



Wood-Aggregate Concrete Masonry Unit

Douglas C. Stahl
Gregg Skoraczewski
Bryant Stempksi

Objective:

Demonstration of the use of recycled wood particles as aggregate for a lightweight concrete block...

...to create increased market opportunities for the concrete masonry industry
...to create increased market opportunities for recycled wood materials

Focus on developing a block that can be...

...made with conventional block equipment
...installed with conventional techniques.

Strength requirement: 600 psi per ASTM C129 (non-loadbearing CMU)

Weight requirement: 105 pcf to be "lightweight"

Marketing niche depends on economics as well as durability, fire rating, sound absorption properties. Present study is limited to fabrication possibilities and the weight and compressive strength limitations.

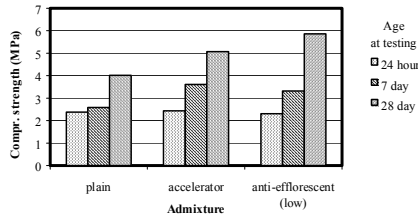
Materials:

Wood particles were produced by a Milwaukee-area wood recycler. The wood was waste material from a local mattress manufacturer, and was chosen because the wood recycler identified it as "mostly softwood." While this waste source is not as voluminous as others (the majority of the recycler's material is waste pallets) it suggested a potential reduction of wood-cement incompatibility problems by minimizing the amounts of oak, maple, and other hardwoods. The material was subsequently identified by the U.S.D.A. Forest Products Lab as a mixture of spruce, yellow pine, hard maple, tulip-poplar, and species from the poplar-aspen-cottonwood group. The wood particles were produced with a horizontal in-feed grinder with a 19 mm screen.

Cement, sand, and admixtures were standard materials used in the commercial manufacture of concrete masonry units in the Milwaukee area.



"CMU" cylinders manufactured in lab



Results of lab trials



CMU coming out of block machine in plant

Lab and plant manufacturing processes:

Concrete block is made from zero-slump concrete, formed under intense compression and vibration, and removed from its form after about 5 seconds.

We tried various mixes in the CSEC Lab with a laboratory version of the commercial CMU manufacturing process, consisting of a bench-top mixer, a gang of four forms, a concrete vibrator and a compression machine. Mixes were evaluated by their ability to form properly and look good after forming, and by their 7-, 14, and 28-day strengths. Results shown in a bar chart above illustrate the gain in strength for mixes with no admixture and with two standard CMU admixtures.

Operations were moved to the Quality Concrete block plant in Sussex, Wisconsin for production runs of promising mixes. Plant personnel adjusted the machinery to account for the greater spring-back in the wood-aggregate blocks compared to normal blocks. Six one-cubic-yard batches were made. All blocks were put through the plant's standard material handling operations, cured in the steam rooms for approximately 18 hours, "cubed" onto pallets, and trucked to MSOE.

Block testing results:

Compressive strength, oven-dry density, durability, and workability were evaluated for each mix. The table below shows the critical input parameters and results for all six mixes. All except mixes P2 and P3 meet the ASTM requirement for density of a "lightweight" cmu. All except P5 meet the ASTM requirement for compressive strength of "non-loadbearing" cmu.

Durability was assessed by two tests: One set of blocks were cycled wet-dry by soaking them in a barrel of water for 15 minutes then drying them to oven-dry conditions over a three day period. The cycle was repeated ten times. Another set of blocks was left soaking for 14 days. All blocks were allowed to rest in lab conditions for 24 hours before testing. Results in the bar chart below show that strength actually increased with moisture cycling for two of the mixes.

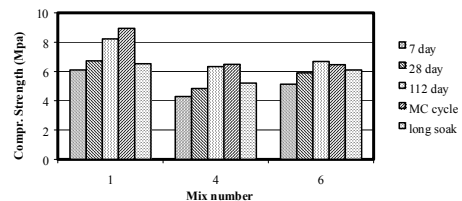
Workability was assessed informally. A mason had no trouble building a small wall with the blocks, and had great fun driving nails and screws into the blocks!

mix	stone:sand:wood:cement (kg)	total water (kg)	admix/treatment	oven-dry density (kg/m ³) ¹	7 day strength (MPa) ¹	28 day strength (MPa) ¹
P1	0:1230:80:200	110	-	1680	6.1 [.09]	6.7 [.14]
P2	0:1410:80:200	95	-	1720	3.6 [.07]	5.6 [.09]
P3	180:1230:80:200	102	-	1700	3.2 [.14]	3.5 [.07]
P4	320:1090:80:200	130	anti-efflorescent	1690	4.3 [.09]	4.8 [.08]
P5	320:1090:80:200	110	accelerator	1690	3.4 [.10]	3.6 [.07]
P6	320:1090:80:200	110	silicate	1690	5.1 [.07]	5.9 [.06]

¹Coefficient of variation in brackets (n = 5 replicates).

Note that 1690 kg/m³ density is equal to 105 pcf; 600 psi strength is equal to 4.14 Mpa.

Results of plant-made cmu



Results of plant-made cmu

Conclusion:

The feasibility of manufacturing a lightweight cmu for non-loadbearing interior applications (partitions) has been demonstrated. We were unable, however, to demonstrate a cost savings by use of these blocks. Developments to watch for are:

- Proposed regulations from OSHA regarding workplace ergonomics might make lightweight cmu more attractive to the industry.
- Future environmental regulations might make the cost of recycled wood particles decrease and/or the cost of mined stone aggregates increase.

This project was funded by:
Lake States Wood Utilization Consortium
Wisconsin Concrete Masonry Association