**CMG ENGINEERING SERVICES**
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9 February 1995

Dear Mr. Merchant,

I have great pleasure in submitting to you a final copy of my brief technical report on the series of structural loading tests completed at Iowa State University, which I was invited to witness on your behalf. Both in my own view and in the opinion of Dr Max Porter *PE*, who supervised the test procedures for the University, they demonstrate in a clear and quantified way the remarkable ability of AMT's Ceramic Bonding Coats to utilize simple construction materials and convert them into structural components of a viable building system.

Anyone must be impressed with the demonstration of load-carrying capacity which you show in your brochure. Having replicated that in the laboratory, you now also have results that put numerical value to that strength, which I trust will be of value in convincing interested parties of the virtues of your product. The ease with which viable structural members can be formed from the simplest of materials such as the hollow concrete blocks is remarkable, and should be of great assistance in many countries where there is an urgent need to build adequate housing for the people rapidly and at moderate cost.

But it was not only as a *building* material that we were impressed by these ceramic coatings. Since the tests were designed to determine the ultimate load-carrying capacity of the beams at destruction, they did eventually break. In each case the ceramic coating was still bonded to the concrete surface beneath it, demonstrating in a remarkable way the adhesive strength of the formulations you have developed. This property remains valid whether they are used in housing or any of the other surface protection roles to which you apply them. Since my return to Canada I have found great interest developing in these coating properties, both in the private and public sectors of this country.

Yours very truly,

Iain Clayre

**Dr Iain F Clayre, MA PEng,** *Principal*
*CEng. FICE. FIHospE. MInstWM.*

Brief Report on AMT Beam Tests at Iowa State University under the direction of Dr. Max Porter, PE, 20 December 1994

1. Four tests were conducted between 2:00 p.m. and 5:30 p.m. on Tuesday 20 Dec, to put verifiable numbers to the observed structural strength of beams made out of simple hollow "sandcrete" block sections bonded together with a rage of AmTex composite materials -- as, for instance, their load-carrying capability demonstrated by the photograph in the brochure of a truck supported on such a beam.

2. The sections tested were:

   2(a) The identical beam section appearing in that photograph, 16"x16"x8" hollow blocks laid end-to-end and bonded into a beam approximately 6'- 0" long by about 1/8" AmTex 10/01 applied only on the top and bottom surfaces;

   2(b) A beam of similar length of 8"x8"x8" hollow blocks bonded with about 3/32" AmTex 10/01 on its top (compression) surface and an AmTex / Fiberglass composite on the sides and the bottom (tension) surface, together about 1/8"- 3/16" thick;

   2(c) A beam similar to 2(b) but also containing a single 5/8" diameter deformed rebar located centrally in the notch in the bottom surface;

   2(d) A beam broadly similar to 2(c), but with only AmTex 10/01 on its four outer surfaces and a plain round bar replacing the deformed bar. Anchorage of the ends of this bar was enhanced by bending the bar ends up through an angle of about 90° at the extremities of the beam.

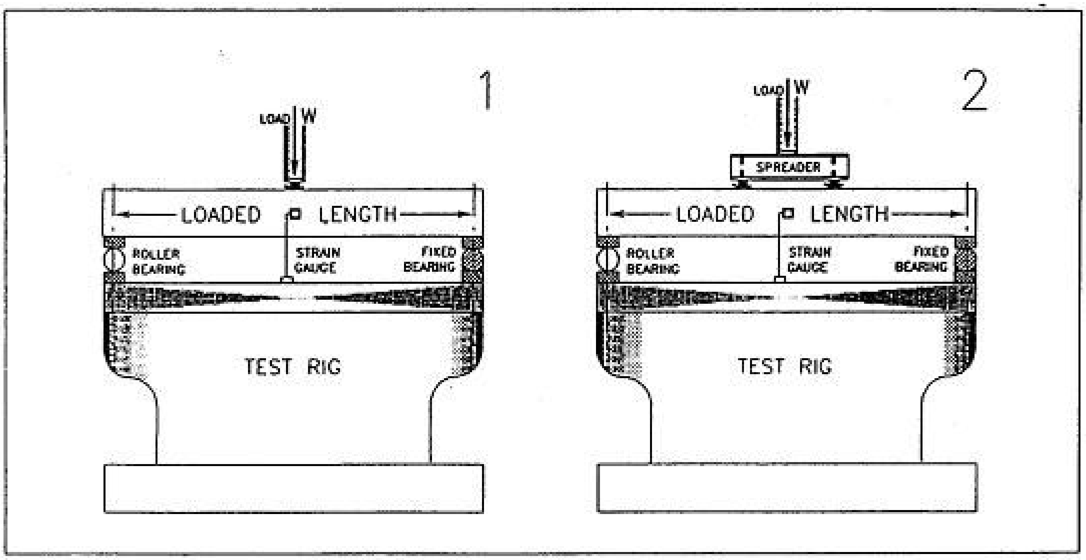
3. The order of testing was:
   2(c), with a single loading line at its centre
   2(b), 2(d), 2(a), each loaded some 12" either side of the centreline.

