Mulpha Australia Limited

Transport House

Stage 1 - Outcomes from the Preliminary Building Investigation

REP02

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Contents

1 Executive Summary

This report describes the outcome of the preliminary site investigation aimed at improving the understanding of the existing structure and assumptions to date. Furthermore, detailed investigations will be required in the subsequent design stages depending on final configuration of extension works to the building.

Member Sizes

- Concrete footing sizes observed and measured on site showed good correlation with the existing structural drawings with the exception of the depth of TF1. This highlights the need for future investigation closely linked to the choice of final modifications works.
- Steel members sizes observed and measure on site show a good correlation with the existing drawings. Some minor inconsistencies were noted for clarification in future investigations. A difference in member type was identified in TB3. This highlights the need for future investigation closely linked to the choice of final modification works.

Member Connections

- Steel member connections observed on site are considered <u>flexible end</u> connections with little capacity to transfer moments and thus act as sway frames. This is an important observation as it discounts the possibility of considering a sway frame for stability of the modification works.

Material Testing

- Material properties tested for yield strength demonstrated the base assumption of 200MPa is valid and that an increase may be possible in future based on additional testing to increase sample size.
- Weldability testing undertaken on steel describes that typically the steel is readily weldable however future testing will be required to thicker plates.
- Concrete testing conducted on footings correlated well with the drawings however no reinforcement was encountered in the cores extracted. Future investigations will be required depending on the final configuration of modification works.

Future Investigation and Testing

- Testing of concrete walls should be undertaken.
- Recommendations are presented at the end of this report.
- Finalisation of the preferred modification and strengthening arrangement will focus the future design and investigations works.

2 Introduction

This report discusses the outcomes from the preliminary testing and investigation into the structure of Transport House. The purpose of this investigation was to confirm a number of fundamental assumptions about the existing steel and concrete structure in order to validate previous structural inputs and to assist design decisions going forward.

It should be noted that this investigation is preliminary and inspection points selected were those accessible with least disruption to building operation.

The specific foci of the investigation were the following:-

- As-built condition the structure – confirming beam, column footing sizes;
- Material properties and current condition – steel, concrete and geotechnical properties by both observation and physical testing;
- Steel connections details – investigate the type of beams-columns connections in the existing steel frame to inform stability design approach;
- Wall construction type and connection details – investigate the construction of the internal stair and lift walls and their connection to the steel frame (not part of the works completed to date).

Locations for columns, beams and footings were chosen to provide representative samples. The works were done in the subbasement and basement to limit the impact on the usage of the building. Reference is made to Arup's investigation and testing briefing document dated 23/08/2018.

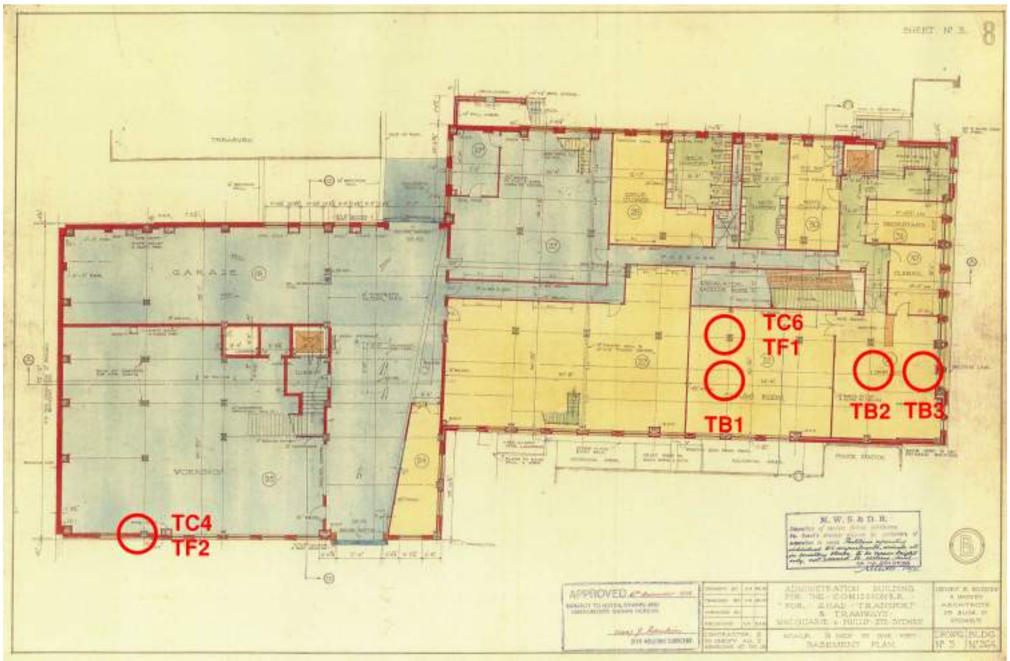


Figure 1 Location of tests for columns and beams (underside of Ground/L3) and footings (subbasement/L1)

2.1 Arup Reference Documents

Key reference documents from Arup that define the scope of the investigation and which summarise the structural design issues are listed below.

- **Arup**, Transport House Stage 1 – Preliminary Building Investigation Brief Issue, dated 28/03/18
- **Arup**, Transport House, Memo 1 – Additional Existing Building Assessment Revision 3, dated 09/02/18

2.2 Investigation Reports

From the investigation works, three reports were produced that described the geometry of the structure and the testing of the steel, concrete, and foundation material. These reports are listed below.

