Test on “Star Point” roof flexible pointing to AS 4046.8-2006 for wind class C3

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Commercial-in-confidence

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Test on “Star Point” roof flexible pointing to AS 4046.8-2006 for wind class C3

1 SUMMARY

A cyclic fatigue loading test was conducted on an adhesive mechanical fastener, more commonly referred to as flexible pointing, used for installing the ridge tiles onto a tile roof. The flexible pointing was tested to the fatigue loading sequence described in the Australian Standard AS 4046.8-2006, for wind class C3. The ultimate limit state design pressure was 8.21 kPa. The test specimen completed all fatigue loading cycles without failure.

2 INTRODUCTION

CSIRO JOB No.: R-00415-03 TR3783

SPONSOR: Westflex Pty Ltd

TEST DATE: 30 April 2010

TEST LOCATION: CMSE, North Ryde

The Facade Engineering & Weather Performance of Buildings Group, of CSIRO’s division of Materials Science and Engineering (CMSE), was engaged by Westflex Pty Ltd to assess their flexible pointing product for compliance with the Australian standard AS 4046.8-2006, ‘*Methods of testing roof tiles*’, ‘*Method 8: Adhesive mechanical fasteners – Flexible pointing*’. This Standard sets out the method for testing flexible pointing to determine its suitability for use as an adhesive flexible pointing after conditioning by prolonged water saturation.

This report details those relevant aspects of testing required by the Standard.

3 FLEXIBLE POINTING COMPOUND

The flexible pointing compound supplied by the sponsor goes by the product name “Star Point”.

The product came supplied in a 4 litre pale as shown in Figure 1, overleaf. Attached to the pale and lid were labels displaying the following information:

‘ST86S, NAT. TERRACOTTA, BATCH 7096’.


Star point
Flexible pointing for tiled roofs
ST86S
NAT. TERRACOTTA
BATCH 7096
4 litres
CONFORMS TO AS 2050 APPENDIX F - C3 RATING


STARPOINT
Application Instructions
• Starpoint covers approximately 25 lineal metres of ridging per 10 litre bucket.
• Apply at a uniform thickness of 3-5mm. Applying Starpoint thicker than 5mm increases cost and drying time and increases the risk of rain damage.
• Starpoint should not be sponged. It is a trowel finish product.
• Weep holes should always be installed.
• Clean up tools with water.
Risk:
Safety:
Telephone: (08) 9458 3921
1/43 Felspar St
Welshpool WA 6106
Shelf Life

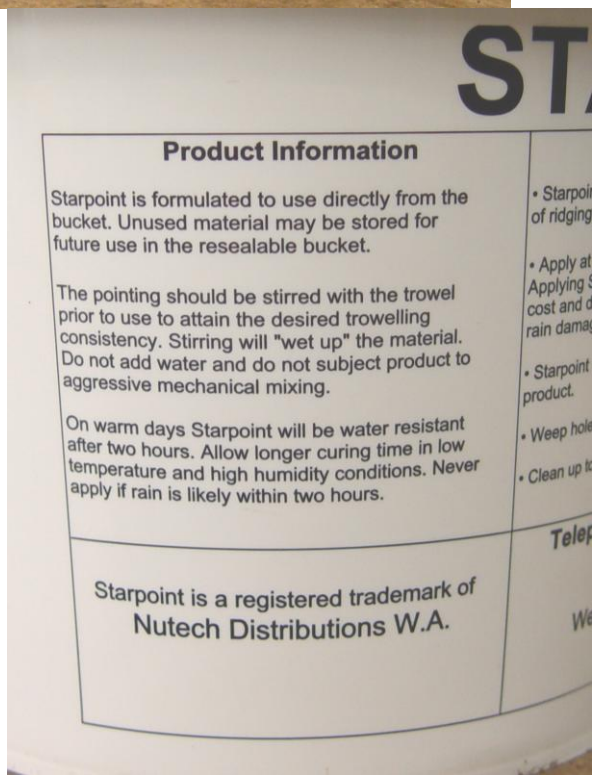
Product Information
Starpoint is formulated to use directly from the bucket. Unused material may be stored for future use in the resealable bucket.
The pointing should be stirred with the trowel prior to use to attain the desired trowelling consistency. Stirring will "wet up" the material. Do not add water and do not subject product to aggressive mechanical mixing.
On warm days Starpoint will be water resistant after two hours. Allow longer curing time in low temperature and high humidity conditions. Never apply if rain is likely within two hours.
Starpoint is a registered trademark of
Nutech Distributions W.A.

