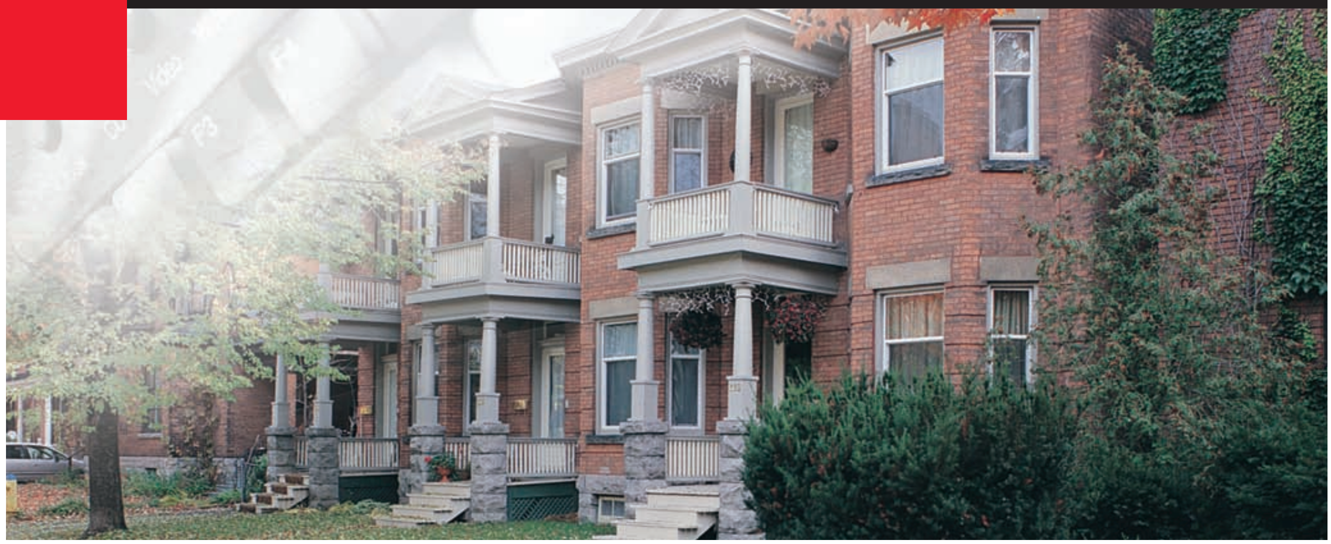
RESEARCH REPORT



Alternative Floor Bridging System

Canada

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ALTERNATIVE

FLOOR BRIDGING SYSTEM

BY

BRIG-EEZ INCORPORATED

DECEMBER 1992

"This project was carried out with the assistance of a grant from Canada Mortgage and Housing Corporation under the terms of the Housing Technology Incentives Program. The views expressed are those of the author and do not represent the official views of the Corporation."

ABSTRACT

Following computer modelling initial samples of product were made in the most common cross-bridging size (2" x 8" joists @ 16" ctrs). Many factors were discussed and analyzed prior to final prototypes prepared for testing.

A test bed of 12' x 20' using 2" x 8" joists @ 16" centres was constructed and allowed to dry for 15 days. Then standard 2" x 2" wood cross-bridging with bottom strapping was installed and controlled weight was applied to various areas and data recorded. This procedure was repeated using "*BRIG-EEZ*" Bridging System with a resulting deflection comparable to that of wood cross-bridging plus strapping.

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SUMMARY

This report summarizes activities in the project that support our efforts to confirm the viability of an alternative cross-bridging product for wood floor construction as in part 9 of the National Building Code of Canada.

The findings of this project are included in the various appendixes at the back of our report. Computer analysis was first used to confirm that the original concept had merit. Testing of prototype pieces on a measuring test bed confirmed performance guidelines consistent with deflections as allowed in wood span tables.

Various other issues as related to installation and use of "*BRIG-EEZ*" with subsequent services in a floor cavity were studied and confirmed to be very favourable.

Conclusions have been drawn showing this design concept to be very positive to the integrity of residential floor systems.

RÉSUMÉ

Le rapport résume les activités de recherche qui avaient pour but de démontrer la validité d'entretoises croisées de rechange, composantes d'un plancher de bois conforme à la partie 9 du Code national du bâtiment du Canada.

Les conclusions de cette recherche se trouvent dans les annexes, à la fin du rapport. Une analyse informatique a d'abord déterminé que le concept d'origine était valable. Les tests des prototypes effectués sur banc d'essai ont permis d'établir des grandes lignes de performance conforme aux flèches dont font état les tableaux des portées d'éléments en bois.

Divers autres aspects relatifs à la pose des entretoises croisées «BRIGEEZ» et au jumelage de services dans la cavité du plancher se sont révélés, après étude, très efficaces.

Les conclusions tirées montrent que ce concept peut très bien contribuer à la solidité de l'ossature de plancher d'un bâtiment résidentiel.

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BACKGROUND STATEMENT

The product "*BRIG-EEZ*" was conceived as a replacement product for cross-bridging systems now in use in North America in the home building industry including manufactured homes and light commercial buildings.

Floor systems at present suffer from, bouncing, squeaking and vibrations, mainly as a result of the removal of existing bridging systems as required to facilitate services such as heating, plumbing, central vacuum, high efficiency exhaust vents and fresh air intake pipes.

Although cross-bridging as presently used does an adequate job when installed continuous, this in reality is never the case, and since all wood span tables are based on continuous cross-bridging, we feel that it was time to develop a product that was not disposable, and once installed would be a permanent structure in the flooring system and bring the floor system into the 21st century.

PROJECT OBJECTIVES

This project was initiated to develop and test various prototypes to confirm that the original design concept for "*BRIG-EEZ*" was viable from all points of view. The primary objective being the development of a product for bridging in floor systems that was non-disposable and once installed would be a permanent structural member which would maintain the integrity of the bridging system and the overall floor system.

A second project objective was to establish additional benefits to direct and indirect users of the continuous cross-bridging system.

A final objective was to prove the strength of the "*BRIG-EEZ*" Product as comparable to existing wood cross-bridging systems as fully installed as required for various span tables, and partially installed as is the case in the field.

PRODUCT DESCRIPTION

The "BRIG-EEZ" Product design was based on a basic desire to create a cross-bridging product with the same or greater strength of existing wood cross-bridging systems, incorporated in a one piece easy to install design.

Therefore it was thought from the outset that the centre section should be unobstructed in all joist spaces to allow for the easy passage of all other services which share the cavity in a floor system. (See appendix 'C' page 23)

The idea of a one piece stamped or formed truss design was thought to be the most economical from a production point of view while giving the added benefit of ease of installation by the framing contractor.

PRELIMINARY DESIGN CONCERNS

The "*BRIG-EEZ*" shape was thought to be the best combination of structural stiffness and open space, while addressing our concerns of a truss-type design.

We needed to address issues such as materials, ribbing, folding etc. We were concerned with availability of materials and production methods keeping in mind our target market and end user. Of course price was of some concern as our desire was to make a competitive product that would gain quick acceptance in the building industry.

It was important that the design be user friendly and not the bridging be removed when subsequent trades install their services in these areas.

PRELIMINARY COMPUTER MODELLING

At an early stage it was decided to address various design aspects of the "*BRIG-EEZ*" Product by computer modelling of our first hand built sample.

Our intention was to look at material selection and gauge, and to verify that structural relationships between ribs, webs and flanges worked as desired.

The modelling produced very favourable results changing our original design only slightly, while providing variable issues on the plus and minus side structurally for our decision making. This work was carried out by Pow, Peterman & Associates Inc., and is included as Appendix 'A' on pages 17, 18, 19, 20 and 21.

PROTOTYPE DEVELOPMENT

Once the "*BRIG-EEZ*" Product design parameters were established the first hand made prototypes were fabricated for "Feel and Touch" observations allowing additional ideas to be discussed prior to computer modelling.

The firm of Pow, Peterman & Associates Inc., provided invaluable new information in their computer modelling and the second generation prototypes were made incorporating the latest ideas. These second prototypes were used for in house testing under the direction of Pow, Peterman & Associates Inc.

After testing the "*BRIG-EEZ*" Product under controlled conditions and documenting all installation procedures, drawings and specifications were altered slightly and the third generation prototypes were made for use in marketing and additional sampling. (See appendix 'D' page 24)

TEST BED

A test bed was constructed, based on consultation of the engineering firm of Pow, Peterman & Associates Inc. A partial foundation was constructed and a floor system was constructed that was typical of many housing floors.
(See appendix 'E' page 25)

One of the most common floor joist combinations is 2" x 8" spruce @ 16" ctrs. We built our test bed using that combination with a clear span of 11'-6". In order to facilitate testing the normal plywood subfloor was omitted and a 1" x 4" continuous strap was installed on top of the test joist over the bridging location.