- **Bureau Veritas**, Stage 1 Preliminary Building Investigation Transport House on behalf of Built c/o Mulpha Australia Ltd

  (Ref. 18-2855243-1)

- **JK Geotechnics**, Report to Built on Geotechnical Investigation for Proposed Alternations and Additions at 99 to 113 Macquarie Street, Sydney NSW, 13/06/18

  (Ref. 31504SMrpt)

- **Mahaffey Associates**, Letter – Re: Transport House Preliminary Investigation, 13/06/18

  (Ref. JS/L01/11285)

3 Confirmation of member sizes and investigation into steel connections

Arup's assessment of the existing structure to date has been on the basis of the structure as documented in the 1936 structural drawings by A.W. Morrison consulting civil engineers provided by Mulpha. As no as-built drawings are available and in order to validate the information on these design drawings as representative of the structure, the concrete encasement to the steelwork was removed and detailed measurements taken and compared to the documentation.

In parallel to the site investigation, a literature review of historic steel design documents was undertaken by Arup. Two BHP design guides from before (1924) and after (1952) construction of Transport House were reviewed to determine the likely steel sections sizes available and their stated material properties. These references provide an important connection between the steel industry at the time of construction, the structural drawings, and the material testing.

This work was undertaken by Bureu Veritas and documented in their report dated 13/06/2018 (Ref.18-2855243-1)

The two BHP documents:

- **Hand Book of Rolled Steel Sections and Other Products** Manufactured by The Broken Hill Proprietary Company Limited at their Iron and Steel Works Newcastle, Australia also Useful Tables and Miscellaneous Information for the Guidance of Engineers, Contractors, Builders, and Other Users of Steel.

  BHP Melbourne, 1924

- **Shapes and Sections**. Information and Tables for Engineers, Architects, and Designers of Buildings and Other Steel Structures. Relating to Products Manufactured by The Broken Hill Proprietary Company Limited and Allied Industries Australia.

  BHP Melbourne, 1952

Extracts of pertinent information from these guides are provided in Appendix A.

3.1 Review of steel member sizes

Two locations were chosen for removal of the concrete encasement around the steel members and connections. The column-beam connections at **TC6** (Grid F7) and **TC4** (Grid A21) represented a typical internal column-beam connection and edge column-beam connection respectively.

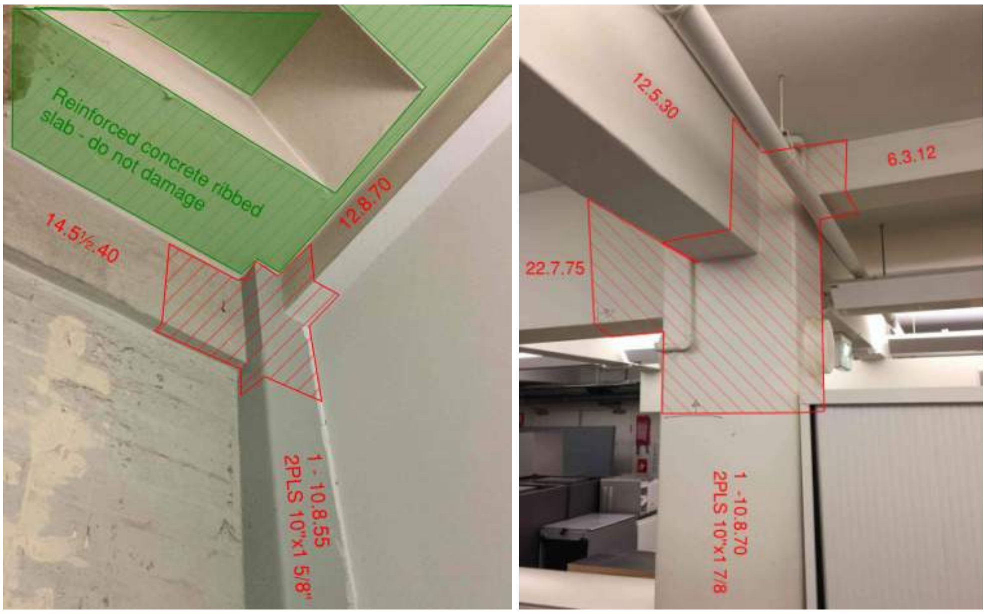


Figure 2 TC4 (left) TC6 (right) column/beam locations with member sizes

Figure 3 TC4 (left) TC6 (right) column/beam locations after removal of concrete encasement

The *Mahaffey* letter (JS/L01/11285) documented the measurable dimensions of the steel elements. These are compared to the documented sizes in the following table.