Figure 1 Flexible pointing compound, as supplied

4 SPECIMEN INSTALLATION

The flexible pointing compound and test roof segment were installed by a professional roof tiler/installer, contracted by the sponsor.

The test roof segment was constructed using timber battens (35 mm x 40 mm radiata pine) and new terracotta roof and ridge tiles (CSR Wunderlich brand, glazed terracotta, Marseille pattern). Figure 2 shows the tiles used.

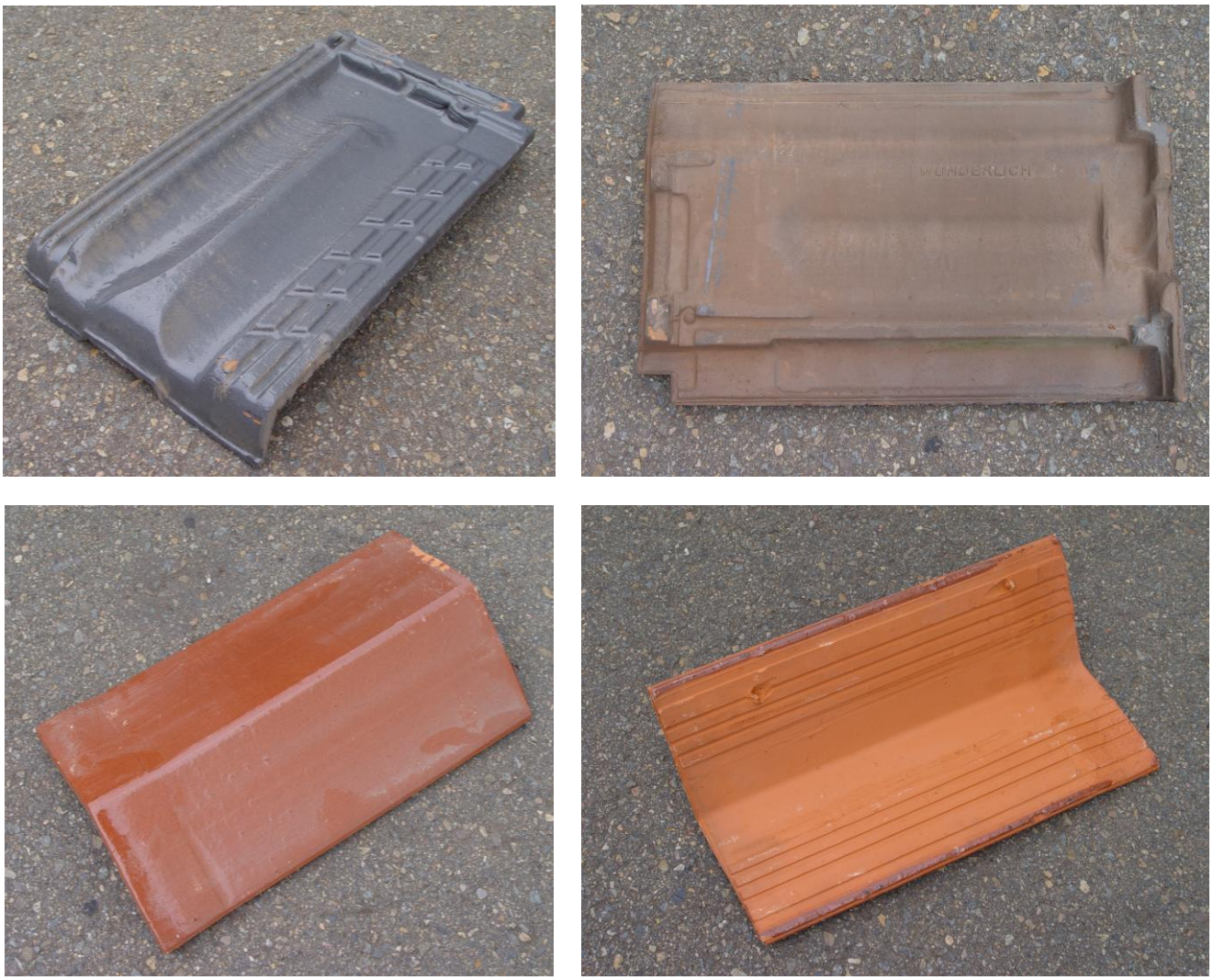

Figure 2 Wunderlich glazed terracotta roof and ridge tiles

The test roof segment and flexible pointing were installed using typical industry practices. Deviation from normal or standard practice occurred when the battens were fastened with screws to the test apparatus and the roof tiles were also fastened in place with a screw through the head of each tile. The reason for doing so was to ensure the part of the test roof segment not under assessment was sufficiently reinforced to resist the cyclic uplift force applied, and so not compromise the test results by precipitating a failure in the flexible pointing.

Figure 3 Installation of roof tiles

Once this part of the test roof segment had been installed, a bed of mortar – made according to the Standard from a sand and cement mix of 4:1 ratio – was laid along both top rows of roof tiles to accept the ridge tiles (Figure 4). The mortar bedding was arranged such that after placement of the ridge tile, the resulting bed of mortar would conform to a size approximating 50 mm ±10 mm wide with a finished height of 25 mm ±5 mm (Figure 5), as stipulated in the Standard.

Figure 4 Sand and cement mix

Figure 5 Mortar bed

The flexible pointing was applied to comply with the product application instructions (see Figure 1), stating, "*Apply at a uniform thickness of 3-5mm*". Application of the flexible pointing is shown in Figures 6, 7 and 8.

