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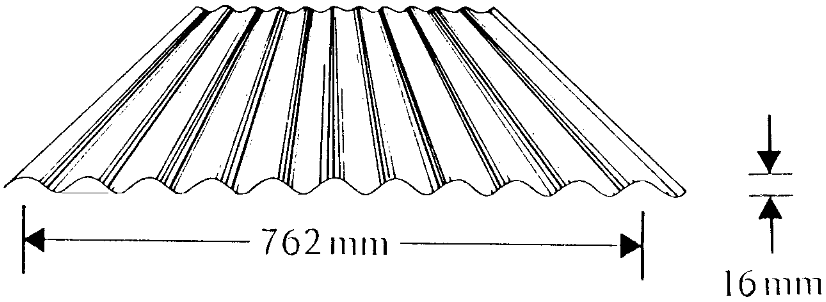
BEHAVIOUR OF DIFFERENT PROFILED ROOFING SHEETS SUBJECT TO WIND UPLIFT

Synopsis

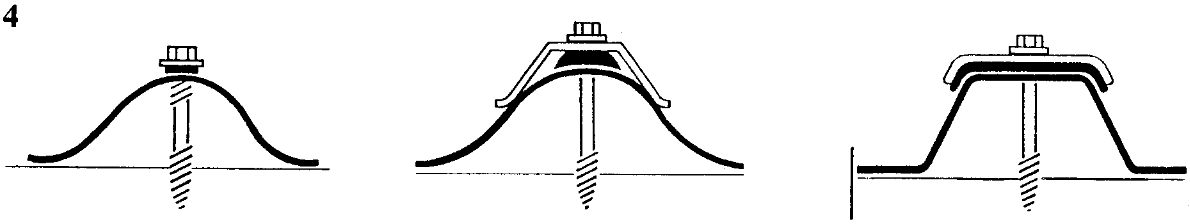
CONTENTS

1 INTRODUCTION

Profiled steel sheets play an important role in light gauge metal building construction, particularly as a roof cladding in houses, low rise commercial and industrial buildings. Numerous types of cold-formed roofing fastener reaction force was independent on roofing spans and could be



(a) Arc-Tangent Type



(a)
Screw Fastener

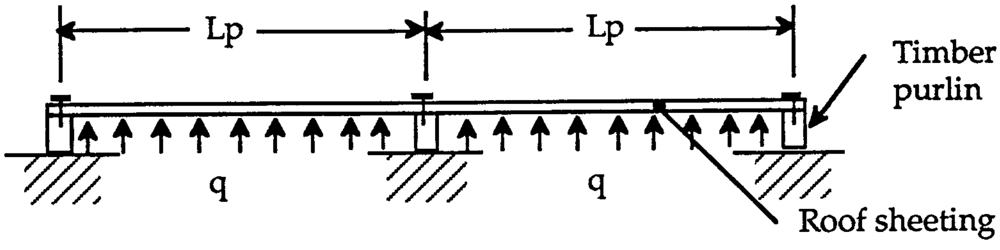
(b)
Screw Fastener with
Cyclone Washer for
Custom Orb

(c)
Screw Fastener with
Cyclone Washer for
Spandek and Trimdek

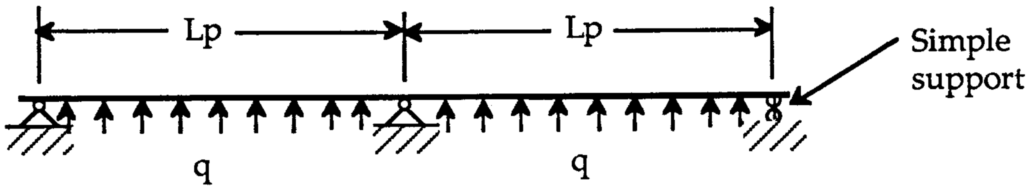
FIG.2.2 SCREW FASTENER AND CYCLONE WASHERS

2.2 Modelling of Prototype Roof Assembly

expensive and time-consuming due to the manufacture of the vacuum chamber system. The air bag method has the apparent advantage of both [redacted]