TEST PROCEDURES

The test procedures were established by consultation with Pow, Peterman & Associates Inc. Four basic variances of continuous bridging were analyzed using point loadings at various numbered joist locations.

At first we installed standard 2" x 2" wood cross-bridging with a continuous 1" x 4" wood strap top and bottom at the cross-bridging location. All joists were numbered and 230 lbs were applied to various joists and measurements for deflection were taken before, during and after the loads were applied. These measurements were recorded.

The same procedure was used with standard 2" x 2" cross-bridging with the continuous bottom strap removed. We then removed 25% of the cross-bridging, as is typical in most homes, and retested.

Then 25% of removed cross-bridging was replaced with our "*BRIG-EEZ*" Product and retested. The final test was done with a complete installation of "*BRIG-EEZ*" without the installation of bottom strapping.
(See appendix 'F' pages 26-42)

TEST RESULTS

On site tabulation of all test results was handled by Pow, Peterman & Associates Inc., by Mr. Dave Pow. His notes were complied in tabular form for later use in preparation of formal tables.

In summary the "*BRIG-EEZ*" Product performed to an equal or better level than combined 2" x 2" cross-bridging and 1" x 4" continuous strapping on the bottom side of the 2" x 8" joists @ 16" ctrs.

The final test results on 2" x 8" joists are most encouraging as it is felt that this is the weakest combination of floor joists and cross-bridging combinations. Cross-bridging in 2" x 2" wood or "*BRIG-EEZ*" Product is more effective as floor joists increase in depth and the truss section of cross-bridging becomes more substantial. (See appendix 'F' Pages 26-42)

SIDE BENEFITS

Several important side benefits were realized through our development and testing program of our "BRIG-EEZ" Product.

The redesign of the centre opening resulted in greater web stiffness, resulted in greater structural strength which will benefit subsequent service installations when "*BRIG-EEZ*" is used as a pipe hanger.

Adding the bottom side tabs, to allow for shrinkage of wood joists and additional lateral bracing, acts as a slide tab which makes "twist" installation easy.

Tabs added to the centre opening allow subsequent service installers to attach pipes or clips to "*BRIG-EEZ*" for a positive connection to limit movement of their assemblies after coverup.

COST ANALYSIS / TIME ANALYSIS

INSTALLATION TIME

While our test bed was in place, we timed the nailing and installation of the top side of 2" x 2" wood cross-bridging for a sample floor area of 240 sq. ft. However we did not install the 1" x 4" strapping on the bottom of the joists as would be necessary to comply with the maximum permissible span in the building codes. We also timed installation of "*BRIG-EEZ*" and nailing the top only. As is required in house construction the bottom side of all cross-bridging systems is nailed after sub-floor installation.

The resulting times indicated that our "*BRIG-EEZ*" Product can be installed 440% faster. (See appendix 'B' page 22)

COST ANALYSIS (1920 SQ. FT. HOME)

Standard 2" x 2" cross-bridging		
Material 120 pcs. @ .60	=	$72.00
Labour 2 hrs. @ $30.00	=	$60.00
TOTAL		$132.00

"*BRIG-EEZ*" Product		
Material 120 pcs. @ $1.80	=	$216.00
Labour 1/2 hr.@ $30.00	=	$15.00
TOTAL		$231.00

Typical additional cost for an average home for a superior "*BRIG-EEZ*" floor system is $100.00

CONCLUSIONS

We are very satisfied with the results of this project as all areas have given us positive results.

All objectives have been met, there have been no failures.

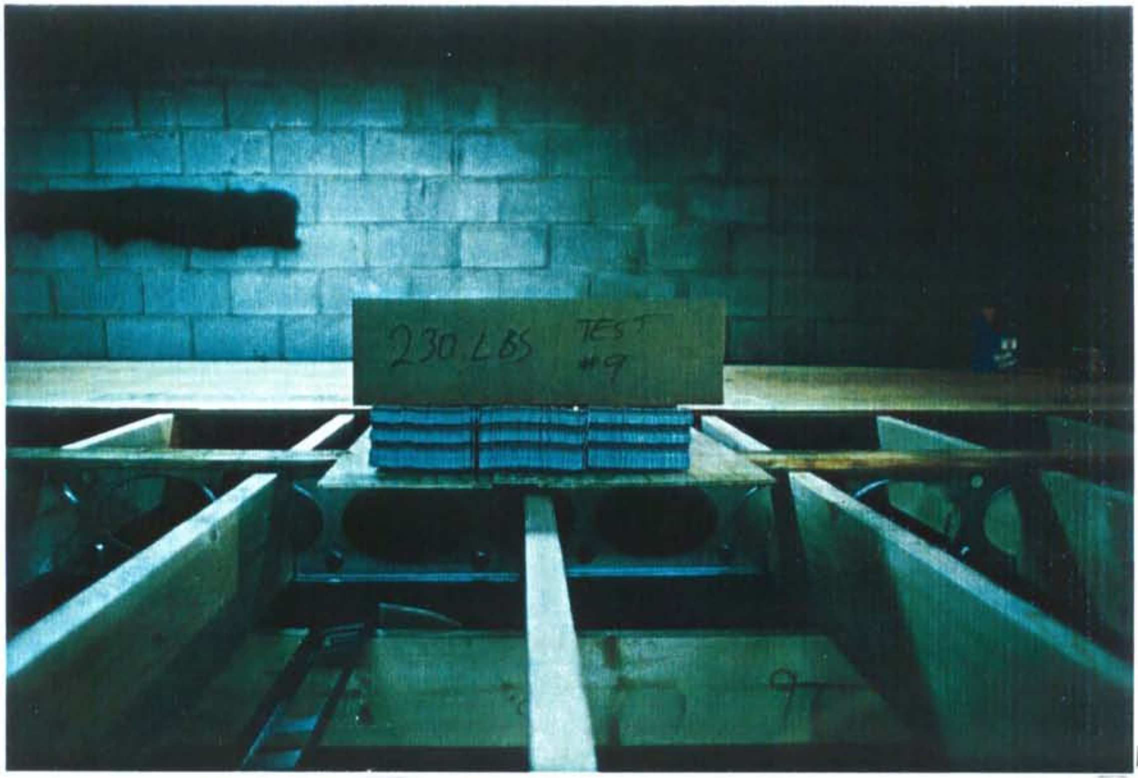
On the strength issue our test indicates that "BRIG-EEZ" has comparable strength to wood cross-bridging including 1" x 4" strapping as indicated in the wood joist span tables in the building codes. Our tests reveal results in line with section A-9.23.4.1 (2) of the O.B.C.

Hands on testing enabled us to make additional modifications to both shape and utility to enhance our product.

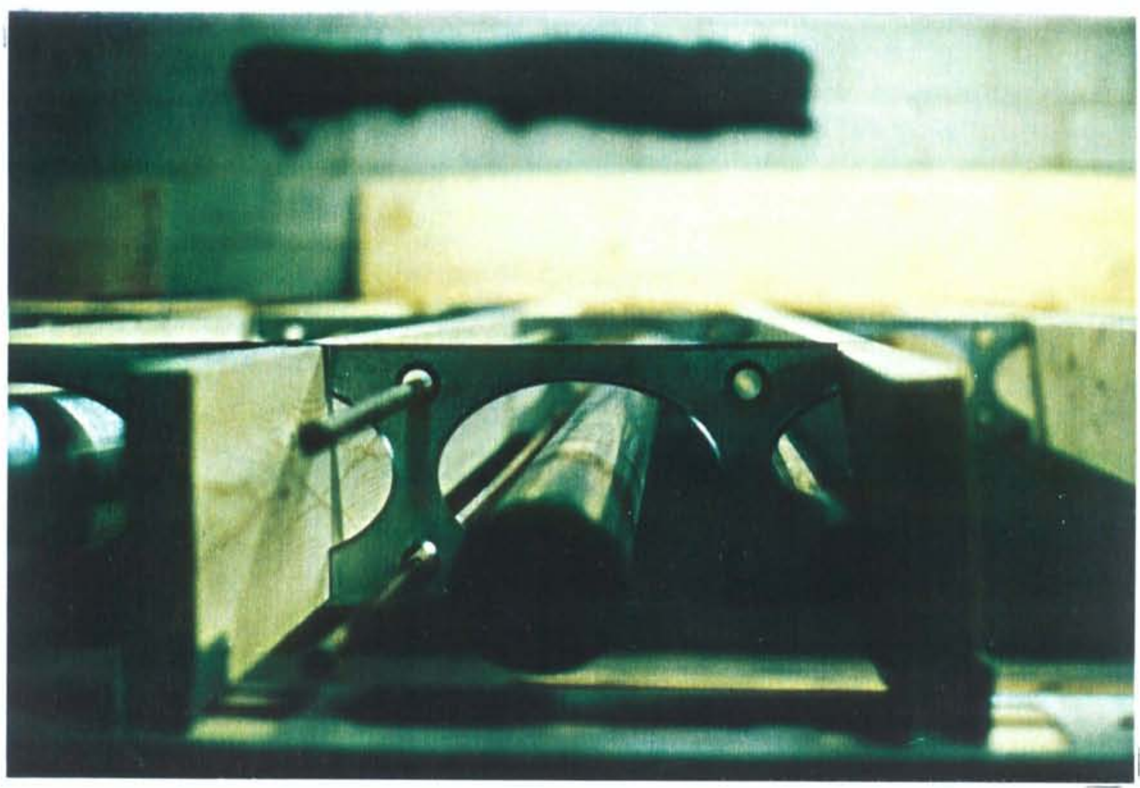
The project has allowed us to analyze production and installation techniques to help produce an alternative bridging product at a competitive price.