Figure 6 Application of flexible pointing on collar

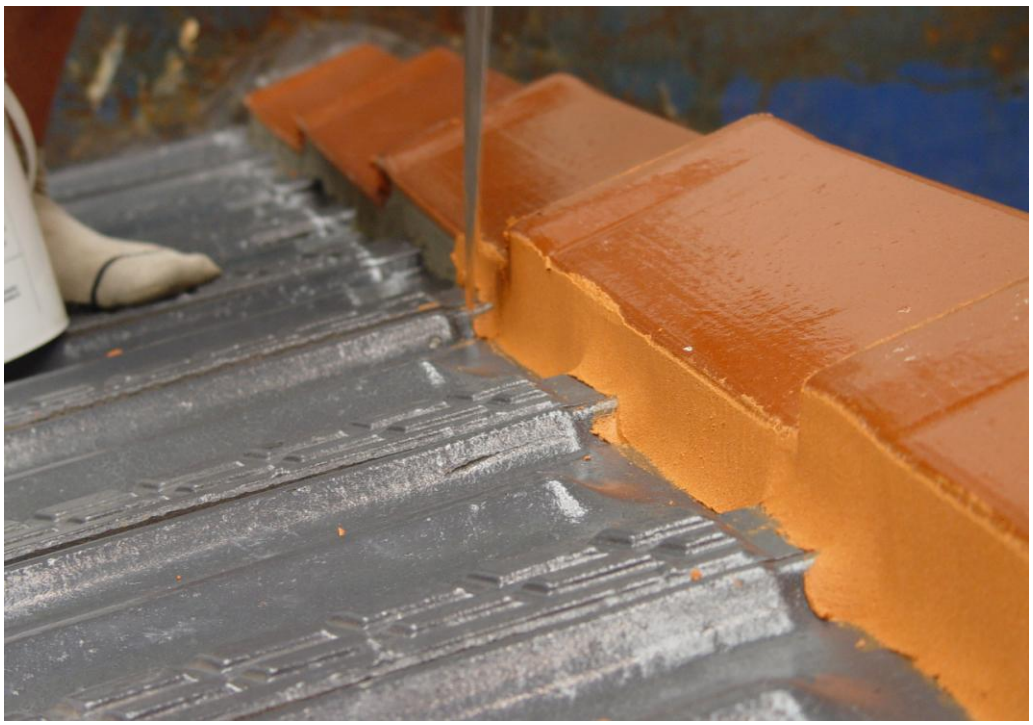

Figure 7 Application of flexible pointing along ridge

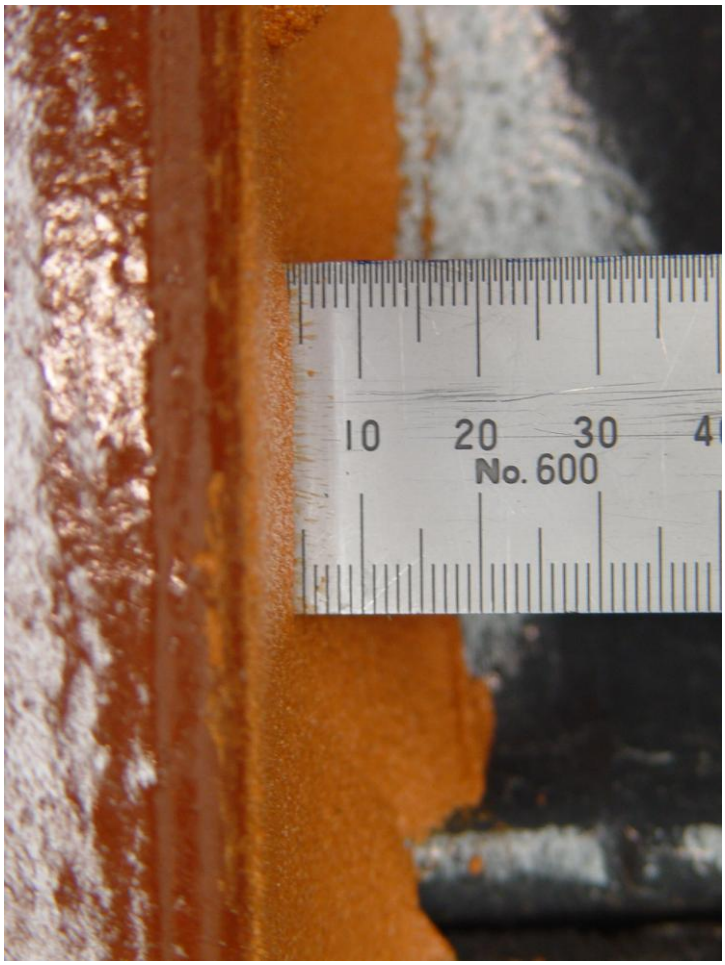

Figure 8 Typical depth indication of applied pointing

5 TEST APPARATUS

The testing apparatus used for applying cyclic fatigue loads consisted of: a steel framed roof segment; pressure chamber; hold-down beams; water spray system; cyclic valve mechanism; an electrically driven air blower; and calibrated digital manometer. Part of the apparatus is shown in Figure 9.

Figure 9 Test apparatus – steel framed roof segment and water spray system

The steel framed roof segment emulates a portion of a trussed frame type domestic dwelling roof. It is 2.4 metres in length, allowing for four rows of roof tiles, two either side of the ridge line, and accommodates six full ridge tiles. The roof segment is set to a pitch of 18 degrees and comprises rafters spaced at 600 mm intervals.

Hold-down beams are positioned over each row of roof tiles to prevent uplift, for the reasons previously stated. Plastic shims are used to fill any gaps between them.

Water is sprayed onto the specimen, for conditioning, using a set of spray nozzles positioned above and parallel to the ridge-line (see Figure 9). Flow is metered through a calibrated rotameter.

The pressure chamber is simply a large five sided box with viewing ports. Its base dimensions are the same as those of the roof frame segment. A gasket around the bottom underside edge of the chamber's perimeter forms an air-tight seal. The chamber has two ports for connecting the cyclic valve mechanism.

The cyclic valve mechanism consists of intake and exhaust ports, each having a rotating vane off-set to one another to produce the cyclic suction action. This mechanism is controlled by an electronic counter that is able to stop the mechanism at a preset cycle count.