(a) Prototype



(b) Mechanical Model of Prototype

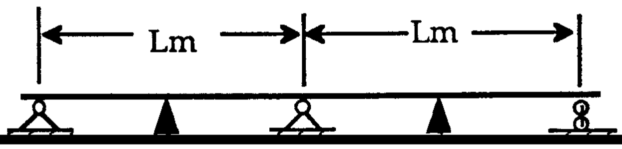
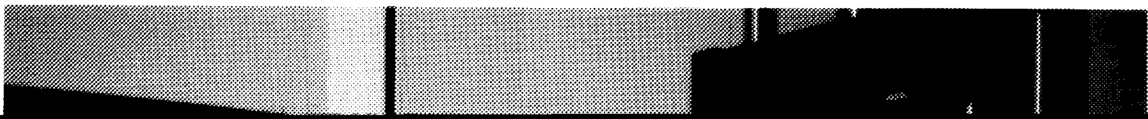
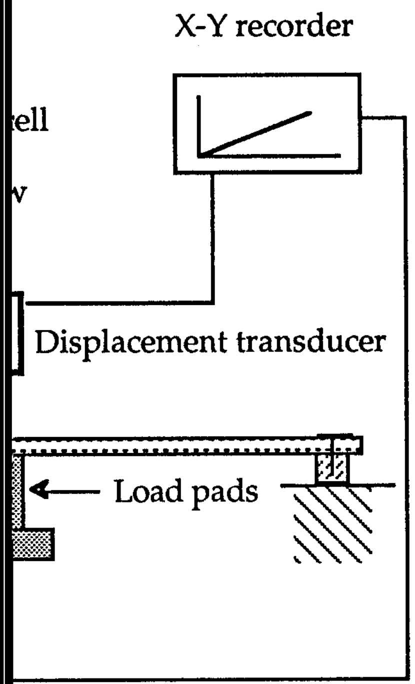


TABLE 2.1 ROOFING ASSEMBLY DETAILS IN THE TEST

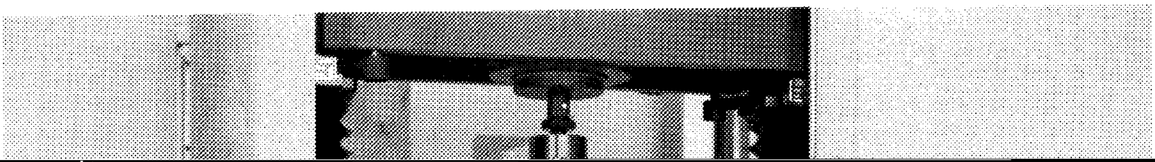




MENT

All tests were conducted by controlling the displacement of the movable ram of the Instron machine in order to follow the entire loading path through any unstable localised failure stages. The calibration results of the

