middle stations along the assembly line, the reinforced concrete core is placed. This is followed by the placement of the second layer of Durisol. Finally, the panel is inserted into a press for a set time before the panel is transferred into a curing chamber.
A beneficial characteristic of the Durisol material is its moldability. A patterned liner can be placed into the form to produce an attractive surface on the panel. Although limited in design, a pattern can also be imprinted into the Durisol material by the press lid.

Performance Requirements of Absorptive Noise Barrier Walls

Relevant to this discussion, the three important performance requirements of noise barrier walls are the following:
Acoustical Properties
In addition to preventing the transmission of sound, the panels must absorb sound to reduce the echo that can exacerbate noise levels, especially between two opposing walls.
Strength
The strength of the panels has to be sufficient to withstand handling loads and the highest expected local wind loads during its service life.
Durability
The panels must be durable to survive the ambient conditions for the service life of the wall, generally specified to be 25 to 30 years. In northern and temperate climates, the resistance to freezing and thawing is essential.

Durisol Material Properties

The sound absorption of Durisol is determined by subjecting production panels to the standard ASTM C423 test which measures the noise reduction coefficient, NRC. Durisol meets the coefficients specified by its customers, generally ranging from 0.70 to 0.85.
Apart from having sufficient strength integrity, the Durisol layers of the sandwich panel contribute to the load bearing capability of the panel in bending. The strength of the panel is measured in a full-scale bending test. The strength of Durisol material is established by measuring its Modulus of Rupture (MOR), and its Internal Bond strength (IB). These strengths are at least 1.4 MPa and 200 kPa respectively.

The durability of Durisol is established by subjecting prisms of the material to 300 cycles of freezing and thawing in accordance with ASTM C666. In addition, a modified version of the ASTM C672 salt scaling test is performed on Durisol surfaces to establish their durability in the salt laden environment prevalent along roads and highways in the winter.

Mix Design Parameters

To ensure that the properties described above are achieved, it is important to understand how certain parameters of the Durisol mix design affect the performance of the Durisol material. These parameters are Density, Cement/Wood (C/Wd) ratio and Water/Cement (W/C) ratio.
A test program was put in place to optimize the mix design of Durisol with respect to the above parameters. This program is used to study the current Durisol material made with shavings as well as Durisol made with other wood aggregates. A new wood aggregate, prochips, is being investigated which is made from waste trimmings from the lumber industry. Prochips are chunkier than shavings and Durisol made with this material is expected to exhibit different values for the optimum parameters.

Density

Durisol material is compressible making it necessary to establish its desired density and control Durisol's compaction in the manufacturing process. It should be understood that although Durisol is compacted in the manufacturing process, once the pressure is released, the Durisol material will rebound.
Therefore it was important to establish the rebounded density of Durisol. A method was sought to isolate the weight contributions of the constituent materials of the mix. It was surmised that the bulk volume of wood determined the volume of Durisol when all ingredients had been added. On that basis, an in-house test was devised to determine the weight of dry wood in a cubic metre of Durisol. From this test, it was established that a cubic metre of Durisol made with shavings contained about 130 kg of dry wood shavings. In comparison, Durisol made with prochips contained about 160 kg of dry wood. These densities of dry wood were maintained in the subsequent mix designs for parameter testing.

The effects of C/Wd and W/C ratios

Modulus of Rupture tests on Durisol made with prochips were carried out by varying both C/Wd and W/C ratios and their results were plotted on the contour graph shown in Figure 3. With the increase of both C/Wd and W/C ratios, the MOR was found to increase as well. Of the two parameters, the W/C ratio had the greater effect.
It is worthy to note in Figure 3 that for any specific MOR band range, there are many potential combinations of C/Wd and W/C ratios for choosing a mix design. The selection of an optimum combination of these ratios will depend on other considerations such as density, acoustical property, workability, open life, appearance and cost.

