Abstract—A series of compression and flexural tests of Mi Panels is presented. The lightweight panels are made from polystyrene beads called Neopor, cement, three proprietary chemicals mixed together and 4.5mm-thick fibre-cement sheeting compressed on either side of the inner core. A distributed load is applied throughout the width of the panel in compression tests. Line loads are applied simultaneously, at quarter and three quarter span of the panel in flexural tests, as required by agreement, South Africa. The compression and flexural tests are performed to simulate the behaviour of the wall, when subjected to vertical loads from the roof and wind loads, respectively. Most of the panels tested experienced a sudden failure as the maximum load is attained. The tests showed that the panels are capable of carrying the required loads, and can be used in place of brick walls, as is normally done in practice.

Keywords—Mi Panel, compression, flexure, Polystyrene beads, fibre-cement.

I. INTRODUCTION

Mi Panels have been used as structural elements in India, Australia and Indonesia, in building structures ranging from single (ordinary houses, sheds, factory and warehousing developments) to multi-storey buildings [1]. The panels are lightweight, easy to construct and require far less construction materials than conventional building technology, which makes them an excellent choice for remote construction projects. Mi Panels save significantly on the cost of materials, manpower and scaffolding, required to assemble the structure. The panels can easily be adapted to any design and are manufactured under controlled conditions according to established quality procedures. Mi Panels can be much more versatile than concrete and brick structures in meeting the various construction conditions on site, for example, panel removes or minimizes the wet environment during construction, which reduces the construction time. Aesthetically, the finished panel structure is slimmer and has cleaner lines than its bulkier and heavier competitors.

The interlocking panels comprise of 4.5mm-thick fibre-cement sheeting compressed on either side of an inner core of expanded graphite impregnated polystyrene beads called Neopor, cement, and three proprietary chemicals mixed together, as shown in Figure 1. Delaminating on the fibre-cement sheeting is prevented by the chemicals and the method of production. The aim of this investigation is to determine the compressive and flexural strength of similar panels, manufactured by MIBT, South Africa.

II. TEST PROGRAMME

Two set-ups were prepared to test the load carrying capacity of Mi Panel; one for the vertical compression tests, and the other for flexural tests.

A. Compression Tests

Compression tests were performed to simulate the behaviour of the wall, when subjected to vertical loads from the roof. The panel, size 2700x600x75mm, was oriented vertical, underneath the head of the Instron, as shown in Figure 2. Care was taken to make sure that the panel is exactly vertical. Thick flat steel plates were placed at the top and bottom ends of the panel so that the load could be distributed evenly along its width. The load was applied using a 500kN Instron, at the rate 1mm/minute.
B. Flexural Tests

Flexural tests were performed to simulate the behaviour of the wall, when subjected to wind loads. The test system consists of specially designed supporting rigs and load spreader beams. Line loads were applied simultaneously, at one-quarter and three quarter span, as required by Agreement, South Africa (Figure 3). Simply support conditions were provided using 30mm diameters steel bars, at 100mm away from the end of the panels. This test configuration simulates a distributed load, applied to the panel. The load was applied using a 250kN Instron through a load spreader, as shown in Figure 4, at the rate 1mm/minute. A Linear variable displacement transducer (LVDT) was attached at mid-span of the panel to measure the vertical displacement.

III. TEST RESULTS

In this study, all the tested panels experienced a sudden fracturing failure, at mid-height for the panels in compression and at mid-span for the panels in flexure.

A. Compression

The maximum loads achieved by the panels, in compression, and the corresponding distributed loads are given in Table 1. Figure 5 shows the corresponding load-deflection graphs for the panels. The graphs are largely elastic, and the maximum load and stiffness are almost the same. The average maximum load achieved by these three panels is 150kN or 250kN/m. As shown in the figure, most of the panels tested experienced a sudden failure as soon as the maximum load was attained.

<table>
<thead>
<tr>
<th>Test</th>
<th>Load (kN)</th>
<th>Distributed load (kN/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>152.76</td>
<td>254.60</td>
</tr>
<tr>
<td>2</td>
<td>146.52</td>
<td>244.20</td>
</tr>
<tr>
<td>3</td>
<td>151.30</td>
<td>252.17</td>
</tr>
</tbody>
</table>

Fig. 2 Test set-up of panels in compression

Fig. 3 Two-line loading configuration

Fig. 4 Test set-up of panels in flexure

Fig. 5 Load-deflection graphs of panels in compression
B. Flexure

The maximum loads and load-deflection graphs of the panels, in flexure, are shown in Table 2 and Figure 6, respectively. As with compression, the graphs are initially elastic, however, the graphs become inelastic as the panels reach their maximum capacity. The inelastic behaviour is caused by 4.5mm-thick fibre-cement sheeting, and is important in limiting sudden failure in a structure. Note that the loads in the graphs do not include the weight of the load spreader; however, this load has been included in Table 2. The weight of the two round/flat bars used to transfer the line-load was negligible, and therefore ignored.

<table>
<thead>
<tr>
<th>Test</th>
<th>Total load (kN)</th>
<th>Line loads (kN/m)</th>
<th>Exp. Moment (kNm)</th>
<th>Exp. Pressure (kN/m$^2$)</th>
<th>Wind Pressure (kN/m$^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4.88</td>
<td>8.13</td>
<td>1.53</td>
<td>3.01</td>
<td>0.55</td>
</tr>
<tr>
<td>2</td>
<td>6.00</td>
<td>10.00</td>
<td>1.88</td>
<td>3.70</td>
<td>0.55</td>
</tr>
<tr>
<td>3</td>
<td>6.28</td>
<td>10.47</td>
<td>1.96</td>
<td>3.88</td>
<td>0.55</td>
</tr>
</tbody>
</table>

Fig 6 Load-delection graphs of panels in flexure

The maximum unfactored theoretical pressure on the walls, based on SANS 10160[2], is determined as shown in Equation 1.

\[
p_{z} = K_{p} V_{z}^2 \times (C_{pe} - C_{pi})
= K_{p} (K_{z} K_{v} V)^2 \times (C_{pe} - C_{pi})
= 0.6 \times (1 \times 0.64 \times 40)^2 \times (0.6 + 0.8)/10^3
= 0.55 \text{kN/m}^2
\]

where, $K_{p}$ is site altitude above sea level (taken as 0), $V_{z}$ is the characteristic wind speed at height $z$ ($m/s$), $K_{r}$ is the mean return period correction factor (taken as 50 years), $K_{z}$ is the wind speed multiplier, $V$ is the wind speed, $C_{pe}$ is the external wind pressure coefficient and $C_{pi}$ is the internal wind pressure coefficient. The calculation in Equation 1 assumes that the height is 5m and the terrain category is 3 (suburbs, towns, suburbs, wooded areas, industrial areas). Based on this calculation, it is clear that the theoretical pressure is far much smaller than the experimental pressure resisted by the panels. Table 2 shows the pressure results for the three tests.

IV. CONCLUSION

Based on the strengths in Tables 1 and 2, it can be concluded that Mi Panels are strong in compression and flexure and meet the minimum requirements required by South African building codes.

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REFERENCES