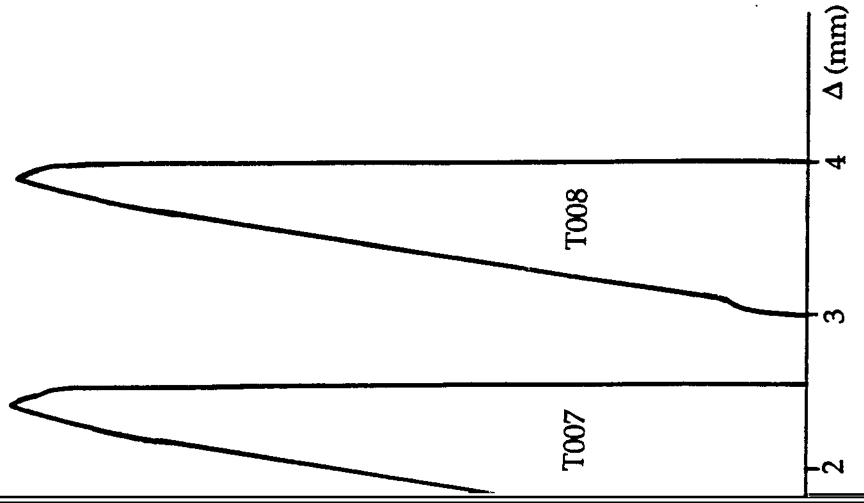
3.1 Test Pieces and Methods



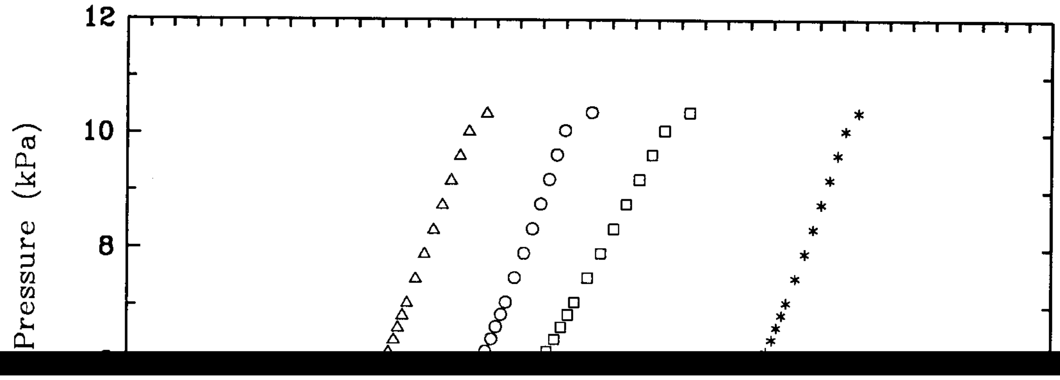
variation of the measured yield stress was small, but the total elongation was possibly larger than 2%. It also found that a larger strain rate of 9.5 x 10^{-4} did not significantly affect the material properties. Fig. 3.4 shows some

3.3 Properties in Transverse Direction.

Some properties of the sheeting material in the transverse direction were found to be different from those in the longitudinal direction. The [illegible]



TENSION CURVE IN
RSE DIRECTION

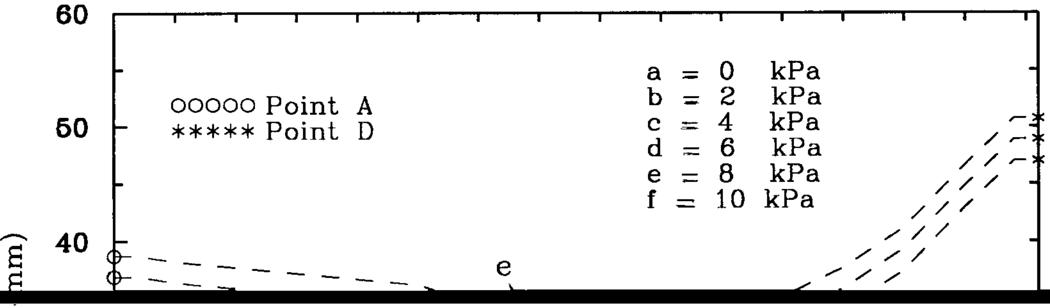

12
10
8
Pressure (kPa)

g

approximate)