Table 1 Summary of measured dimensions of steel members

TH Drawing Ref.	BHP Ref. (1952)	Depth (mm)	Flange width (mm)	Flange thick. (mm)	Web thick. (mm)	Extra plates – width (mm)	Extra plates – thick. (mm)
TC4 – Grid A24							
14.5½.40	**ASB119**	355	140	16	9.4	-	-
Site Measured		350	2x70+tw	15	-	-	-
Comments		Good match to measured dimensions.					
12.8.70	**ASB117**	305	205	23	11	-	-
Site Measured		-	200	15	10	-	-
Comments		Good match, flange thickness difference may be explained by measurement of the tapered flange at its minimum dimension					
1-10.8.55 (2PLS 10"x1⅝")	**ASB114 + PLATES**	255	205	20	10	203	41
Site Measured		255	2x95+14 = 194	14	-	-	17+25 = 42
Comments		Good match, flange thickness difference may be explained by measurement of the tapered flange at its minimum dimension. Plates built up with 2 plates on each flange instead of one large.					
TC6 – Grid F7							
22.7.75	**ASB125**	558	178	21.2	12.7	-	-
Site Measured		560	175	15	-	-	-
Comments		TB1 measured at the column. Refer TB1 comments.					
6.3.12	**ASB105**	152	76	9.6	5.8	-	-
Site Measured		150	75	7	-	-	-
Comments		Good match on measured dimensions.					

12.5.30	**ASB116**	304	127	12.9	8.4	-	-
Site Measured		300	130	15			
Comments		Good match on measured dimensions					
1-10.8.70 (2PLS 10"x1⅞")	**ASB115 + PLATES**	254	203	24.6	15.2	254	47.8
Site Measured		250	2x90+tw =180+tw	15	-	250	3x16 =48
Comments		Good match, flange thickness difference may be explained by measurement of the tapered flange at its minimum dimension					
TB1 – Grid 7/C-F							
22.7.75	**ASB125**	558	178	21.2	12.7	-	-
Site Measured		560	180	15	14	-	-
Comments		Close match, flange thickness difference may explained by measurement of the tapered flange at its minimum dimension					
TB2 – Grid 3/C-F							
22.7.75	**ASB125**	558	178	21.2	12.7	-	-
Site Measured		-	-	15	14	-	-
Comments		Close match, flange thickness difference may explained by measurement of the tapered flange at its minimum dimension					
TB3 – Grid E/1-3							
14.5½.40	**ASB119**	355	140	15.9	9.4	-	-
Site Measured		300	128	10	9		
Comments		This section does not appear to match the drawings. This section aligns closely to a *ASB116 (12.5.30)*. In this location, the beam may have been substituted for the same size as the adjacent beam on Grid F (see excerpt from DWG 3 below).					

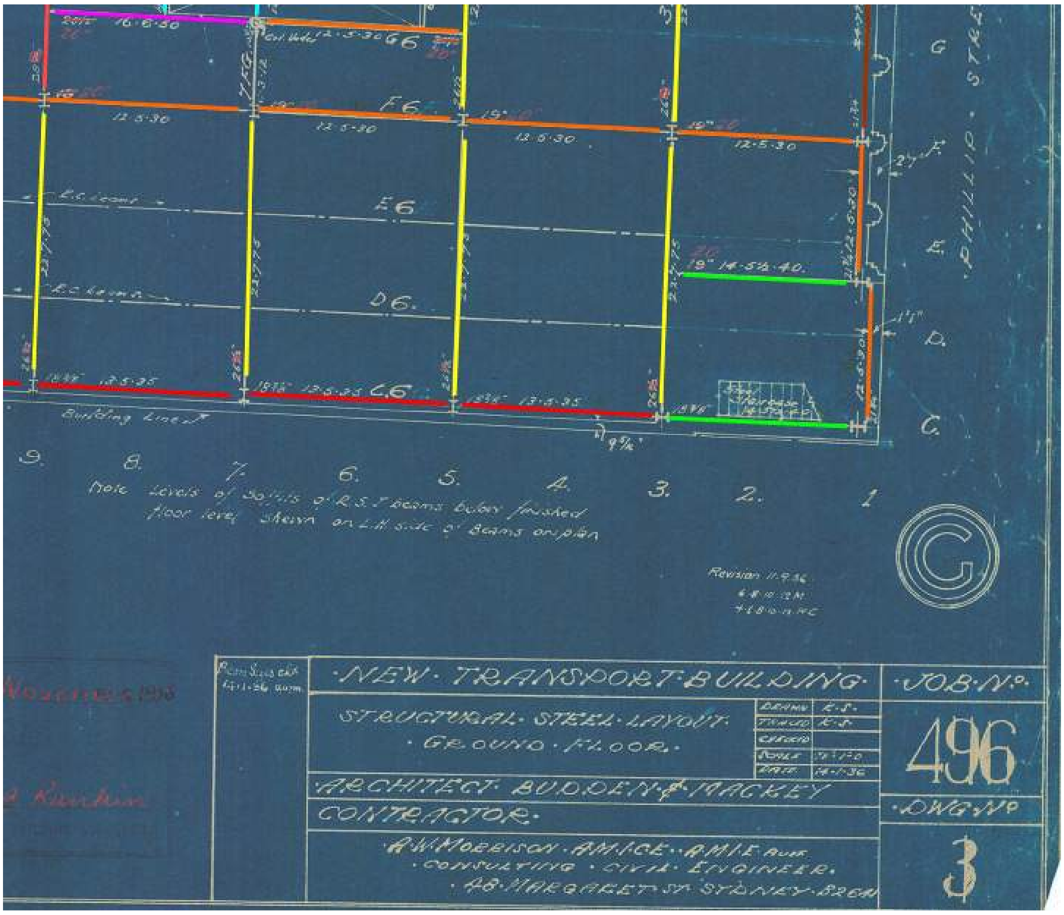


Figure 4 Structural drawing no. 3 with beam sizes highlighted. TB3 is green at Grid E-D/1-3

The example of **TB3** beam size discrepancy illustrates the need for further confirmation of the as-built condition of the structure.