6 TEST METHODOLOGY

Upon completion of the installation, the flexible pointing air-cured for at least 28 days before conditioning. During this time, gaps between the roof tiles were sealed with a flexible sealant to achieve an airtight seal, thereby allowing a suction pressure to be applied during testing.

At the completion of the 28 days period, the specimen was subjected to a minimum 72 hours conditioning by water saturation, at a rate of 0.05 L/m^2/s. As per the Standard, the area used to calculate the water spray rate includes the ridge tiles and one row of the tiles either side of the ridge tiles. The area calculated was 2.4 m^2, giving a water spray rate of 7.2 L/min.

The sponsor had requested the product be tested for a rating for cyclone prone areas, region 'C', wind class C3. The ultimate limit state design pressure calculated was 8.21 kPa. The steps used for calculation can be viewed at Appendix A.

The fatigue loading sequence given in AS 4046.8-2006, section 7, Table 1, is shown below in Table 1. Included, also, are the calculated test pressures for each range of test pressure.

Test Regime		**Test Pressures (kPa)**
Range of test pressure, p_d (kPa)	**Number of Cycles**	**C3**
0 to 0.40 p_d^*	8000	3.28
0 to 0.50 p_d	2000	4.11
0 to 0.65 p_d	200	5.34
0 to 1.00 p_d	1	8.21

Where,

* p_d = the ultimate limit state design pressure

Table 1 Test sequence as per AS 4046.8-2006, Table 1

The fatigue loading sequence was commenced immediately after completing conditioning; starting at the test pressure range of 40 percent at 8,000 cycles. The pressure was monitored using a calibrated digital manometer. The lower limit of the test pressure range did not exceed 10 percent of the upper limit of the same load cycle. The rate of load cycling did not exceed 3 Hertz, as per the Standard.

The fatigue loading sequence was done continuously. On completion of the required number of cycles for each test pressure range, the pressure was zero. The cycle count was then reset and the pressure adjusted before starting the next pressure range.

The final test pressure range, of one cycle at 100 percent of the ultimate limit state (ULS) design pressure, was held for at least one minute. Figure 10 shows the pressure attained during this cycle.

Figure 10 Indicated pressure at 1 cycle of 100% of the ULS design pressure

Testing deviated from the Standard in the conditioning of the specimen. Where the Standard states, "*The test roof specimen shall be conditioned by a continuous water spray for a minimum of 72 h.....immediately preceding and during the test*", the specimen was not conditioned during the test. The reason for this is that the test apparatus does not have this facility.

7 OBSERVATIONS & RESULTS

No signs of failure or distress in the flexible pointing were noted throughout the whole fatigue loading sequence.

Closer post-test inspection revealed the ridge tiles had remained intact and the flexible pointing appeared unchanged from before the test (Figure 11).