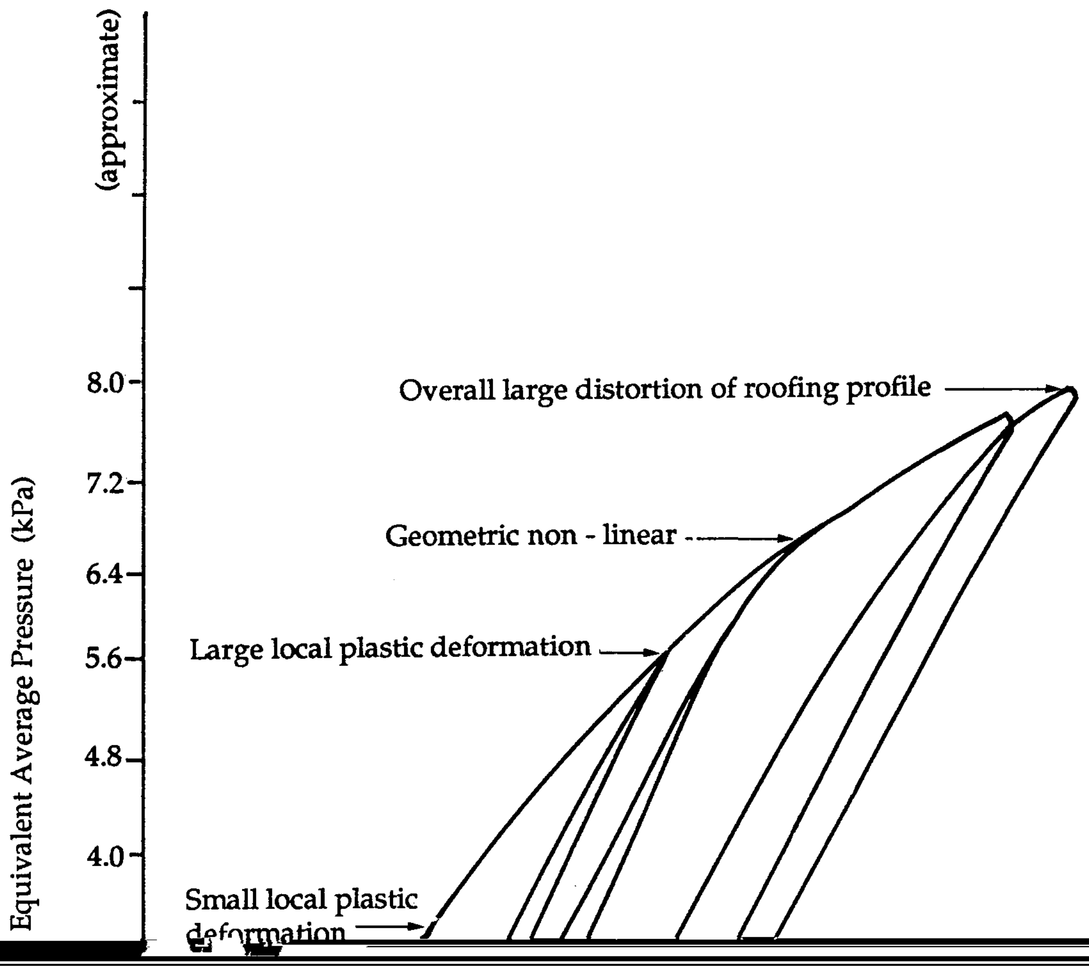
HEET

18


60
50
40
mm)
ooooo Point A
***** Point D
a = 0 kPa
b = 2 kPa
c = 4 kPa
d = 6 kPa
e = 8 kPa
f = 10 kPa
e

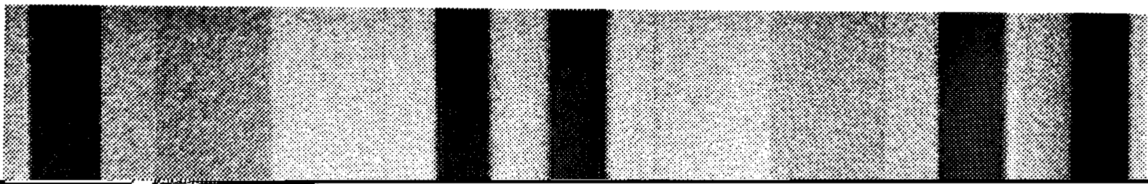
[redacted]

between the load and deflection appeared. Obviously, this deflection [redacted] roofing behaviour. The space between the first curve and the second curve


(approximate)
Equivalent Average Pressure (kPa)
8.0
7.2
6.4
5.6
4.8
4.0
Overall large distortion of roofing profile
Geometric non - linear
Large local plastic deformation
Small local plastic
deformation

Although the load-deflection curves shown in both figures seem to be linear until an equivalent pressure of about 5 kPa, small plastic dimples at the deflection was approximately linear again. When the load reached an equivalent pressure of 9.2 kPa, buckling of wrinkle type appeared in sheeting valleys around the midspan load pads. Shortly, crippling collapse occurred pressure increased to 3.6 kPa, a small plastic dimple appeared under the head of the screw fasteners at the central support, but caused a little influence on overall sheeting deformation as shown in Figs. 4.11 and 4.12. The area of the corresponding hysteresis loop was also very small, which indicated that there was no strong interaction between local and overall behaviour of the ribbed type roofing sheet. With the further increase of loading, the geometric deformation of roofing became obvious and the plastic dimples under the head of the screw fasteners became larger and larger, as shown in Fig. 4.13. The local plastic deformation of two sides of the crest, however, was not as

[redacted]



[redacted]

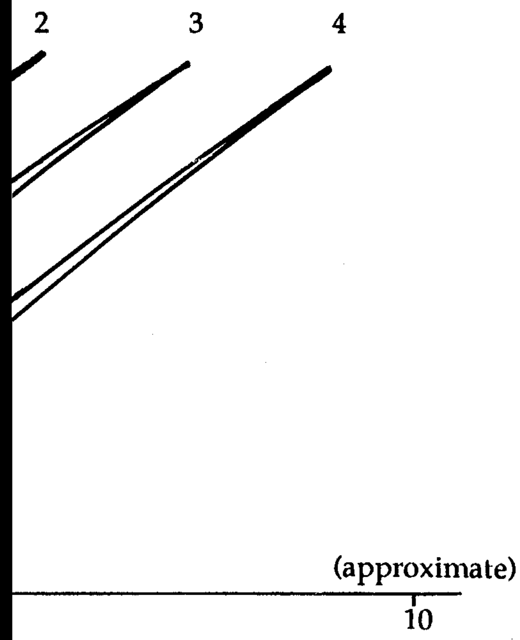
Fig. 4.15 shows the fastener force-deflection response of the arc-

[redacted]