A comparison of the section properties for the two beams shows that a smaller beam with less capacity has been substituted for the larger beam shown on the structural drawings.

Table 2 Comparison of properties for ASB116 and ASB119

TH Ref	BHP Ref	D	W	t_w	t_f	A	I_x	I_y
		mm	mm	mm	mm	mm^2	mm^4	mm^4
14 · 5½ · 40	**ASB119**	355	139	9.4	15.9	7593	156e+6	6.2e+6
12 · 5 · 30	**ASB116**	304	127	8.4	12.9	5696	86e+6	3.7e+6

Further investigation into as-built beam sizes will be necessary to validate future designs. Particular emphasis needs to be placed on locations where modifications to the existing structure are proposed such as at roof level, at bracing/strengthening locations, and at footings which attract additional lateral loading forces.

Final selection of structural strengthening for lateral stability will drive extent of future investigations.

3.2 Review of steel connection details

The structural drawings provide general arrangement plans of the steel and concrete structure, however there are few details which describe the connections between members. The connections between steel members are key to understanding of the stability performance of the structure under seismic loading. This is discussed in more detail in the Arup document, *Memo 1 – Additional Existing Building Assessment Rev. 3*.

This preliminary investigation exposed a number of representative steel connection in order to gain some insight into the steel connection detailing approach at the time of construction.

In the images below, the beam-column connections at **TC6** are shown and the connecting elements highlighted.

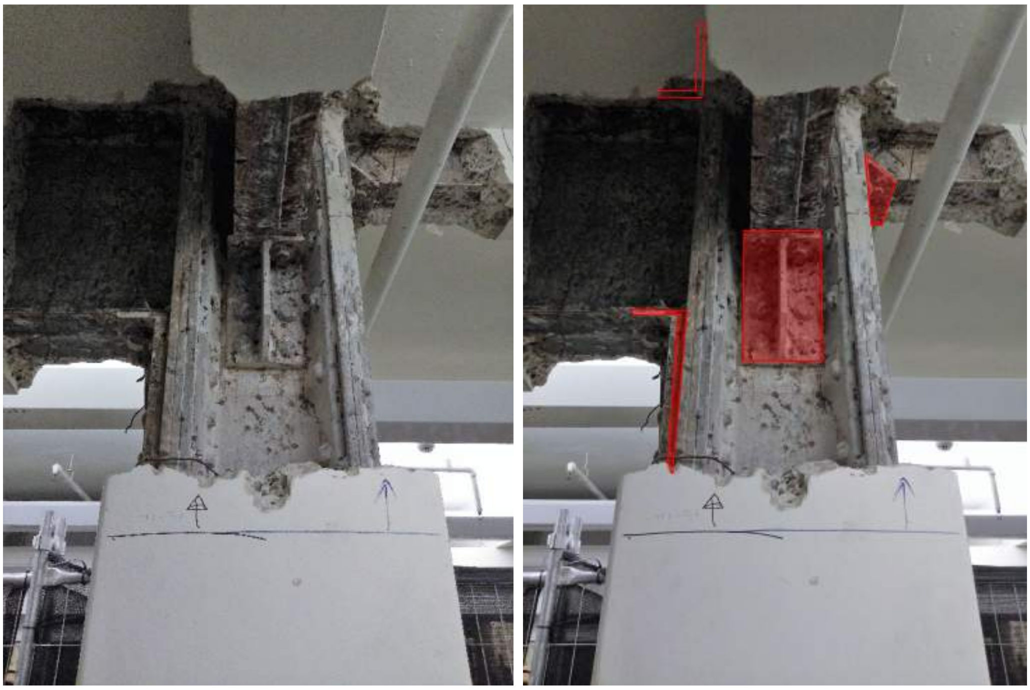


Figure 5 Exposed steel column connection at TC6 (left), with angle support brackets highlighted (right)

This configuration of structural connection observed is commonly described as an angled seat bracket. In these cases, the angle is riveted to the built-up column section and then bolted through the flange of the beam. Bolts can also be seen through the top flange suggesting that the angle bracket connection is mirrored at the top. There is no connection of the web of the beam to the column.

These connections were similar to those at location **TC4**.

A similar connection appears in the 1924 BHP handbook.

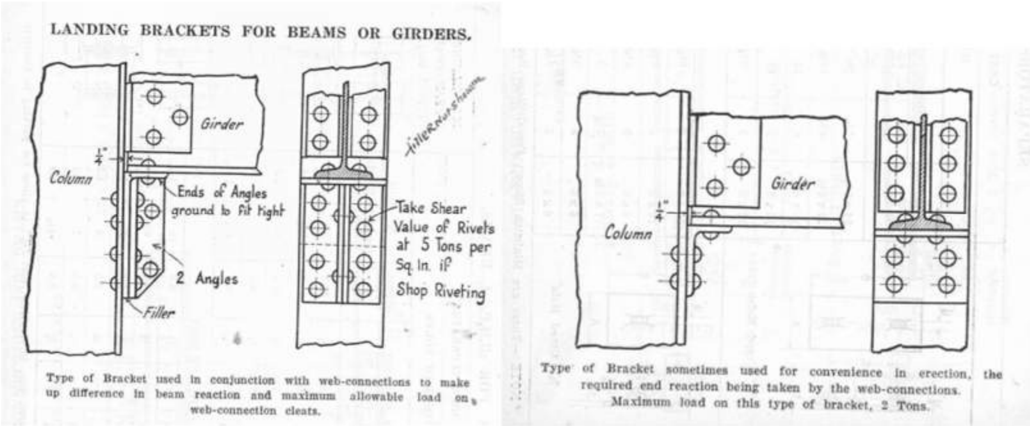


Figure 6 Typical connection details from 1924 BHP handbook

In these details a beam web connection is provided with additional angles, this is not provided in the connections exposed at Transport House.