"BRIG-EEZ" TEST BED

"BRIG-EEZ" INSTALLED IN TEST BED

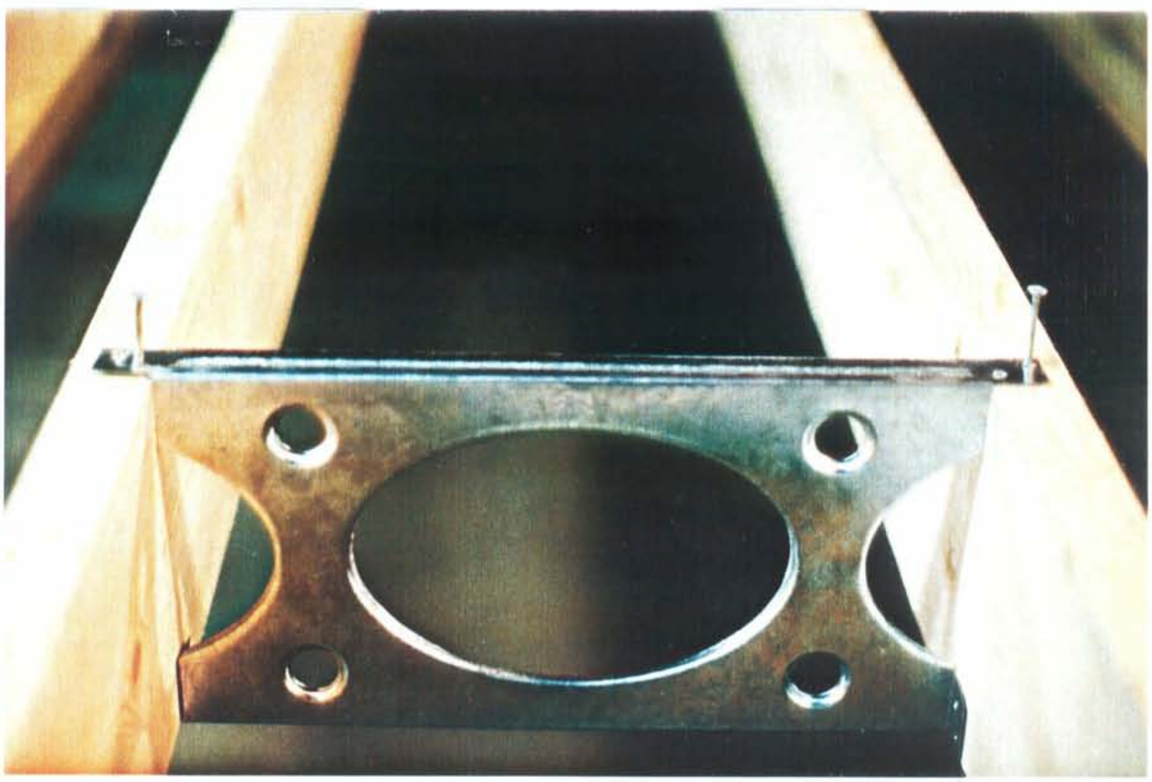


TEST BED SHOWING "LOADING" OF FLOOR JOIST.



"BRIG-EEZ" WITH SERVICES INSTALLED

INSTALLING "BRIG-EEZ"



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PRELIMINARY FINITE ELEMENT ANALYSIS

FOR

BRIG-EEZ INCORPORATED

8" BRIDGING UNIT

PREPARED FOR: Mr. Steve Okopny
Mr. Warren Eberschlag

Date: August 17, 1992

PREPARED BY: Mr. David J. Pow, P. Eng.,

POW, PETERMAN & ASSOCIATES INC.
Consulting Engineers,
P.O. Box 1087, 63 Ridgeway Circle, WOODSTOCK, Ontario. N4S 8P6.

Phone: (519) 539 - 8501 Fax: (519) 537 - 7894

SUMMARY OF FINITE ELEMENT MODELLING

Client: BRIG-EEZ INC.
Date: August 17, 1992
Reference: 92172
Description: Bridging Unit for 2 X 8" Floor Joists

Base Unit Description - See Figure 1.

Material: Steel - E = 30E6 psi
Fy = 33,000 psi
t = 0.024 in

Dimensions: Depth - d = 7.25 in
Length - l = 15.00 in

The following configuration was used for the base analysis:

- 5.25 X 8.00" duct hole with elliptical shape with 0.375" flange on duct hole

- 4.55 X 2.00" side cutout with elliptical shape with 0.375" flange on duct hole

- four electrical holes as per standard insert requirements place 2.50" vertically and 4.625" horizontally from center

- 0.75" wide flange horizontally top and bottom with 0.125 deep X 0.35" wide rib placed 0.25" from web

- 0.75 X 0.90 horizontal tabs placed in four corners with ~0.125" gap between web and edge of joist for support condition

- 1.00 X 1.35" vertical tabs placed on two lower web sections with one fastener placed into joist at center of tab

- no ribs in web area around the electrical openings

- rigid element to act as subfloor on top of unit between tabs

- boundary conditions on top horizontal flanges for flooring sandwich effect

- boundary conditions on bottom horizontal flanges to simulate truss effect

- boundary conditions on vertical tabs to allow for rotation about fastener

SHEAR MODULUS FOR BASE UNIT AND GEOMETRY MODIFICATIONS

A. Base Unit Results - See Figure 2.

The analysis was performed with an applied vertical load 100 lbs transferred from one side of bridging to the other in an attempt to address the criteria for floor vibrations specified in the O.B.C. For example, a 2 X 12" joist spanning 17'-0" would require a transfer of ~ 2 X 60 lbs through the two adjacent bridging units to keep deflection to below 2 mm when a concentrated load of 225 lbs in applied. This would cause a maximum deflection of 0.5 mm on the adjacent joists. The shear modulus of the bridging is the number of lbs vertical load required to deform the bridging 1" vertically. Therefore, a shear modulus of 60 lbs per 1.5 mm is required (= 1000 lbs/in). If 1.25 mm of total movement occurs in the fasteners at both ends, then a shear modulus, as analyzed, would have to be 60 lbs per 0.25 mm (= 6100 lbs/in). The shear modulus for the base unit is 5000 lbs/in without accounting for the flexibility of the fasteners.

Shear Modulus = Sm = 5000 lbs/in
Maximum Stress in web area of unit = 13,500 psi
Maximum Stress in tab area of unit = 15,000 psi
Allowable Stress = 33,000 X 0.67 = 22,000 psi

B. Modifications to Base Unit

The following list indicates the benefits and limitations to various geometry and installation changes to the unit. The movements are relative to the base unit analysis.