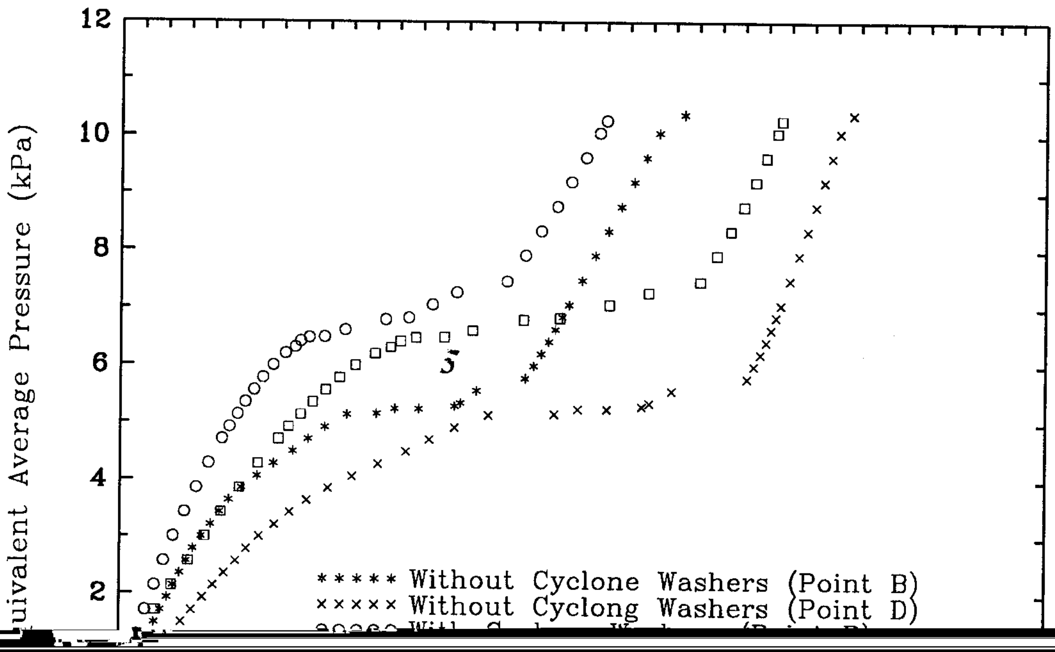
The experimental results also showed that both ribbed and trapezoidal [redacted] es

[redacted] of screw B*

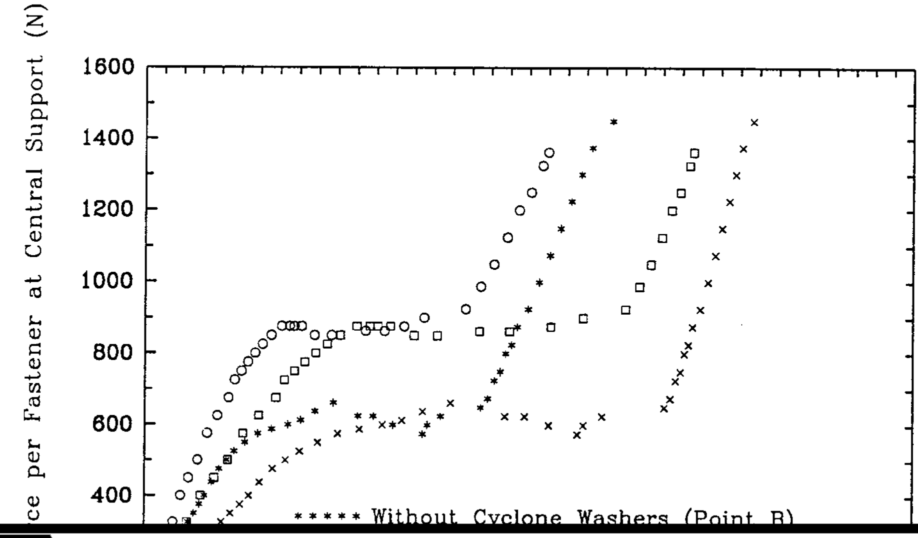
[redacted]