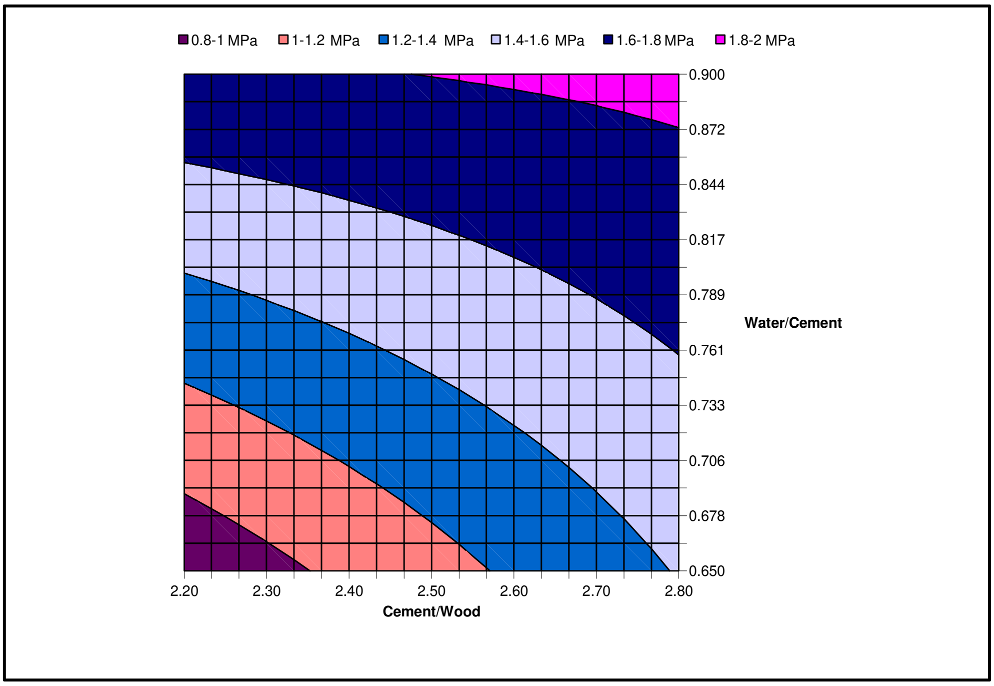

Figure 3 – Contour plot: the effects of Cement/Wood ratio and Water/Cement ratio on MOR

The effect of W/C ratio on the Modulus of Rupture and Internal Bond was studied when the C/Wd ratio of Durisol made with shavings was held constant. As can be seen in Figure 4, as the W/C ratio increased, the Modulus of Rupture increased as well but the Internal Bond started to decrease after peaking at W/C = 0.90. After considering some of the other characteristics mentioned above, the W/C ratio at the highest Internal Bond strength was selected as the optimum.

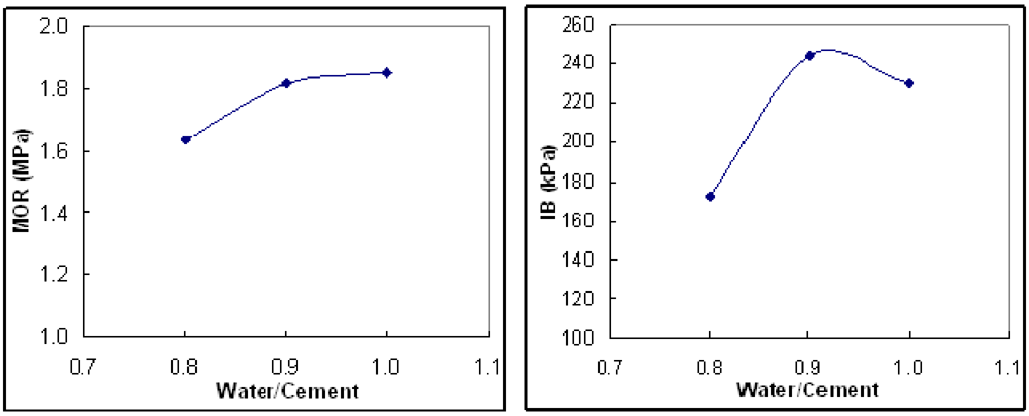

Figure 4 – The effect of Water/Cement ratio on MOR and IB

Controlling Material Batching to the Parameters Established

Having identified the importance of controlling the W/C ratio, the challenge became how to control the batching of Durisol to accurately meter all the ingredients. Traditionally, in Canada, Durisol was batched by filling the wood shavings into a hopper up to a calibrated volume line. It was assumed that the dry weight of wood would not vary significantly with moderate fluctuations in the moisture content of the wood. However, variations in the wood raw materials presented quality control difficulties and demanded frequent labour intensive calibrations of the hopper.

Water was added either by predetermined quantities or in accordance with feedback received from a moisture meter in the mixer. Final additions of water were made manually based on a visual inspection of the

mixed material. Because the exact moisture content of the wood was not known, the exact W/C ratio also remained unknown.
It was recognized that to improve the manufacture of the Durisol material, it was necessary to know the dry weight of the wood. This meant knowing the moisture content of the wood as it was metered into the hopper. Only then could the parameters C/Wd and W/C ratios be controlled.
A batch control system was designed for the mixer which included a moisture meter that was able to instantaneously measure the moisture content in the wood as it filled the hopper. This meter communicated with the weigh scale, which converted the wet weight of wood into its actual dry weight, enabling the metering of a desired dry weight of wood. Furthermore, the control system would compensate for the water held in the wood when it metered in the final water. The C/Wd and W/C ratios could now be controlled more accurately in the batching process.

CONCLUSION

Much laboratory work was carried out on Durisol materials to establish the relationship of the Cement/Wood and Water/Cement parameters that will yield optimum properties for noise barrier panels. The traditional material batching process was improved by developing a comprehensive measuring and control system to achieve the target mix designs.
Future work is now focusing on applying these study methods and concepts to researching other wood materials that will enhance the performance of Durisol materials and widen the market for Durisol products.