Description of Change	Movement	Shear Modulus
1. Double Nail one Vertical Tab only - no rotation - see Figure 3	- 9%	Sm = 5500 lbs/in
2. Double Nail two Vertical Tabs - no rotation	- 20%	Sm = 6300 lbs/in
3. Four Vertical Tabs Double Nailed - no rotation - see Figure 4	- 36%	Sm = 7800 lbs/in
4. Increase Material Thickness to 0.030"	- 24%	Sm = 6600 lbs/in
5. No Fasteners in Vertical Tabs - - see Figure 5	+ 230%	Sm = 1500 lbs/in
6. Increase Duct Hole by 10% to 5.75 X 8.8" - see Figure 6	+ 44%	Sm = 4350 lbs/in
7. Decrease Material Thickness to 0.018"	+ 42%	Sm = 3514 lbs/in
8. Increase Duct and Side Hole Flange to 0.75"	- 2%	Sm = 5100 lbs/in
9. Include Ribs on Web area near Electrical Holes - see Figure 7	- 6%	Sm = 5300 lbs/in

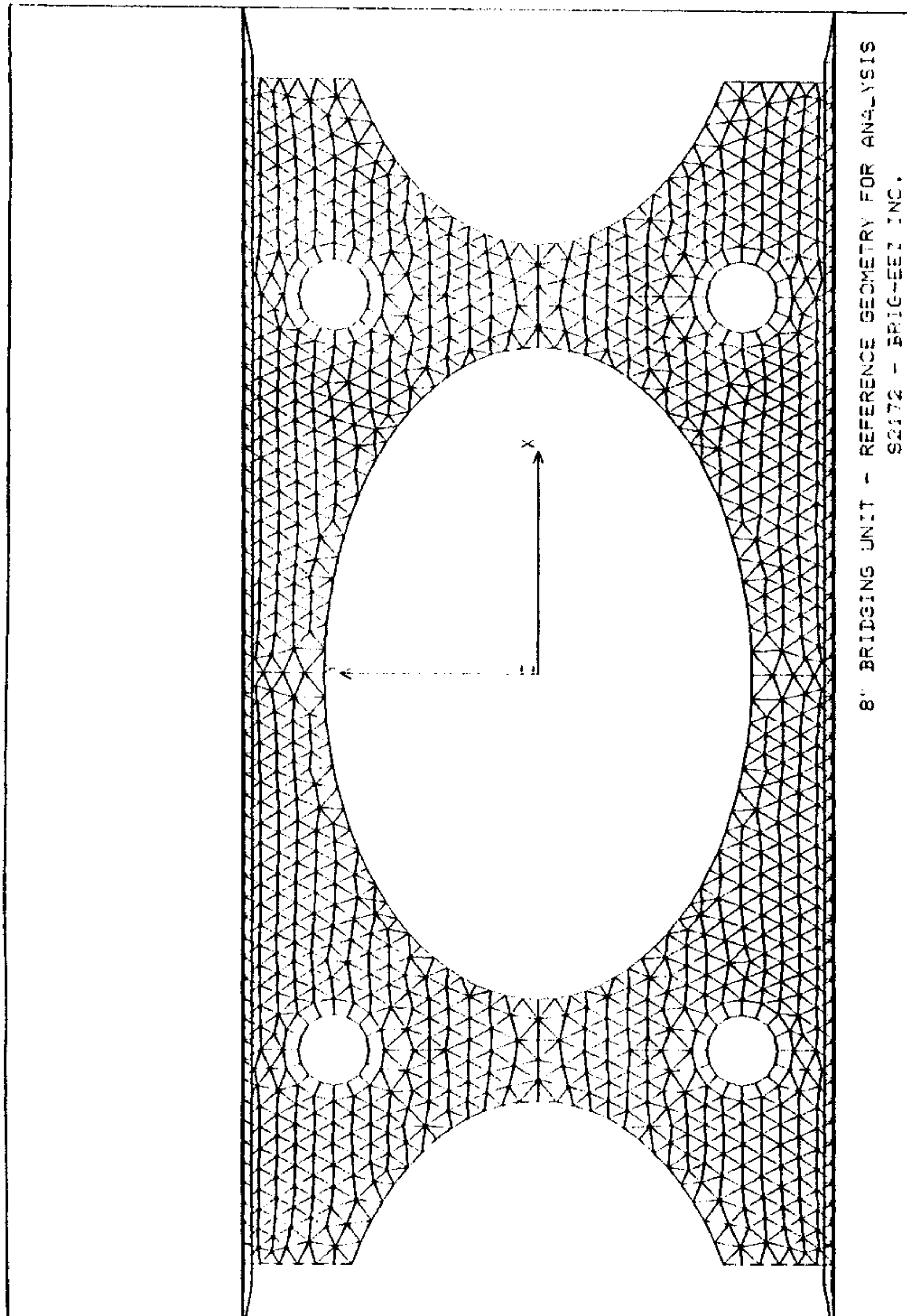

FIGURE 1 - 8' BASE UNIT GEOMETRY