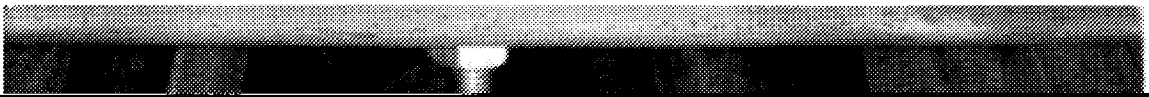


[redacted] ARC-TANGENT

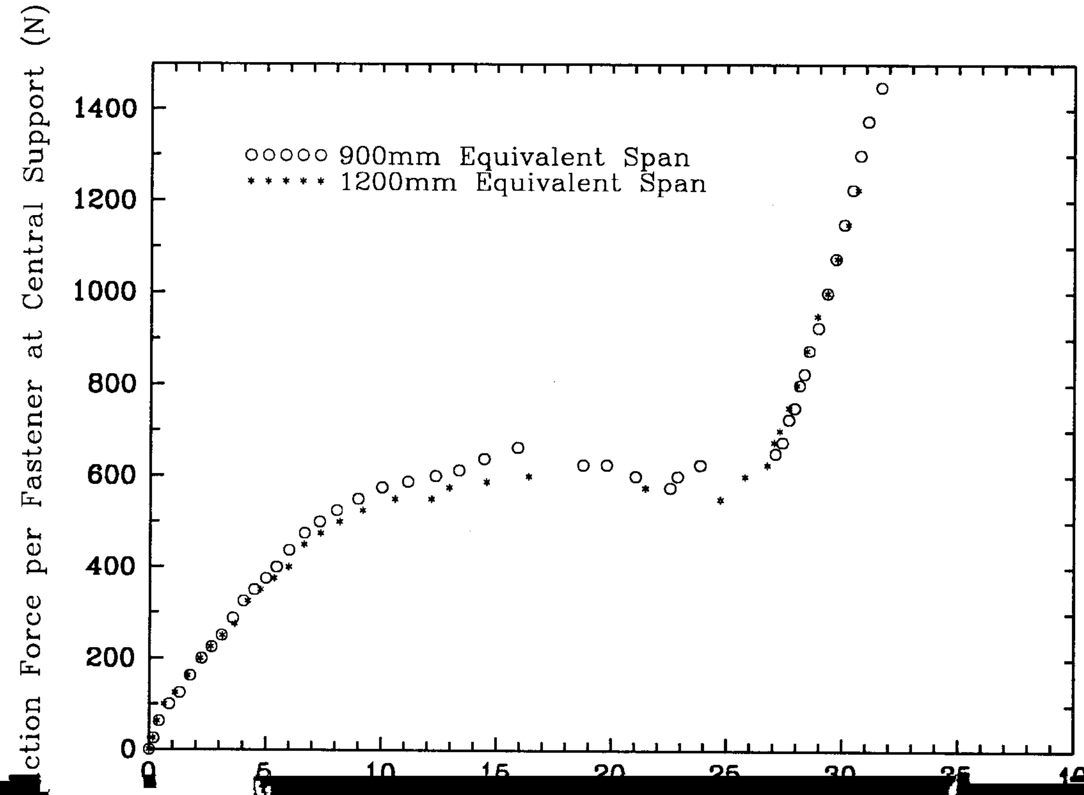

12
10
8
6
4
2
uivalent Average Pressure (kPa)
***** Without Cyclone Washers (Point B)
××××× Without Cyclong Washers (Point D)

wind uplift were closely related to the relation between the wind uplift and fastener reaction force. This is discussed in Section 6.1.





The effect of the cyclone washers on the overall structural behaviour of the ribbed type roofing sheet is showed in Fig. 5.7. The slope of the load-deflection curves was again increased, which means that overall sheeting deflection was reduced under a given wind uplift. The ultimate load was increased by a factor of 1.15. Form the fastener reaction force-deflection curves the ultimate fastener reaction force at the central support was found to be increased by a factor of 1.22. The increase of ultimate load or reaction limit values of load or fastener reaction force. The fact that the use of the


ction Force per Fastener at Central Support (N)
1400
1200
1000
800
600
400
200
0
ooooo 900mm Equivalent Span
***** 1200mm Equivalent Span
0
5
10
15
20
25
30
35

For the trapezoidal type roofing sheet, the difference of the limit pressure values between the equivalent 1200 mm and 900 mm span roofing sheets was quite large for the initial failure as shown in Fig. 5.10. The value corresponding to the long span roofing was about 5.5 kPa while the value for the shorter span was 8.6 kPa. It is noted that the ratio of the limit pressure values (8.6 kPa divided by 5.5 kPa) was larger than the ratio of the roofing sheet was due to overall buckling around the midspan pads rather than the abrupt fracture observed in the equivalent 900 mm span roofing. It is

SPANDEK roofing sheets, i.e., 0.47 mm and 0.53 mm (TCT). A static test

Another comparison as to effects of sheeting thickness was conducted between Lysaght CUSTOM BLUE ORB roofing sheet of 0.66 mm (TCT) and Lysaght CUSTOM ORB sheet of 0.47 mm (TCT). Both sheets are made from zincalume steel, but BLUE ORB sheeting material is more ductile, with a yield stress of 300 MPa.