4. **Matt Merchant** and **Mark Seabold** witnessed the tests for AMT. **Dr Iain F Clayre** *PEng FICE* of CMG Engineering Services Corporation of Canada witnessed them as an independent consulting Engineer engaged by AMT for the purpose.

5. The Test Procedure was similar in each case, despite the variation in the method of applying the load:

   Each beam was weighed on the pattern of the loading rig at the Lab (as shown in a photograph of the tests taken at the time). It was then supported close to its ends on a small spreader slab seated on a circular section, fixed at one end and free to rotate at the other end, the distance between their centres being "the span" - in each case about 5' 9".

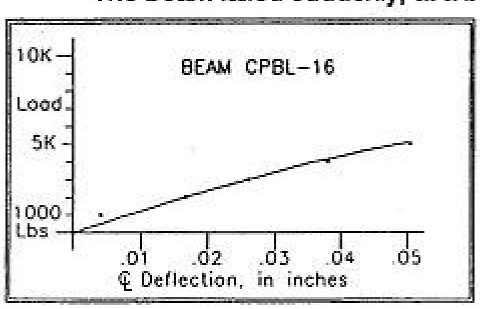
Load was applied from the hydraulic screw-press testing rig through a 1" side square bar extending the width of the section, with a 3/4" thick neoprene pad protecting the loaded surface from local crushing. The general arrangement is shown below. [Later tests had the load divided by a spreader beam, as mentioned at 3 above, to provide some length in which the Ben ding Moment remains constant, but were in all other respects identical] A linear extensometer attached to the mid-point of each beam recorded the centre line deflection automatically with the applied loads. The print-outs of loads and deflections for each test are attached.




6. Summary of Results

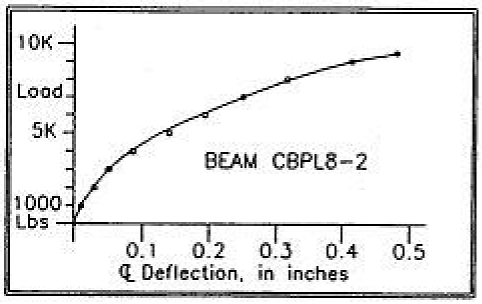
6(a) 16" wide hollow-block beam, loaded 12" either side of centre.

All through the test the relationship between load and deflection was virtually linear. At 5000 lbs, the maximum deflection recorded was 1/8". The beam failed suddenly, at a block junction, at 5030 lbs of applied load.




Close inspection of the plane of failure, involving measurement of the thickness of the AmTex at about 12 points, showed a mean coating depth of .096", leading to a stress on failure of the tensile coat of 4550 psi. This means that a working design allowable tensile stress of about 2500 psi is totally acceptable.

6(b) <u>8" hollow-block beam, no rebar</u>, loaded 11 1/2" each side of centreline.