This detail is <u>not regarded</u> as a 'rigid' connection that would transfer bending from the end of the beam into the column. The reference manual, AISC Design of Structural Connections from the *Australian Institute of Steel Construction*, defines it as amongst the more flexible of steel connections.

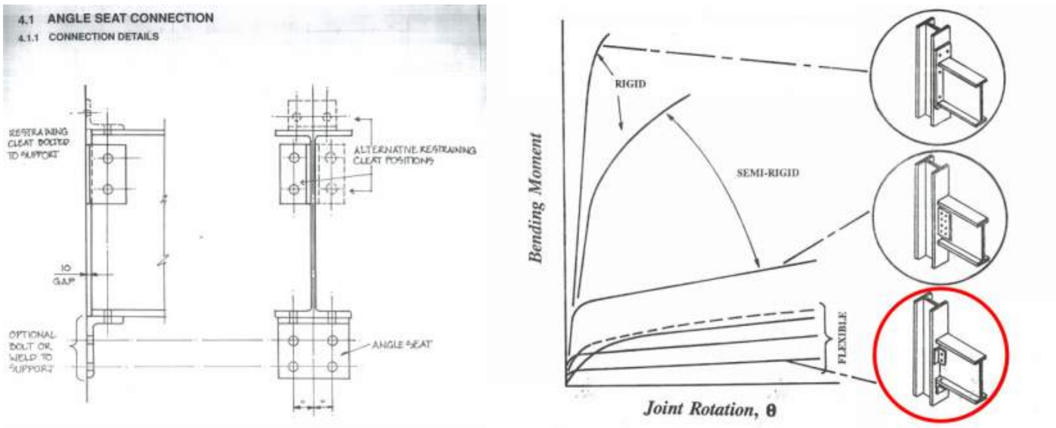


Figure 7 Similar detail from AISC manual (left) and classification as 'flexible' (right)

It is therefore reasonable to conclude that the steel frame was not be as a moment frame for stability. The additional seismic loads from the proposed modifications to the structure could not be accommodated by the observed connections without extensive strengthening at most column-beam joint locations.

3.3 Review of concrete footing sizes

The locations of the columns investigated were also excavated at foundation level to determine the as-constructed dimensions of the concrete footings. The measured dimensions were compared to those documented on both the architectural drawings and structural drawings.

Table 3 Summary of measured dimensions of concrete footings

	D (mm)	B (mm)	Depth (mm)
TF1 – Grid F7			
Structural drawing **496-10** (05/01/1937)	1447	1524	1430
Architectural drawing **DWG. 2** (16/11/1936)	1143	1143	-
Measured	~1580	~1640	~900
Comments	Good correlation of dimensions to structural drawings but not to architectural plans. Depth measured is 500mm less than documented on structural drawings.		
TF2 – Grid A24			
Structural drawing **496-10** (05/01/1937)	825	1064	760
Architectural drawing **DWG. 2** (16/11/1936)	813	1063	-
Measured	~950	~1126	~750
Comments	Good agreement with drawings.		

Due to the discrepancy in the depth of footing **TF1**, further investigation and testing will be required to validate the future design.

The final locations for future testing will be determined by the arrangement of the stability strengthening works.

4 Material testing

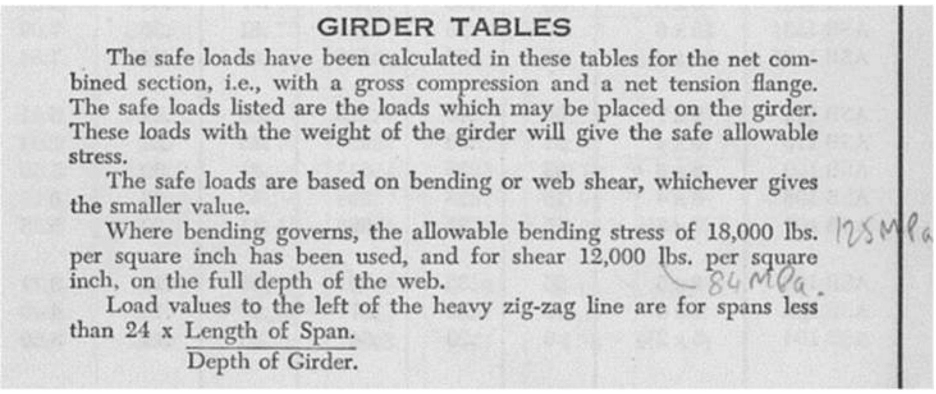
4.1 Steel

Three sample of steel were obtained for testing from **TB1**, **TB2**, and **TB3**. This testing of the 1930s steel properties was necessary to validate the assumptions made regarding the strength and stiffness of the existing structure. Properties such as ductility and weldability are also important considerations when considering modifications to the building and were included in the investigation.