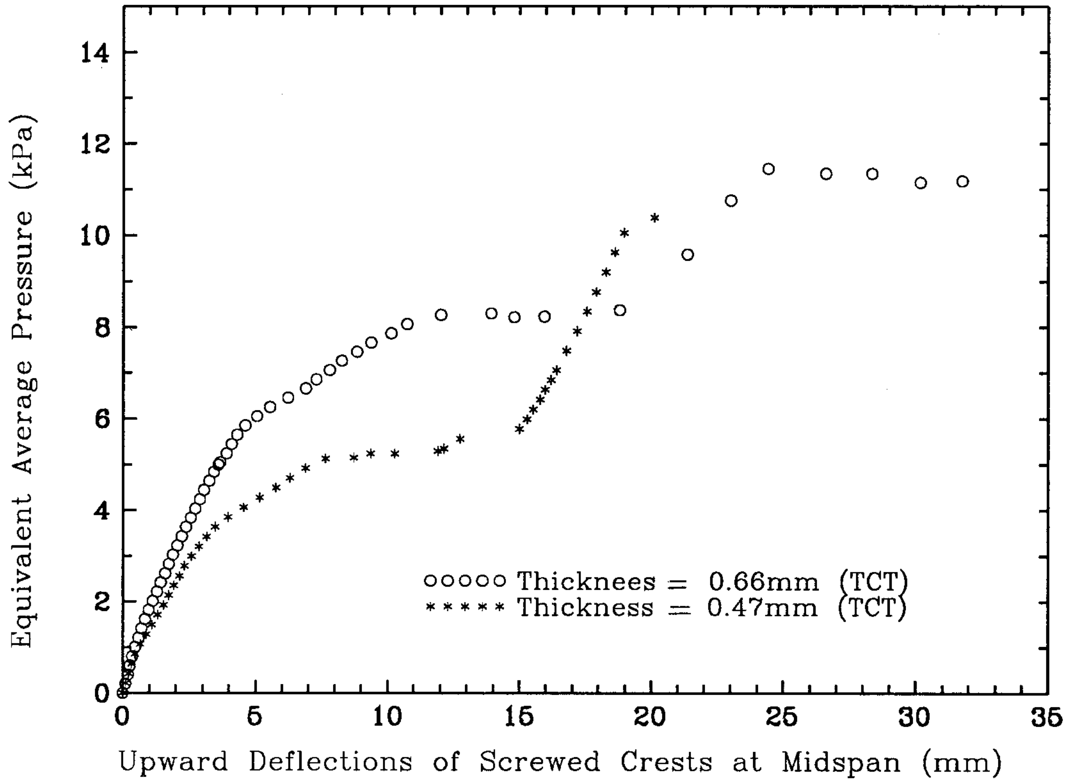
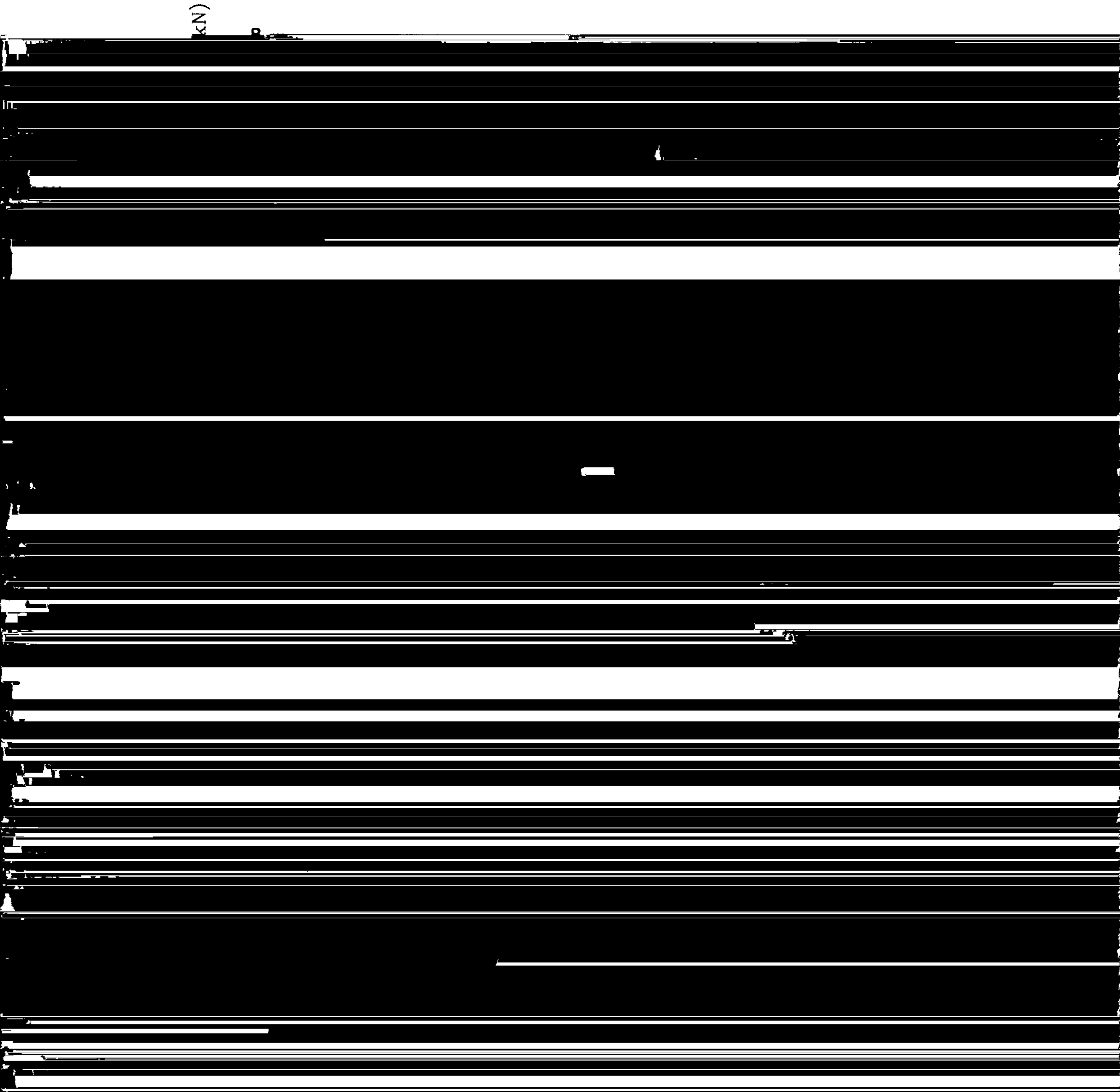