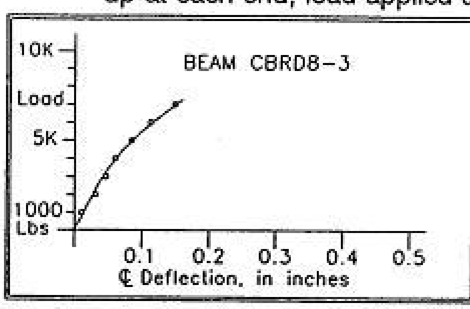



AmTex and fibreglass bottom and sides. Shortly before failure, the AmTex layer in compression peaked up at a node close to the loading plane. The failure, when it came, was also dramatic and sudden, at an ultimate load of 9680 lbs. Ultimate load in the AmTex/Fibreglass Composite would be about 12,000 psi in tension, so leading to 6750 psi for safe design.

<u>Summary of Results</u>

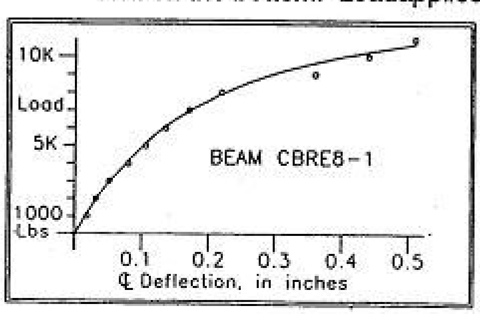
The sudden change in slope of the Load:Deflection plots probably represents a physical closing up of one or more joints between blocks, as indicated by the pop-up of the compression layer at joints nearest the maximum load.

6(c) <u>8" square hollow block</u>, AmTex only on all four sides, 5/8" round bar bent up at each end; load applied at two points, 11" either side of centreline.




The first failure appeared to be slippage between the plain bar and the block, in one "short" end of the beam outboard of a loading plane, at about 5500 lbs. The tension layer of AmTex failed at 7300 lbs and then the gap progressively widening as the end hook at the short end rotated from the vertical.

6(d) <u>8" square hollow block</u>, AmTex only on all four sides, 5/8" ***deformed*** bar coated in AmTex into bottom groove, AmTex and fibreglass on the sides and on the bottom. Loadapplied at centre plane for maximum deflection.




Initial distress was evidenced at both of the joint planes either side of the load line, AmTex spoiling up with a concrete sliver from the block top attached to it as blocks in the area of maximum load closed up under compression. Surface compressive failure moved outward to two and then three joint planes, each time accompanied by failure at the top of the side sheathing. The beam failed in tension under the loading point at 11,210 lbs with a maximum deflection of 0.66". [It should be noted that this is equivalent to design loading of 6400 lbs at an acceptable Load Factor of 1.75 on 5' 9 1/2" loaded span, and 5060 lbs on the 88" load span designed into the Lahore House. The actual design load on this floor is 4400 lbs, giving an actual Load Factor of 2.0] The rebar did not appear to be stressed, but serves a useful function as a ductile element to support the abrupt brittle failure mode of the AmTex, with or without fibreglass.

## 7. General Observations on the Test Results

7.1 The capability of the unreinforced beam to carry a substantial load [See 6(b)] has justified, in principle, its use as a column in all the housing developments where it will be called on to transmit wind loading to the base slab and to the floor-beam system. The ultimate test failure load was applied at the third points of the span, and would produce the same central bending moment as a uniformly distributed load of 12,900 lbs on the loaded length of 69 inches. The same Moment would be produced by a UDLoad of 9680 lbs over the 92 inch loaded height of the 8 ft column. It is acceptable to work to a Load Factor of 1.4 for wind loads, allowing a design wind loading of 6915 lbs.

Calculations show that the maxium wind loading on an 8 ft column supporting an 8 ft square wall panel is approximately 4000 lbs under the extreme conditions of 150 *mph* hurricane winds.

7.2 The capability of an unreinforced beam to carry adequate self weight, construction deadweight and applied design load is demonstrated. Inclusion of reinforcement, even nominal steel, will further protect the structure from the collapse mechanism of sudden rupture which is demonstrated by the AmTex alone or with composite material construction in the ultimate loading condition.

7.3 In every instance of surface failure, the plane of rupture was within the concrete; the AmTex Bonding Coat, AmTex / FibreGlass composite and AmTex : Concrete interface bond remained intact at all times.

Dr Iain F Clayre, *PEng*
21 December 1994

Iain Clayre