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# PRODUCTION OF VALUE ADDED LIGHT-WEIGHT, ECO-FRIENDLY GREEN CONCRETE BY MGX TECHNOLOGY

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## Introduction

This study deals with the use of waste wood (WW) and also waste expanded polystyrene (EPS) as an aggregate in the production of light-weight eco-friendly green concrete, using a patented formulation called Mecalithe® developed by MGX Research Centre BV. This study aims at the commercialization of this technology and to reduce $CO_2$ emissions and hazardous waste.

The global average temperature in the last century has increased by > 1 °F (0.7 °C) and in 2001-2010 temperature increased by > 2 °C above pre-industrial levels. Scientific evidence indicates that if the temperature increases more than 3.6 °F, this is critically dangerous. Global warming and the availability of surplus waste wood prompted this research. In general, if a sample of wood contains about 10 % water so roughly one ton of this wood, if burnt, will produces approximately 1.5 tons $CO_2$, (0.4 ton-carbon equivalent).[1,2,3]

## $CO_2$ reduction and the production of lightweight, green concrete

WW and EPS have been used as aggregates in the production of light weight Mecalithe® based concrete. EPS was used to reduce the density and to make a floating/stable concrete without using traditional sand and gravel. Research efforts are made to use WW and EPS in production of light-weight low density concrete (0,785 to 0,876 kg/$m^3$) and achieve sustainable environmental protection. Aggregates used in the production of this special light weight concrete are either free or bring money (negative cost). This makes the concept cost-effective and simultaneously induces the reduction of atmospheric $CO_2$. In addition, it is easy to transport, due to its light-weight and has potentials to reduce noise pollution as a sound absorbent. Tests conducted at MGX Research Centre have shown that the concrete shows significant fire resistance and has excellent performance to sensitive Freeze-Thaw test. It was also revealed during the research that there are possibilities to produce different attractive surface textures in different colors and shades.

### A typical procedure for preparing concrete from CWW/EPS:

Place all WW/EPS in the mixing unit and mix. Now add a fractional amount of cement and mix, then add fractional water. At this stage Mecalithe® powder is added in stages. Sand may also be added in blended concrete. EPS may have static charge so it should be neutralized suitably. Finally, the remaining cement and final water with liquid Mecalithe® is added in a specified sequence and mixed.

## Results and Discussion

Concrete waste wood (CWW) or concrete with EPS produced with Mecalithe® has Compressive Strength (CS) of 5 to > 30 N/mm$^2$ in general but in these studies, it has 13.32 N/mm$^2$ in 28 days with 100 % WW, Bending Strength (BS) of 2 to > 5 N/mm$^2$, at 350 kg/m$^3$ with CEM I 52.5 cement. Density ranges from around < 0.785 to ~1250 kg/m$^3$. 100 % EPS concrete showed a CS of 7.52 N/mm$^2$ and a density of 0.787 kg/m$^3$ and this is a floating concrete. It was very simple to screw nails in produced concrete blocks. Research indicates a stable chemical transformation of wood fibers to a stable concrete matrix which could be confirmed when this concrete was subjected to fire resistance and exposure to extreme temperatures. WW and sand blends are studied and corresponding testing data is shown in Table 1.
Indicative tests, according to NEN 5077, at TU Eindhoven[4], show that sound absorption of CWW performs is better than the traditional concrete. Similarly, NEN 6064/65/68 indicated that EPS/WW based concrete is resistant to fire and does not burn but glow and stops immediately. Also, when these concrete blocks were subjected to extreme temperatures from 20-35 °C, blocks were stable (with and with-out salts) for 28 cycles.