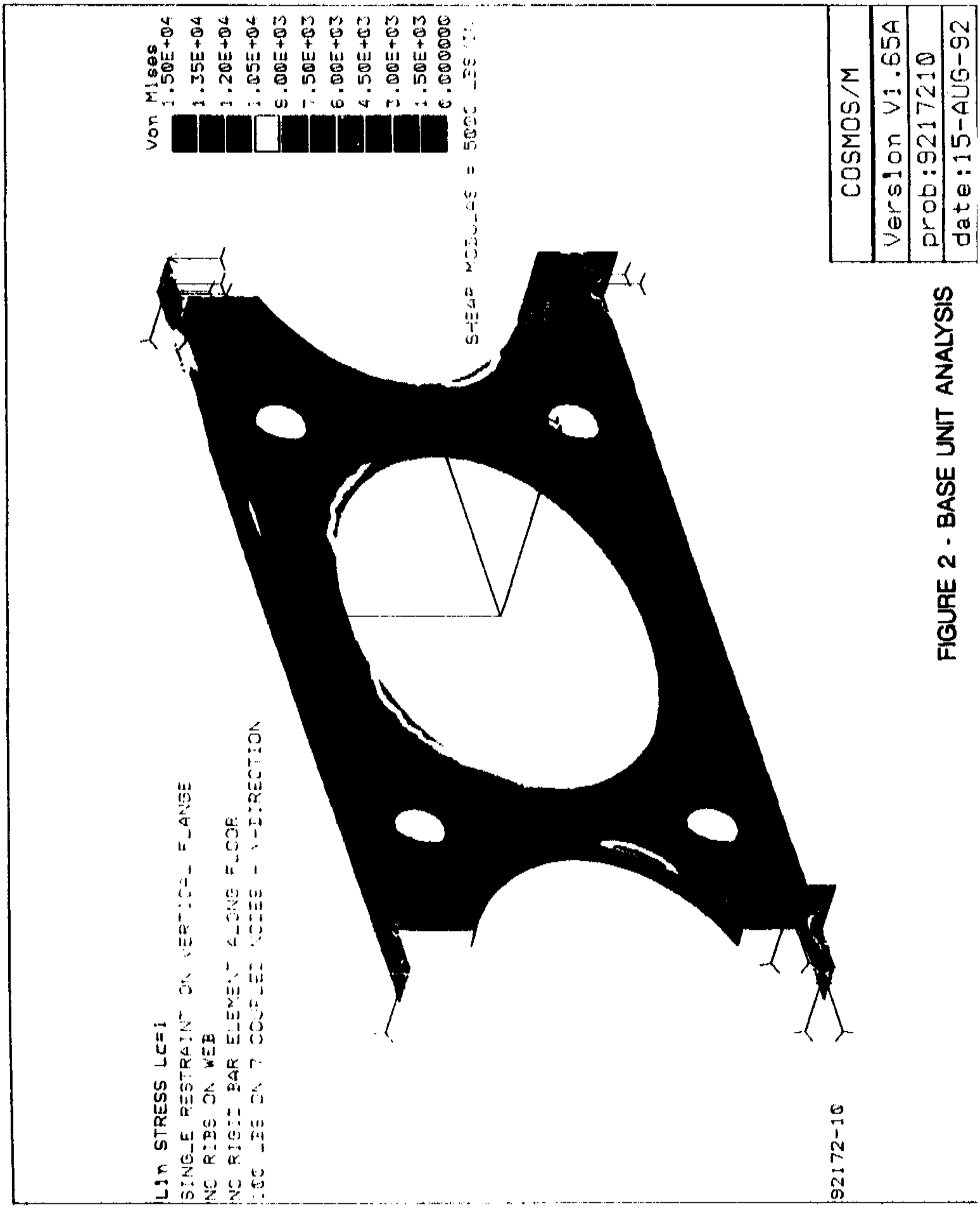

FIGURE 2 - BASE UNIT ANALYSIS

BRIG - EEZ
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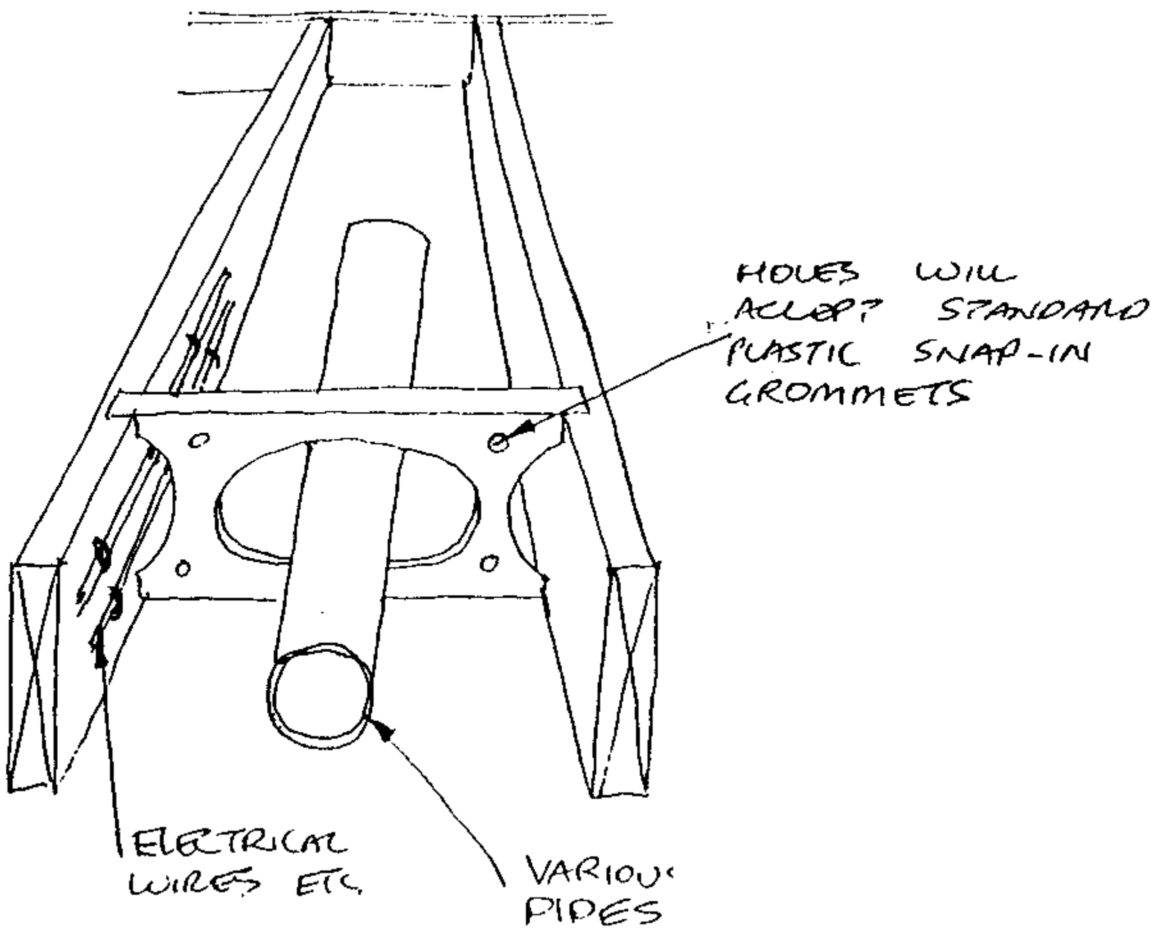
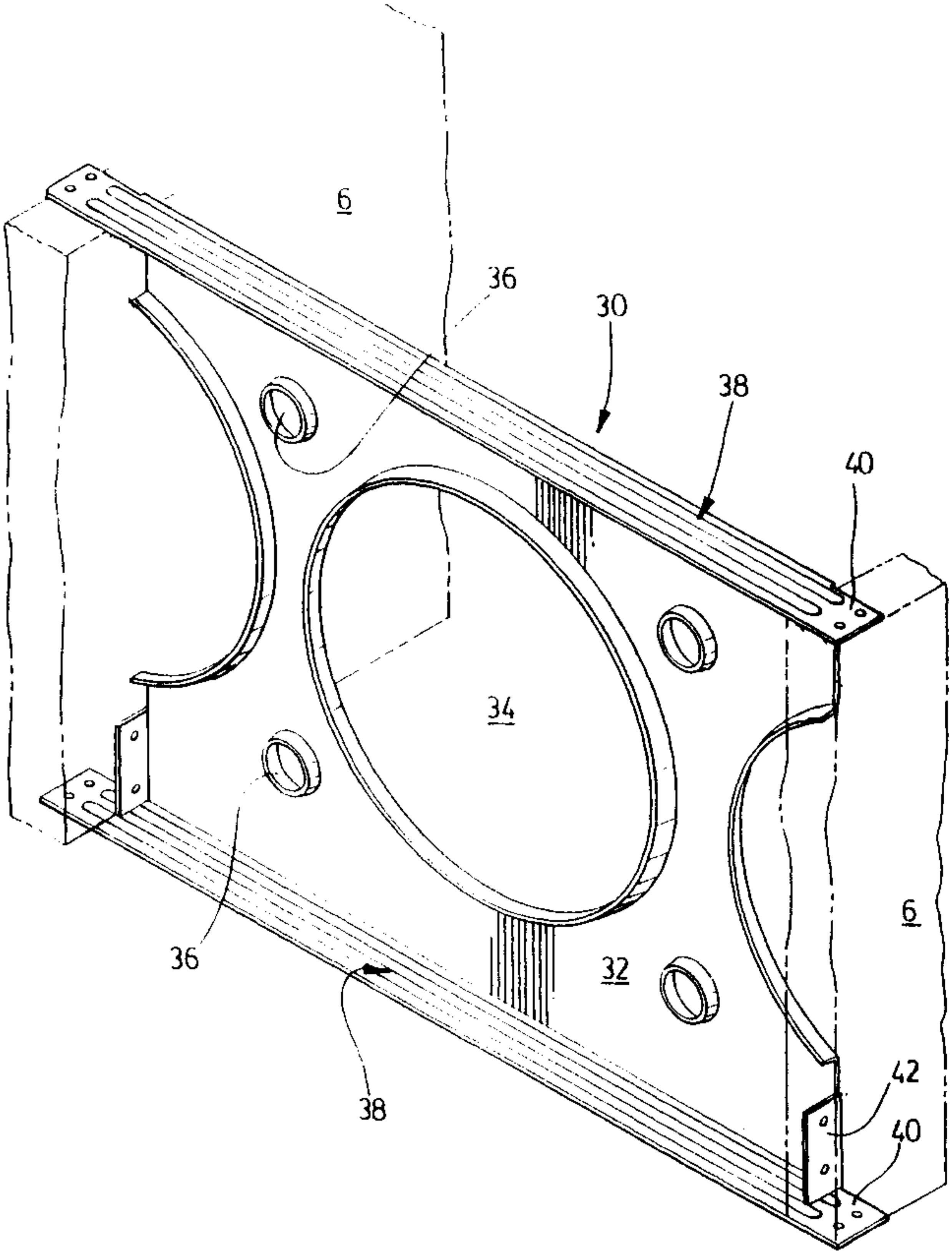
COMPARABLE INSTALLATION TIMES AS TESTED ON NOVEMBER 30, 1992 AND DECEMBER 1, 1992 ON TEST AREA OF 240 SQ. FT. USING 2" X 8" JOISTS @ 16" CENTRES OVER AN 11'-6" CLEAR SPAN.

FLOOR AREA	WOOD 2 X 2 CROSS BRIDGING			BRIG-EEZ
	PRE-NAIL BRIDGING	LAYOUT ON FLOOR AND INSTALL TOP NAILS		LAYOUT BRIG-EEZ AND INSTAL TOP NAILS
240 SQ. FT	9.5 MIN	6 MIN	15.5 MIN	3.5 MIN
960 SQ. FT BUNGALOW	38 MIN	24 MIN	62 MIN	14 MIN
1440 SQ. FT BUNGALOW	57 MIN	36 MIN	93 MIN	21 MIN
1920 SQ. FT TWO STOREY	76 MIN	48 MIN	124 MIN	28 MIN
2400 SQ. FT TWO STOREY	95 MIN	60 MIN	155 MIN	35 MIN

APPENDIX 'C'