FIG 5.13 EFFECT OF SHEETING THICKNESS ON LOAD DEFLECTION

upper limit values of the reaction force per fastener were 1000 N and 1120 N, respectively, for the CUSTOM BLUE ORB sheet; 580 N and 650 N for the CUSTOM ORB sheet. However, if one only considered the first approximate linear stage, the limit value was 5.8 kPa for the equivalent pressure and 900 N for the reaction force per fastener in the case of CUSTOM BLUE ORB roofing sheet.

6. DISCUSSION OF MIDSPAN LOAD METHOD

Using the midspan load method to test roofing sheets is relatively easy and reaction force appeared and again followed the two-span continuous simply supported beam assumption. These observations were identical to the considered three cases. Therefore, the adopted assumption seems to be reasonable for the arc-tangent type roofing, except for the large cross-sectional distortion stage. In the current design procedure for roofing sheets, the limit value of "load" per fastener was first measured through roofing tests. Then the allowable wind pressure was calculated based on two span simple beam theory. Therefore, this design procedure usually provides a conservative value for the allowable wind pressure, especially at the large cross-sectional distortion stage of roofing sheets.



deformation in the long span case. It is also interesting to see that there was [redacted] not satisfactory. The cyclone washer reduced local plastic deformation, and the long span roofing sometimes had a relatively small local plastic type roofing sheet. In this way, the additional restraints between the roofing crests provided by loading pads were basically released. The measured wind uplift-deflection curve was plotted in Fig. 6.4 with the results obtained from

[redacted]

small. However, how to simulate distributed wind uplift on roofing in an than the other two types indicated a necessity of studying the shape, stiffness and size of cyclone washers relative to the shape, stiffness and size of roofing

D. Henderson, Mr. W. Morris and Mr. K. Abercombie in setting experiment or collecting data, and Mrs. W.J. Zhang in preparing graphs is also acknowledged.

9. References

Beck, V.R. and Stevens, L.K. (1976). " Constant repeated loading of

Mahendran, M., (1988), " Static behaviour of [illegible]