**Table 1:** Testing data of concrete with 100% WW and sand blends.

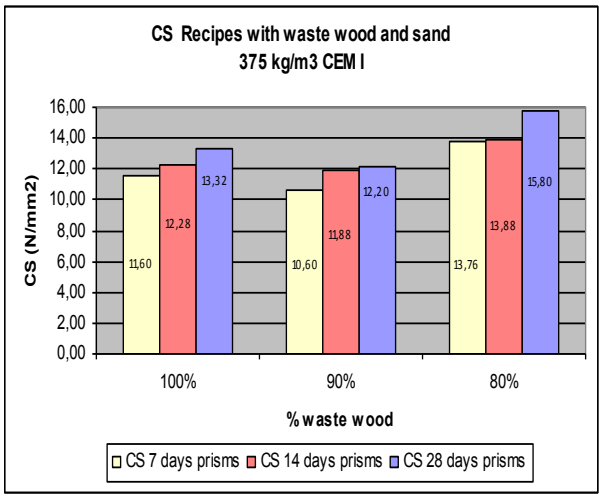
| Sand 0-4mm | Waste wood | cement CEM I 52,5 R | w/c Factor | Moist % against Dry | | Test results | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 7 days | | 14 days | | 28 days | |
| | | | | | | BS | CS | BS | CS | BS | CS |
| | | | | | | N/mm$^2$ | N/mm$^2$ | N/mm$^2$ | N/mm$^2$ | N/mm$^2$ | N/mm$^2$ |
| - | 100% | 375 | 1,225 | 43,9% | P | 4,17 | 11,60 | 4,85 | 12,28 | 4,76 (31d)* | 13,32 (31d)* |
| | | | | | C | | 9,4(3d)* | | 12,80 | | 13,6 (31d)* |
| 10% | 90% | 375 | 1,210 | 41,7% | P | 4,83 | 10,60 | 4,83 | 11,88 | 4,81 | 12,20 |
| | | | | | C | | 10,7 | | 11,6 | | 12,3 |
| 20% | 80% | 375 | 1,175 | 38,6% | P | 5,30 | 13,76 | 5,06 (15d)* | 13,88 (15d)* | 5,02 | 15,80 |
| | | | | | C | | 12,0 | | 14,5 | | 14,4 |
| Concrete with 100% EPS | | | | | | | | | | | |
| 100% EPS | | Density: 0.787 | | | | | | Prism | 0,94 | 5,64 | 7,52 |

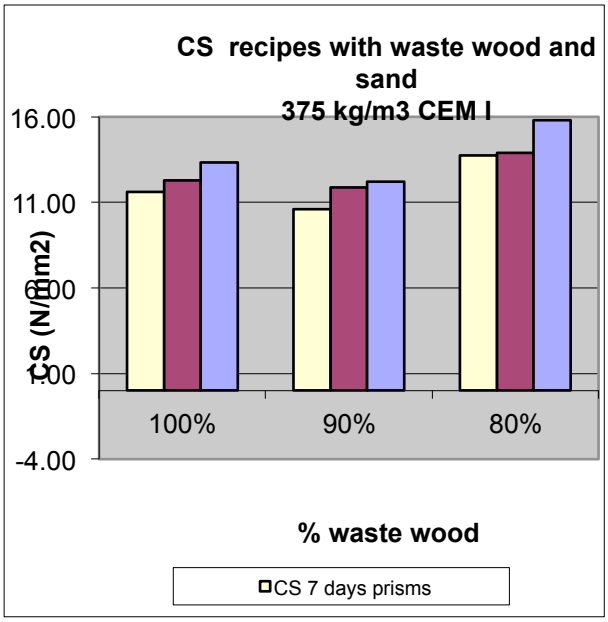
Recipes contains 2, 5 % Mecalithe® with other ingredients
***** Actual days of testing

**Table 2:** Testing data of 100 % CWW with 375, 250 and 200 kg/m$^3$ of cement

| Waste wood | cement CEM I 52,5 R | w/c Factor | Moist %against Dry | | Test results 7 days BS N/mm$^2$ | 7 days CS N/mm$^2$ | 14 days BS N/mm$^2$ | 14 days CS N/mm$^2$ | 28 days BS N/mm$^2$ | 28 days CS N/mm$^2$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 100% | 375 | 1.225 | 43.9% | P | 4.17 | 11.60 | 4.85 | 12.28 | 4.76 | 13.32 (31d)* |
| | | | | C | | 9.4 (3d)* | | 12.80 | | 13.6 (31d)* |
| 100% | 250 | 2.000 | 50.7% | P | 3.33 | 5.68 | 3.12 | 7.08 (15d)* | 2.84 | 7.12 |
| 100% | 200 | 2.535 | 54.3% | P | 2.25 | 4.36 | 2.58 | 4.84 | 2.91 | 6.2 (29d)* |
| | | | | C | | 6.2 | | 6.8 | | 7.6 |