BRIG - EEZ
INCORPORATED

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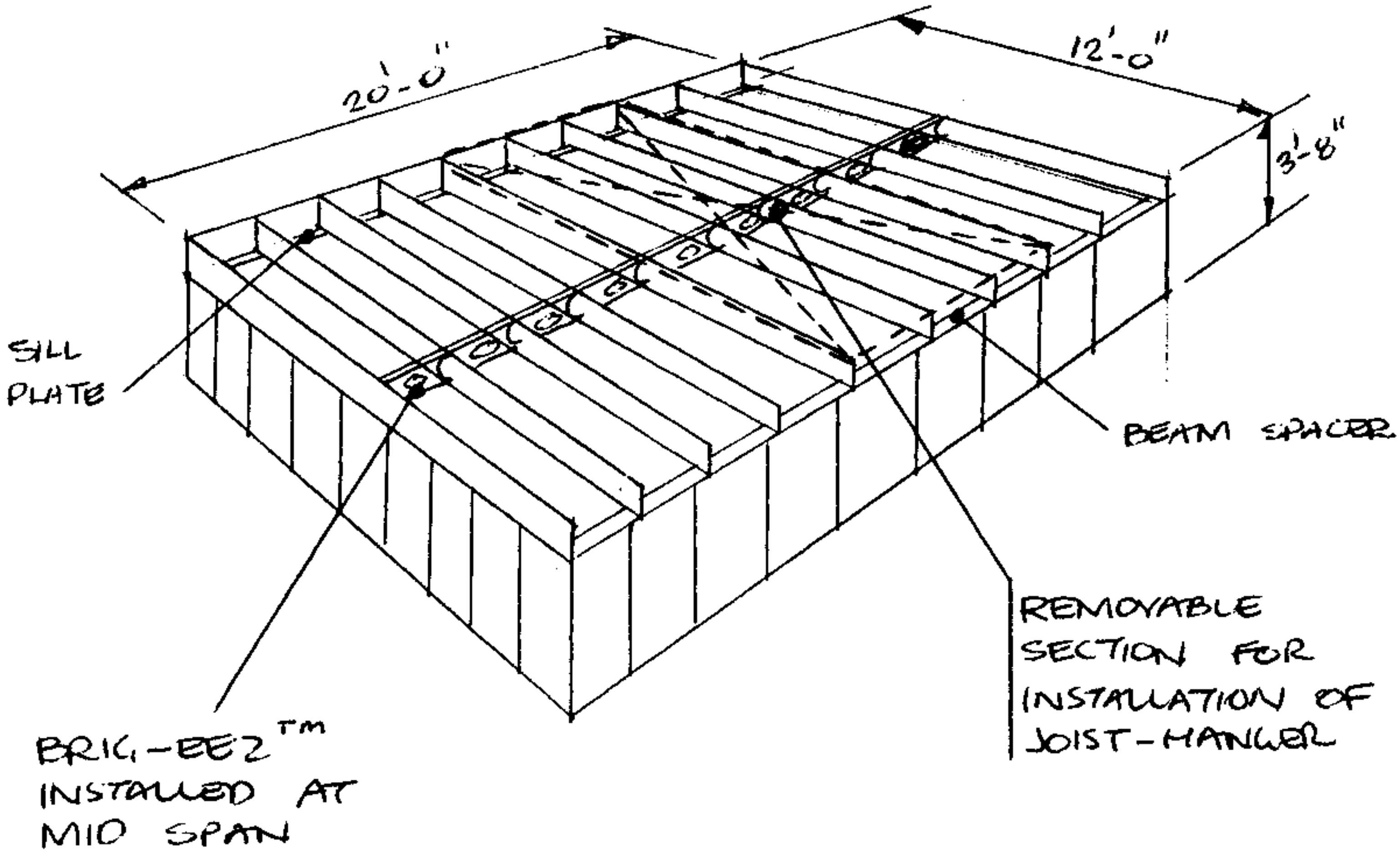
APPENDIX 'E'

TEST BED



NOTES

- ALL CONSTRUCTION TO LOCAL CODES
- ALL MATERIAL CONSTRUCTION GRADE
- HEATING, PLUMBING ETC, INSTALLED AS PER TYPICAL RESIDENTIAL INSTALLATION

PRELIMINARY BRIG-EEZ PRODUCT TESTING

FOR

BRIG-EEZ INCORPORATED

PREPARED FOR: Mr. Warren Eberschlag

Date: December 23, 1992

PREPARED BY: Mr. David J. Pow, P. Eng.

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December 23, 1992.

Reference: 92173.

Brig-eez Incorporated
2245 Wyecroft Road
Unit 1 & 2
OAKVILLE, Ontario, L6L 5L7.

Attn: Mr. Warren Eberschlag

Dear Warren:

RE: PRELIMINARY TESTING OF BRIG-EEZ COMPONENT.

The following is a summary of the testing performed at your facility on December 1, 1992.

OBJECTIVE:

The objective of the testing was to determine the relative performance of the 8" Brig-eez metal bridging component against traditional 1 1/2 x 1 1/2" wood bridging on a floor system spanning 11'-6" clear and evaluate the consistency of the test method. The performance the bridging systems was restricted to the evaluation of the loaded joist deflection at mid-span.

METHOD:

1. A test bed was constructed as per Figure 1 in Appendix A. The joists (2 x 8" SPF No. 1&2) were spaced at 16" o.c. and supported by a rigid wall perpendicular to their spans. The stiffness of the support wall was sufficient to simulate a foundation wall for testing purposes. The effects of sheathing were simulated using a 1 x 4" strap along the top of the joists in the loading areas (similar to test approach used by Forentek during testing of floor system deflection).

2. Traditional wood bridging was installed at mid-span on the test bed and 1 x 4" strapping was fastened to underside of joists.

TEST #1 - Evaluation of Deflections Magnitudes and Consistency of Deflection Measurements.

3. The initial distance between the underside of the joists #6 to #9 and a constant reference point below, distance = "y".

4. A concentrated load of 230 lbs was applied to joist #8 at mid-span and the change in distance "y" was recorded.

5. The load of 230 lbs was removed and the initial distance "y" was measured.

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TEST #2 - Evaluation of Deflections with Traditional Bridging/Strapping 100% Installed.

6. The initial distance between the underside of the joists and a constant reference point below, distance = "y".

7. A concentrated load of 230 lbs was applied to joist #8 at mid-span and the change in distance "y" was recorded for joists #5 to #11.

8. A concentrated load of 230 lbs was applied to joist #6 at mid-span and the change in distance "y" was recorded for the joists #3 to #9.

TEST #3 - Evaluation of Deflections with Traditional Bridging 100% Installed.

9. The strapping was removed from underside of joists.

10. The initial distance between the underside of the joists and a constant reference point below, distance = "y".

11. A concentrated load of 230 lbs was applied to joist #8 at mid-span and the change in distance "y" was recorded for joists #5 to #11.

12. A concentrated load of 230 lbs was applied to joist #6 at mid-span and the change in distance "y" was recorded for the joists #3 to #9.

TEST #4 - Evaluation of Deflections with Traditional Bridging (Bridging 6-7 Removed).

13. The bridging between joists #6 and #7 was removed.

14. The initial distance between the underside of the joists and a constant reference point below, distance = "y".

15. A concentrated load of 230 lbs was applied to joist #8 at mid-span and the change in distance "y" was recorded for joists #5 to #11.

16. A concentrated load of 230 lbs was applied to joist #6 at mid-span and the change in distance "y" was recorded for the joists #3 to #9.

17. The load was removed and initial distance "y" remeasured.

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TEST #5 - Confirmation of Deflections with Traditional Bridging 100% Installed.

18. The bridging was reinstalled between joists #6 and #7.

19. The initial distance between the underside of the joists and a constant reference point below, distance = "y".

20. A concentrated load of 230 lbs was applied to joist #8 at mid-span and the change in distance "y" was recorded for joists #5 to #11.

TEST #6 - Confirmation of Deflections with Traditional Bridging (Bridging 6-7 Removed).

21. The bridging between joists #6 and #7 was removed.

22. The initial distance between the underside of the joists and a constant reference point below, distance = "y".

23. A concentrated load of 230 lbs was applied to joist #6 at mid-span and the change in distance "y" was recorded for joists #6 and #7.

TEST #7 - Evaluation of Deflections with Traditional Bridging (Bridging 6-7/8-9 Removed).

24. The bridging between joists #6-#7 and #8-#9 was removed.

25. The initial distance between the underside of the joists and a constant reference point below, distance = "y".

26. A concentrated load of 230 lbs was applied to joist #8 at mid-span and the change in distance "y" was recorded for joists #5 to #11.

27. A concentrated load of 230 lbs was applied to joist #6 at mid-span and the change in distance "y" was recorded for the joists #3 to #9.

TEST #8- Evaluation of Deflections with Traditional Bridging and Brig-eez 6-7/8-9 Installed.

28. Brig-eez was installed between joists #6-#7 and #8-#9.

29. The initial distance between the underside of the joists and a constant reference point below, distance = "y".

30. A concentrated load of 230 lbs was applied to joist #8 at mid-span and the change in distance "y" was recorded for joists #5 to #11.

31. A concentrated load of 230 lbs was applied to joist #6 at mid-span and the change in distance "y" was recorded for the joists #3 to #9.

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Reference: 92173.

TEST #9- Evaluation of Deflections with Brig-eez Installed.