These tests were undertaken by *Bureau Veritas* and documented in their report dated 13/06/2018 (Ref. 18-2855243-1).

4.1.1 Strength properties

A literature review of the historic BHP resources and guidance from *AS3826-1998 Strengthening existing buildings for earthquake* recommends a design yield stress for historic steel of f_{sy} = 200MPa (AS3826 Table 1) for use in modifications to existing steel buildings.


GIRDER TABLES

The safe loads have been calculated in these tables for the net combined section, i.e., with a gross compression and a net tension flange. The safe loads listed are the loads which may be placed on the girder. These loads with the weight of the girder will give the safe allowable stress.

The safe loads are based on bending or web shear, whichever gives the smaller value.

Where bending governs, the allowable bending stress of 18,000 lbs. per square inch has been used, and for shear 12,000 lbs. per square inch, on the full depth of the web.

Load values to the left of the heavy zig-zag line are for spans less than 24 x $\frac{\text{Length of Span.}}{\text{Depth of Girder.}}$

125MPa

84MPa.

Figure 8 Shapes and Sections shows 125MPa allowable stress – approx. 200MPa yield equivalent, BHP 1952

AS3826 expands on the discussion of this 200MPa yield stress value in Appendix D reproduced below.

Appendix D – D3.4 OTHER EXISTING MATERIALS

The values given in Clause 3.4 for other existing materials are lower bound estimates to allow for uncertainty in material properties and the possible effects of ageing. Good quality concrete would be expected to have a higher compression strength, but this would have to be confirmed by a representative series of tests on the in situ material, e.g. compression tests on cores. ***The yield stress of structural steel may also be higher than 200 MPa, but this would need to be confirmed by reference to the original specifications, or some form of destructive or non-destructive testing, or both.***

The report from *Bureau Veritas* concluded that two of the steel samples exhibited yield and tensile strengths equivalent to modern steel and satisfied the requirements of AS3679.1 for 300 Grade steel. The third sample met the requirements of 250 Grade steel.

It should be noted that **TB1** and **TB2** were from the same section size (22.7.75/ASB125), however they produced results ranging from 250 Grade to 300 Grade. This suggests that, although the properties from testing were greater than the 200MPa expected, there is not sufficient evidence to adopt a higher value for strength than previously used for assessment.

To adopt a higher value of steel strength a statistical probability reduction would need to be applied to account for the limited sample size. If a higher value needed to be justified, consideration will be given to additional testing of steel samples to support the statistical assessment, however the assessment to date has not required an increase in the assumed strength.

The testing provides confidence that the steel material satisfies the design assumptions to date. The design yield stress of 200MPa will continue to be used as a good practise for designing with aging structures which also has a good historical precedent.

4.1.2 Weldability properties

The other key consideration in the testing of the steel is the weldability of the material. This is critical for assessing options to modify the structure with strengthening elements that require welded connections.

Currently, the most viable, cost-effective option for seismic strengthening of the structure is to provide bracing which would require welding of cleats and stiffeners to the existing steel frame.

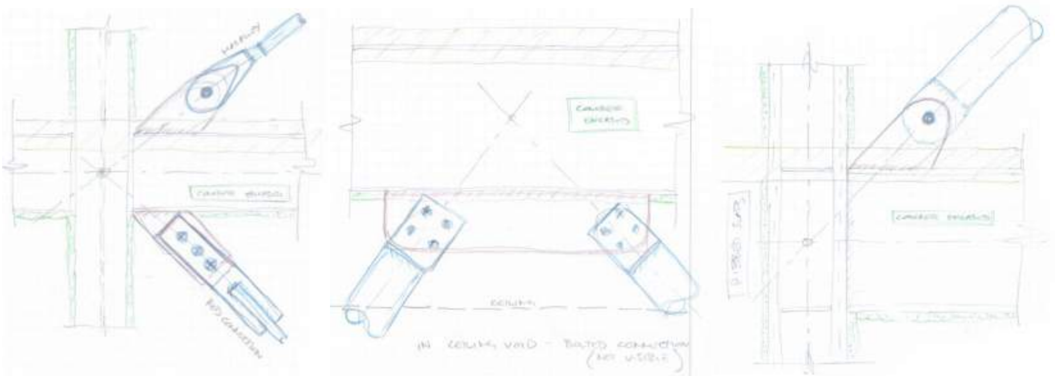


Figure 9 Options for struts and cross-bracing with cleats welded to existing steel frame

Bureau Veritas has concluded in section 4.4 of their report that the materials tested allow welding with minimal controls on preheat.

It should be noted that these tests have been conducted on relatively thin plate from hot-rolled steel sections only. In some locations, welding may be required to much thicker steel plate elements, for example at column base plates and at built-up column sections with thick flange plates. Thicker plates may exhibit different weldability. These elements would not necessarily be precluded from welding, however a more thorough welding procedure may need to be developed with the assistance of an expert such as the *Welding Technology Institute of Australia* (WTIA).

These tests confirmed that welding is possible to the steel frame. Testing of the weldability of thicker plates may form part of a more extensive investigations. Steel samples from thick base plates should be tested as part of the next investigation.