Additives: 2.5% of Mecalithe® (w/w) of cement weight.* Days tested



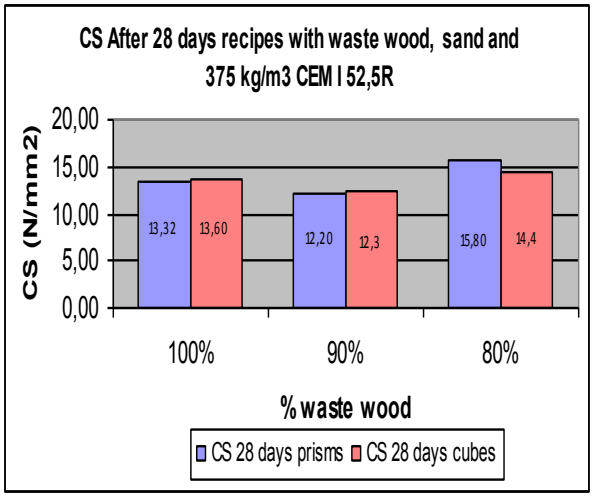
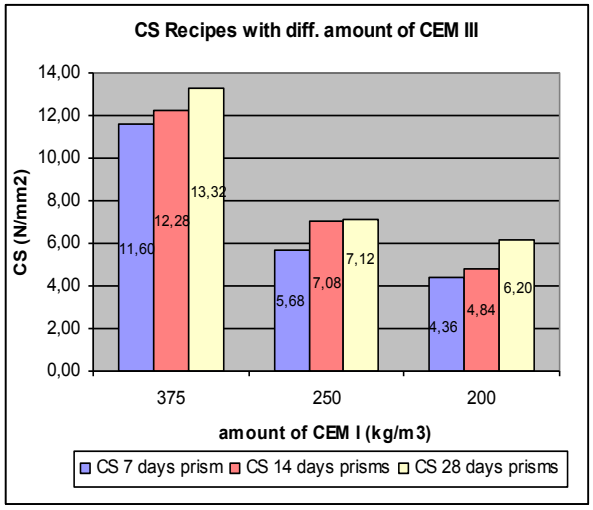
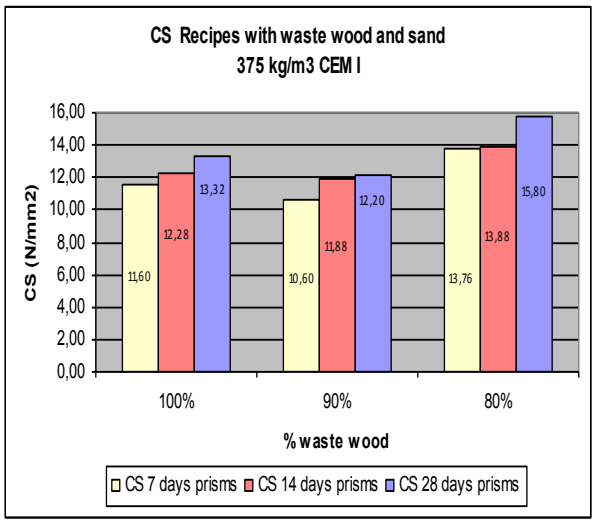



**Figure 1:** Comparative values of CS /BS (N/mm$^2$) of concrete produced with 100 %, 90 % and 80 % WW. Last right is comparison between results of Prisms and Cubes



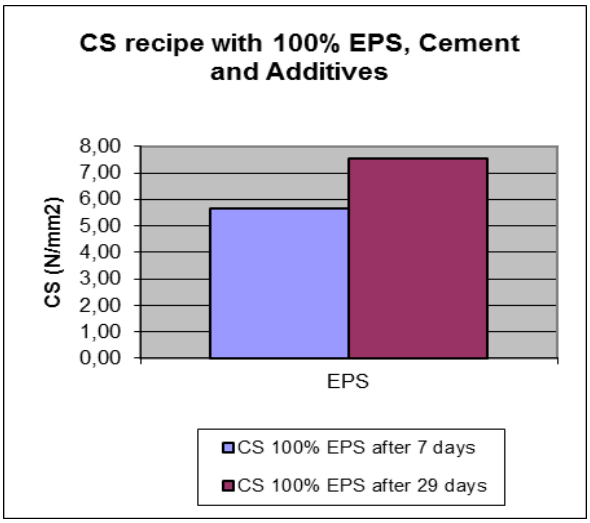



**Figure 2:** CS with 375, 250 and 200 kg/m$^3$ of cement with 100 % CWW, different amount of WW. 100 % concrete from EPS.

**Figure 3:** Following are the pictures showing a model of CWW (left), concrete from EPS (middle and right) at MGX Research Centre BV.

**Figure 4:** Fire resistance test, left test with 100 % EPS, middle test for EPS and WW concrete and right showing cool surface.

## Conclusions

- It is possible to produce a light weight eco-friendly green concrete with 100 % WW/EPS. The density is 0.785 kg/$m^3$ to 1250 kg/$m^3$ using Mecalithe®;
- This has fire-resistance qualities, absorbs sound and qualifies for the Freeze-thaw test;
- CS is 13.32 N/$mm^2$, BS is 4.76 N/$mm^2$with 100 % WW and CS is 7.5 and BS 5.64 N/$mm^2$ with 100 % EPS concrete. The results are excellent;
- This material can be used for construction in earthquake prone areas, non-bearing lightweight sound absorbent panels in modern buildings, high ways, recoding rooms, poles and many more; Innovative textures can be used as decorative concrete with different colours. The concrete is safe and easy to produce and has reduced cost and helps in reducing $CO_2$ emissions with many more advantages.

**Abbreviations used:** EPS: Expended Polystyrene (as waste); WW: Waste Wood; CWW: Concrete from waste wood; CS: Compressive Strength (N/$mm^2$), BS: Bending Strength (N/$mm^2$), WW: Waste Wood, D: Density, P: Prism. C: Cube.

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