32. The traditional bridging was all removed and Brig-eez was installed at mid-span on every joist space.

33. The initial distance between the underside of the joists and a constant reference point below, distance = "y".

34. A concentrated load of 230 lbs was applied to joist #8 at mid-span and the change in distance "y" was recorded for joists #5 to #11.

35. A concentrated load of 230 lbs was applied to joist #6 at mid-span and the change in distance "y" was recorded for the joists #3 to #9.

RESULTS:

The results of each test can be found in Table 1 to 9 in Appendix A.

DISCUSSION OF RESULTS:

Test #1 - The first test demonstrated that the amplitude of the deflections relative to the measuring apparatus was sufficient to achieve reasonable results for a preliminary evaluation of the floor system performance.

Test #2 - The maximum deflection of the joists under a concentrated load of 230 lbs (1 KN) averaged 1.9 mm. The deflection criteria used by Forentek in the development of span tables for floor systems was 2.0 mm deflection under a concentrated load of 1 KN. The criteria was set to address the problem of floor vibration. The O.B.C. limits the span of the system configuration in Test 1 to 12'-2" due to floor vibrations considerations. The 1.9 mm average deflection is in keeping with the values expected using the O.B.C. design criteria.

Test #3 - The maximum deflection of the joist averaged 3.30 mm at the concentrated load without the underside strapping. This configuration is typical of residential construction. The deflection represents an increase of 75% over the value with lower strapping installed. The test demonstrates the transverse truss effect of the strapping in a cross-bridging system.

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December 23, 1992.
Reference: 92173.

Test #4 - #8 These tests did not produce conclusive results using the method outlined above. The deflections should be expected to increase with loading when the bridging was removed, however, the results were not consistent through the group of tests. The average of maximum deflection for Tests #3 and #5 (100% installed) was 3.2 mm. The average maximum deflection for tests #4 and #6 (one cross-bridging set removed) was 2.6 mm. Test #7 was performed with two cross-bridging units out and resulted in a average maximum deflection of 3.5 mm. Test #8 which used Brig-eez installed in the two knocked out spaces of Test #7 resulted in an average maximum deflection of 2.7 mm.

Test #9 The test of the Brig-eez 100% installed produced an average maximum deflection of 1.8 mm. This average was below the deflections measured on any of the tests previously. The test demonstrated that the stiffness of the floor system is at least comparable to the traditional floor systems tested given the limitations of the test method and the small sampling for testing.

CONCLUSION:

After reviewing the results of the testing on December 1, 1992, it is our opinion that the Brig-eez component successfully controls the deflection of a floor joist subjected to a 1 KN concentrated load at mid-span when compared to traditional cross-bridging. A complete evaluation of the Brig-eez floor system a Forentek will yield more accurate results, however, the above tests have given good reason for confidence in its performance and we would not recommend modify the latest production unit. A more complete test program will produce decisive results on the effects of bridging removal and the effect of joist shrinkage as the wood dries out.

If you have any questions, please do not hesitate to contact our office.

Yours truly,

POW, PETERMAN & ASSOCIATES INC.,
Consulting Engineers,

David Pow, P.Eng.
DJP/ig

POW, PETERMAN & ASSOCIATES INC. REPORT

APPENDIX A

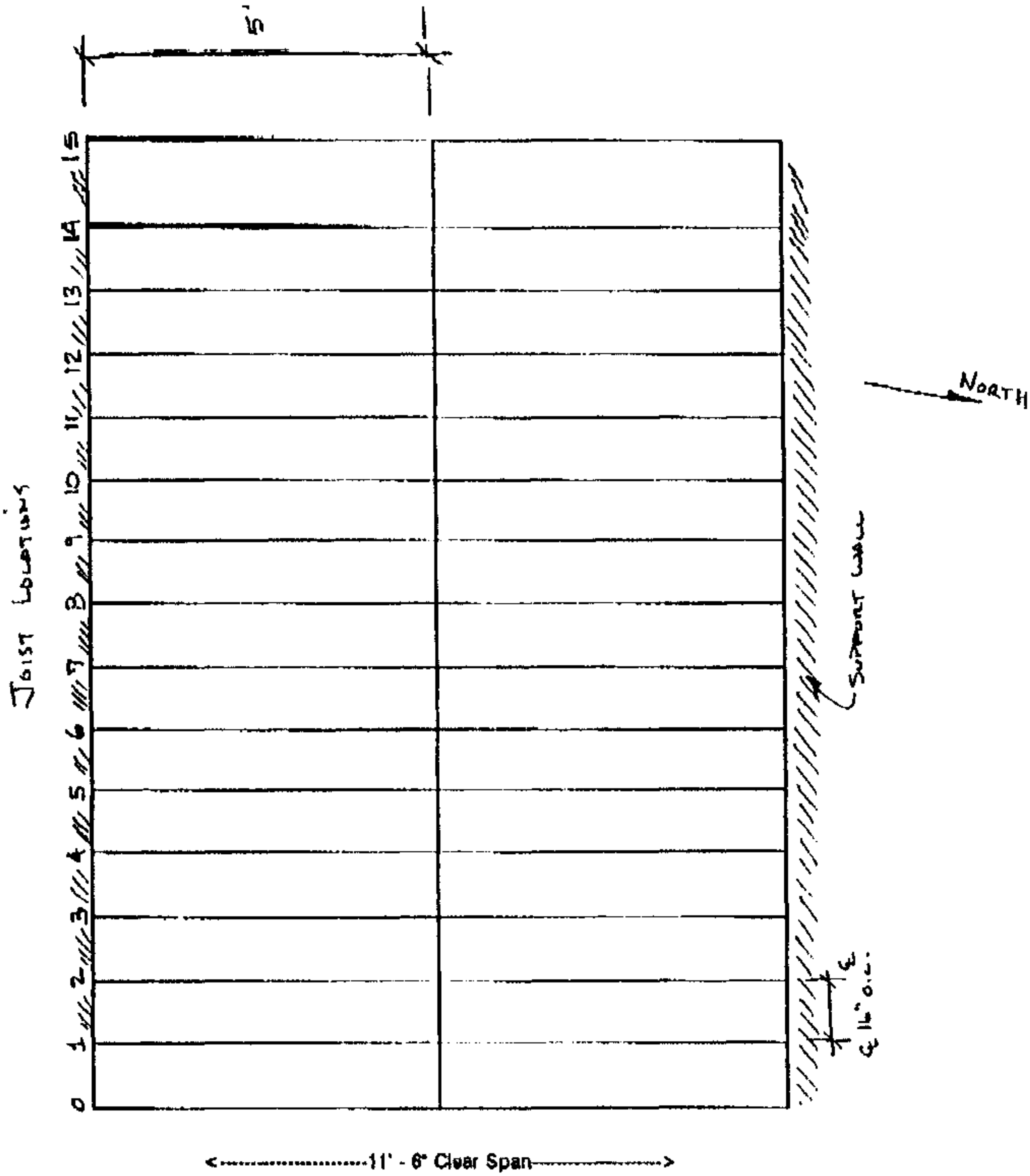

FIGURE 1 - GENERAL TEST BED LAYOUT

TEST #1

BED #1 TEST CONFIRMATION

Location	mm Initial Dist. (mm)	Test "1A" Point Load @6 Reading At 230 lbs (mm)	Test "1B" Point Load @6 Reading At 0 lbs (mm)	Reading At lbs
1				
2				
3				
x 4				
x 5				
x 6	75.6	75.5	75.9	
x 7	77.5	76.4	77.4	
x 8	80.2	78.3	80.2	
x 9	81.8	80.2	81.6	
x 10				
11				
12				
13				
14				
15				

Test Confirmation

TABLE #1

TEST #1

BED #1 TEST CONFIRMATION

Location	mm Initial Dist. (mm)	Test "1A" Point Load @6 Reading At 230 lbs (mm)	Test "1B" Point Load @6 Reading At 0 lbs (mm)	Reading At lbs
1				
2				
3				
x 4				
x 5				
x 6	75.8	75.5	75.9	
x 7	77.5	76.4	77.4	
x 8	80.2	78.3	80.2	
x 9	81.8	80.2	81.6	
x 10				
11				
12				
13				
14				
15				

Test Confirmation

TABLE # 1

TEST #2

Location	mm Initial Dist. (mm)	Test '2A' Point Load @8 Reading At 230 lbs (mm)	Test '2B' Point Load @6 Reading At 230 lbs (mm)	Reading At lbs
1	78.4			
2	80.5			
3	74.4		E3-74.2	
4	76.0		E2-74.5	
5	77.8	E3-77.8	E1-76.4	
6	75.8	E2-75.5	*-74.1	
7	77.5	E1-76.4	W1-76.2	
8	80.3	*-78.2	W2-79.6	
9	81.4	W1-79.9	W3-81.0	
10	81.6	W2-81.0		
11	81.0	W3-80.6		
12	80.5	-80.5		
13	83.4			
14	76.9			
15				