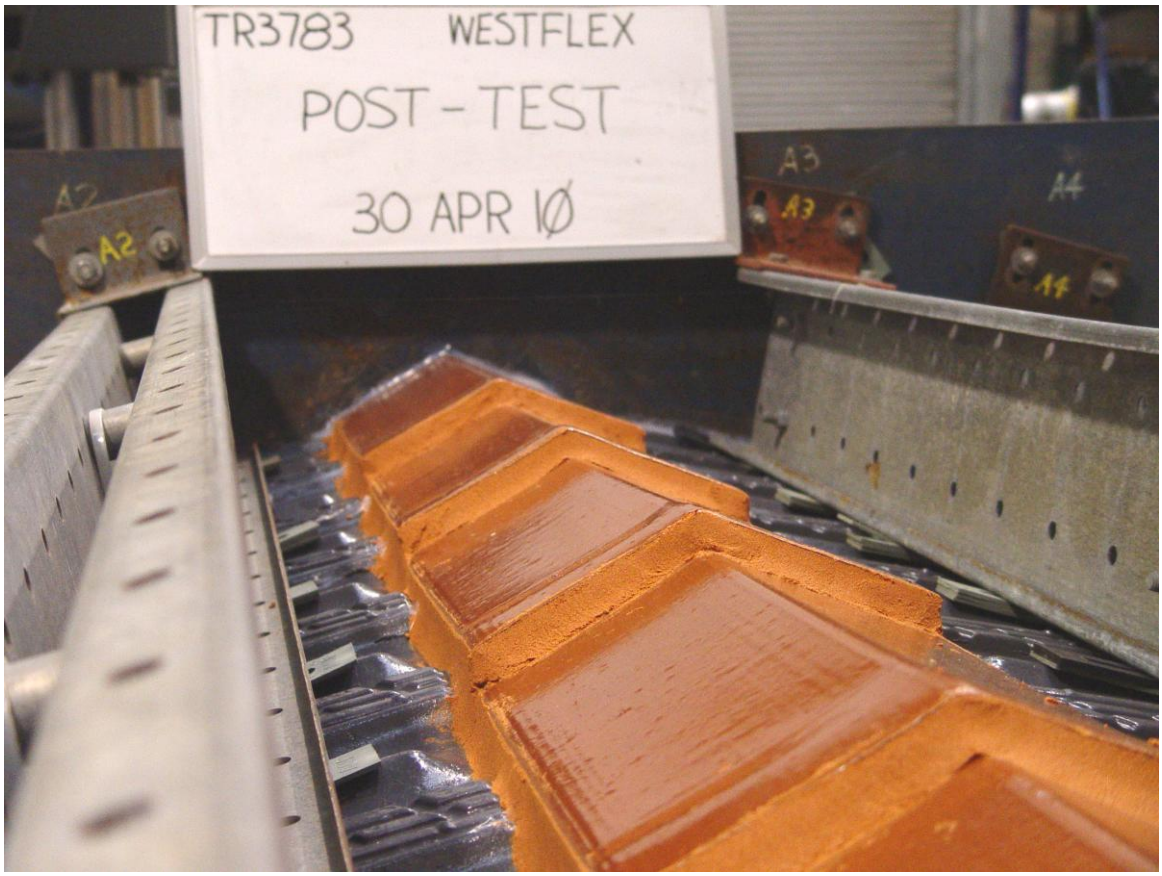

Figure 11 Post-test inspection

To further assess the quality of workmanship, cross-sections of the ridge tile, bedding, flexible pointing and roof tile were cut at random intervals from the test roof segment. This process is shown in Figure 12.

Figure 12 Locations of cross-section profiles

Inspection of the cross-section profiles revealed the bed of mortar was of dimensions nominal to those stipulated in the Standard. As well, the flexible pointing had dimensions nominal to those recommended in the product application instructions. An example of a typical profile removed from the test roof segment is displayed in Figure 13.

Figure 13 Typical cross-section profile

8 COMMENTS

The Westflex flexible pointing compound, product name “Star Point”, as supplied and installed, completed all cycles of the fatigue loading sequence outlined in Table 1 of AS 4046.8-2006, to an ultimate limit state design pressure of 8.21 kPa, without failure.

This flexible pointing compound, described herein, has passed the acceptance criterion of AS 4046.8-2006, for wind class C3, and, therefore, also satisfies the performance criteria for a completed roof as described in Clause 1.4 of AS 2050-2002, ‘*Installation of roof tiles*’.

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Appendices

Appendix A: Steps for calculation of test pressure

Appendix A: Steps for calculation of test pressure

Step	Steps for calculation of test pressure	Values
1	Determine the wind classification and region for which the testing needs to be carried out, in consultation with the client.	C3
2	Using AS 4055-2006, ascertain the maximum design gust wind speed (V_h) (Section 2, Table 2.1, page 8).	74 m/s
3	Using AS 4055-2006, determine the dynamic wind pressure (Section 3.2, equation 3.1, page 16). $p = q_u C_p$ Where, $q_u = 0.5\ \rho_{air}\ [V_h]^2$ and for C_p use the pressure co-efficient given in Table 3.2 (page 16) of AS 4055-2006.	**8.21** kPa
4	Use the value p from Step 3 to design appropriate cycles for fatigue loading sequence (AS 4046.8-2006, Section 7, Table 1, page 2).	

END OF REPORT

Prepared and issued by the Facade Engineering and Weather Performance of Buildings Group

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