4.2 Concrete

Concrete is used structurally in the Transport House primarily in the pad footings, the floor slabs, and the stair and lift core walls. With the exception of the pad footings, a detailed understanding of these elements is less significant as the steel at this stage of the design. Two samples were extracted from the footings investigated at **TF1** and **TF2**.

These samples were taken by *JK Geotechnics* and the testing provided by *Mahaffey Associates* (JS/L01/11285).

4.2.1 Footings

Concrete cores were tested and the results provided in the *Mahaffey* letter (Ref. JS/L01/11285). The compressive cylinder strength tests ranged from 60MPa to 90MPa. No reinforcement bars were observed in the core samples taken, however the cores may have been extracted between bars.

For the assessment of the capacity of the footings, the guidance from *AS3826-1998 Strengthening existing buildings for earthquake* recommends a design strength for unreinforced concrete f'_c = 10MPa (AS3826 Table 1). This provides a lower-bound reference value.

The higher values from the cylinder tests indicate that additional strength may be justified. More samples and testing would be necessary to inform a statistical assessment to determine the appropriate design value.

4.2.2 Slabs

At foundation level, the basement slab is a ground-bearing slab and was observed and measured to be:-

- **TC4** 90mm on a 140mm slab; &
- **TC6** 100mm on a 100mm slab.

It appears that the slab is built up in two layers, possibly to level it at a time after construction.

At Ground level, the slab cover to the top of the steel beams was:-

- **TB1** 109mm to top of beam;

  496-3C documented slab thickness = 4½" (114.3mm)

- **TB2** 113mm to top of beam;

  496-3C documented slab thickness = 4½" (114.3mm)

- **TB3** 80mm to top of beam.

  496-3C documented slab thickness = 6" (152.4mm)

These measurements suggest that the majority of the slab depth is located above the top flange of the beam.

Figure 10 Section B-B from drawing 496 3C showing concrete detail over beam in slab adjacent to test locations

4.2.3 Concrete encasement to columns and beams

At Ground beams, the concrete encasement to the flange (min. thickness) was:-

- **TB1** 58mm to top of beam;
- **TB2** 60mm to top of beam; &
- **TB3** 60mm to top of beam.

The concrete encasement is reinforced with small gauge wire surrounding the steel section.

4.2.4 Core walls

Concrete core walls were not investigated as part of these works. Section 4.3 and Appendix C4 of the Arup inspection briefing document provides proposed locations and a methodology.

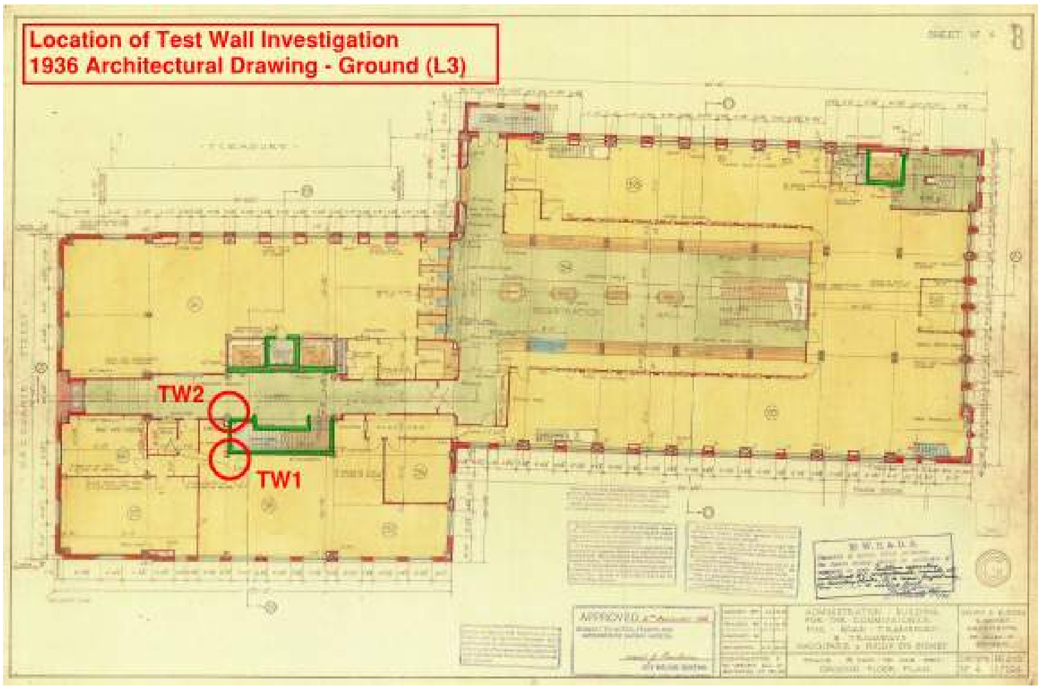


Figure 11 Proposed locations of investigations into walls

Given that the steel frame is unlikely to provide global stability by moment frame action, the concrete walls and their connections are more likely to act as stability elements.

This investigation should be completed to inform the analysis in the next stage of design.

4.3 Foundation materials

Previously a high-level review of the site geotechnical conditions based on observations and a review of the geological mapping for this area was provided by Arup (26/02/2015). The conclusions were that the foundation material was Class IV sandstone and was expected to have an allowable bearing capacity of 2.1-3.2MPa.

Two test locations at **TF1** and **TF2** were investigated by *JK Geotechnics* and core samples taken.