* - LOAD POINT AT

Location	Test '2A' Point Load @ 8 Reading At 230 lbs		Test '2B' Point Load @ 6 Reading At 230 lbs	Average
W3	11	0.4	0.4	0.4
W2	10	0.6	0.7	0.65
W1	9	1.5	1.3	1.4
PT	8	2.1	1.7	1.9
E1	7	1.1	1.4	1.25
E2	6	0.3	0.5	0.4
E3	5	0.0	0.2	0.2

TABLE #2

TEST #3

Beam Location	mm Initial Dist.	Test '3A' Point Load @8 Reading At 230 lbs (mm)	Test '3B' Point Load @6 Reading At 230 lbs (mm)	Reading At lbs
1	Check Only See #2			
2				
3	74.4		E3-74.4	
4	75.0		E2-74.4	
5	77.9	E3-77.4	E1-75.7	
6	75.6	E2-74.5	*-72.8(72.8)	
7	77.5	E1-75.0	W1-75.0	
8	80.2	*-76.4	W2-78.8	
9	81.4	W1-78.6	W3-80.4	
10	81.6	W2-79.9		
11	81.0	W3-80.0		
12	80.5			
13				
14				
15				

* - LOAD POINT

Location	Test '3A' Point Load @ 8 Reading At 230 lbs	Test '3B' Point Load @ 6 Reading At 230 lbs	Average
W3	1.0	1.0	1.0
W2	1.7	1.4	1.55
W1	2.8	2.5	2.65
*	3.8	2.8	3.30
E1	2.5	2.2	2.35
E2	1.1	0.6	0.85
E3	0.5	0.0	0.25

TABLE #3

TEST #4

Beam Location	mm Initial Dist.	Test "4A" Point Load @8 Reading At 230 lbs (mm)	Test "4B" Point Load @6 Reading At 230 lbs (mm)	Test "4C" Initial Reading At lbs
1				
2				
3	74.4		E3-74.6	74.5
4	74.8		E2-74.6	75.0
5	77.4	E3-77.8	E1-76.0	77.5
6	75.6	E2-75.4	* 73.0	75.2
7	77.2	E1-76.0	W1-76.7	77.1
8	79.5	* -77.1	W2-80.0	79.8
9	80.6	W1-79.4	W3-80.5	80.9
10	81.3	W2-80.9		81.3
11	80.9	W3-80.8		80.9
12	80.0			
13				
14				
15				

Location	Test "4A" Point Load @ 8 Reading At 230 lbs	Test "4B" Point Load @ 6 Reading At 230 lbs	Average	Based On "C" Measurements A	B	Avg
W3	0.1	0.1	0.1	0.1	0.4	0.25
W2	0.4	(0.5)	(0.05)	0.4	0	0.20
W1	1.2	0.5	0.85	1.5	0.4	0.95
*	2.4	2.6	2.5	2.9	2.0	2.45
E1	1.2	1.4	1.35	1.1	1.5	1.35
E2	0.2	0.2	0.25	(0.2)	0.4	0.10
E3	UP(0.4)	UP(0.2)	(0.3)	(0.3)	(0.1)	(0.20)

Removing Bridging Between #6 and #7 - Comp. Bridge On Bottom
No Bottom Strapping

TABLE #4

TEST #5

Beam Location	mm Initial Dist.	Test "5A" Point Load @8 Reading At 230 lbs (mm)	Test "5B" Point Load @6 Reading At 230 lbs (mm)	Reading At lbs
1				
2				
3	74.7			
4	75.2			
5	77.6	E3-77.8		
6	75.6	E2-75.8		
7	77.4	E1-76.1		
8	80.0	* -77.1		
9	81.3	W1-79.4		
10	81.5	W2-81.2		
11	81.3	W3-81.4		
12	80.4			
13				
14				
15				

*** - LOAD POINT**

Location	Test "5A" Point Load @ 8 Reading At 230 lbs	Test "5B" Point Load @ 6 Reading At 230 lbs	Average
W3	(0.1)		
W2	0.3		
W1	1.9		
*	2.9		
E1	1.3		
E2	(0.2)		
E3	(0.2)		

Bridging Back In Between #6 & #7
No Strapping On Bottom

TABLE #5

TEST #6

Beam Location	mm Initial Dist.	Test '6A' Point Load @8 Reading At 230 lbs (mm)	Test '6B' Point Load @6 Reading At 230 lbs (mm)	Reading At lbs
1				
2				
3				
4				
5	77.6			
6	76.2	* - 73.3		
7	77.4	W1-76.7		
8	78.6			
9				
10				
11				
12				
13				
14				
15				

Bridging Out Between #6 & #7 - No Bottom Comp. Member
No Bottom Strap

Location	Test '6A' Point Load @ 8 Reading At 230 lbs	Test '6B' Point Load @ 6 Reading At 230 lbs	Average
W3			
W2			
W1	0.7		
*	2.9		
E1			
E2			
E3			

TABLE #6

TEST #7

Beam Location	mm Initial Dist.	Test '7A' Point Load @6 Reading At 230 lbs (mm)	Test '7B' Point Load @6 Reading At 230 lbs (mm)	Reading At lbs
1				
2				
3			E3-74.5	
4	75.2		E2-74.5	
5	77.5	E3-77.8	E1-76.5	
6	76.1	E2-76.1	* - 73.0	
7	77.4	E1-76.2	W1-76.5	
8	79.8	* -75.9	W2-79.9	
9	82.0	W1-81.0	W3-82.0	
10	81.7	W2-81.5		
11	81.1	W3-81.2		
12				
13				
14				
15				

Point Load ---> Maximum = 3.9 mm
76.1 UPL Type = 3.7

Location	Test '7A' Point Load @ 6 Reading At 230 lbs	Test '7B' Point Load @ 6 Reading At 230 lbs	Average
W3	(0.1)		
W2	0.2	0.7	
W1	1.0	1.0	
*	3.9	3.1	
E1	1.2	0.9	
E2	0.0	(0.1)	
E3	(0.3)	0.0	

Bridging Out Between #6 and #7 and #8 and #9
No Bottom Strapping

TABLE #7

TEST #8

Beam Location	mm Initial Dist.	Test "8A" Point Load @8 Reading At 230 lbs (mm)	Test "8B" Point Load @6 Reading At 230 lbs (mm)	Reading At lbs
1				
2				
3	74.5		E3-74.7	
4	75.0		E2-75.0	
5	77.2	E3-77.8	E1-76.5	
6	76.7	E2-76.8	* - 74.0	
7	77.5	E1-76.0	W1-76.2	
8	(78.8) 79.0	* - 76.1	W2-79.0	
9	81.8	W1-80.0	W3-81.9	
10	81.9	W2-81.5		
11	81.0	W3-81.0		
12				
13				
14				
15				

Bridge - Brig-sez in Two Spaces - #5 - #7 #8 - 9
No Bottom Strapping 1 2

Location	Test "8A" Point Load @ 8 Reading At 230 lbs	Test "8B" Point Load @ 6 Reading At 230 lbs	Average
W3	0	(0.1)	
W2	0.4	0.0	
W1	1.8	1.3	
*	2.7(2.9)	2.7	
E1	1.5	0.7	
E2	(0.1)	0.0	
E3	(0.6)	(0.3)	

TABLE #8

TEST #9

Beam Location	mm Initial Dist.	Test '9A' Point Load @8 Reading At 230 lbs (mm)	Test '9B' Point Load @6 Reading At 230 lbs (mm)	Reading At lbs
1				
2				
3	75.5		E3-75.1	
4	75.9		E2-75.4	
5	77.4	E3-77.4	E1-76.4	
6	76.5	E2-76.0	* - 75.0	
7	76.7	E1-75.9	W1-75.9	
8	79.0	* - 76.9	W2-78.6	
9	81.4	W1-79.9	W3-81.2	
10	82.7	W2-81.7		
11	81.4	W3-81.3		
12				
13				
14				
15				

Location	Test '9A' Point Load @ 8 Reading At 230 lbs	Test '9B' Point Load @ 6 Reading At 230 lbs	Average
W3	0.1	0.2	0.15
W2	1.0	0.4	0.7
W1	1.5	0.8	1.15
*	2.1	1.5	1.8
E1	0.8	1.0	0.9
E2	0.5	0.5	0.5
E3	0.0	0.4	0.2

TABLE #9