Unconfined compressive tests (UCS) of these samples provided strengths ranging from 6.8MPa to 21MPa. This data can be adopted in the future assessments of the foundations with interpretation from a geotechnical engineer.

Future investigations at other footings will include additional rock samples and testing to confirm the capacity of the founding material at critical locations such as braced bays.

5 Recommendations

The preliminary testing has confirmed a number of assumptions made in the structural assessment of Transport House to date. The key items confirmed include:-

- Member sizes and dimensions are typically accurately represented by the drawings with one exception;
- Material property assumptions for strength and weldability were confirmed valid to progress the design; &
- Steel connection details reviewed confirmed that the existing steel frame is not appropriate for use as a stability system without extensive strengthening to the majority of connections.

On this basis, we recommend next steps for further analysis and investigations.

5.1.1 Investigate wall materials and connections

Investigate the extent of concrete walls and their connection to the steel frame. This will inform the next stage of stability analysis by confirming their participation in the global stability system.

The scope of the investigation is described in the previous Arup briefing document dated 9/02/2018.

5.1.2 Finalize approach to seismic strengthening

From the investigation outcomes provided in this report, the following comments are made to the five options previously in the DA submission (refer Arup letter *2018-03-21 - Transport House Stage 1 DA*).

1. **Cross bracing to steel frame**

This is considered the least invasive, most cost-effective, and structurally efficient from a constructability perspective. The weldability of the steel confirms that this is an option that would likely not require any special welding procedure for the historic steel material. Variability in size and lack of reinforcement will require detailed investigation where bracing meets existing footings.

This option would have the most limited extent of future investigation and testing.

2. **Portal frames at windows and open internal spaces**

These frames would be relatively large members and require more intensive construction works to integrate them into the existing structure. New footings would be required in the basement and sub-basement. Welding and connection to the existing structure would be more extensive and so it is likely future investigation would be more wide-spread.

3. **New shear walls**

This option proposes closing large areas of the building for demolition and rebuilding of new structure inside Transport House. The conclusions from this report have limited bearing on this option.

4. **Strengthen existing frames and walls**

One conclusion of this report was that the existing steel frame would require extensive strengthening to justify its use as a moment-frame for stability. It is likely that the majority of beam-column connections would need to be exposed and strengthened to adopt this proposal. Significant additional investigation and testing would be required prior to adopting this approach.

Given the arrangement of core walls shown on the drawings, the potential to strengthen the existing cores is limited and not likely to provide significant benefit.

5. **Support Transport House against the Intercontinental Hotel**

The possibility of supporting Transport House against the Intercontinental Hotel in the seismic condition has the potential to reduce the extent of seismic strengthening required, however it has a significant number of technical and legal title complexities associated with it. The analysis required to assess if this is technically possible is considered onerous and prohibitive.

Finalisation of the preferred modification and strengthening arrangement would focus the future design direction and the scope of the next stage of investigation.

5.1.3 Progress the assessment of the existing structure

When a stability system is agreed, a detailed analysis can be pursued. For the assessment of the structural frame to support the new ballroom a more detailed analysis can be undertaken with more confidence. This analysis will examine in more detail both the capacity of the structure to support the new vertical loads and the additional seismic loads.

5.1.4 Prepare Stage 2 detailed investigation brief

Future testing and investigations will be required into the steel framing in upper levels, at critical footings (at brace locations), at roof level for connections to new structures, and in the Intercontinental Hotel for potential locations of connections to the new structure.

The outcomes from the steps listed above will determine the extent of this investigation, however a scope could include the following:-

- Expose steel beam-column connections on each level at proposed locations of bracing to allow bracing connection options to be developed (estimate 3 per level);
- Wider non-destructive survey of beams where accessible to measure overall dimensions of beams and columns included encasement. Use this data to do gross validation of beam sizes with assumptions regarding concrete encasement thickness;
- Measurement and testing of concrete and rock at footings at proposed bracing locations (estimate 4 no.);
- Testing of thick steel samples from column baseplates at footing test locations;
- Investigate roof level structure for connection of new ballroom frame; &
- Investigate Intercontinental Hotel at proposed location of connection to ballroom structure.

Appendix A

Historical steel member sizes

A1 Tables from 1924 BHP Handbook

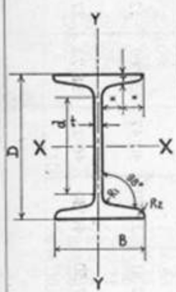
Table 4 Dimensions and Properties of I Beams, Hand Book of Rolled Steel Sections and Other Products, BHP 1924

NBSB. 18	24 x 7½	90	.52	.984	.73	.36	26.47	2443.2	60.44	9.608	1.511	203.602	16.116	24 x 7½

TABLE I. TABLE I.

DIMENSIONS AND PROPERTIES OF I BEAMS (Rolled Steel Joists).

122



For Dimension d (approximate) see Table No. 2.

Reference Marks.	Size D x B Inches	Weight per ft. Lbs.	Diagram. Web t	Diagram. Flange T	Diagram. Radius R_1	Diagram. Radius R_2	Sectional Area Inches²	Moment of Inertia. About X-X	Moment of Inertia. About Y-Y	Radius of Gyration. About X-X	Radius of Gyration. About Y-Y	Modulus of Section. About X-X	Modulus of Section. About Y-Y	Size D x B Inches.
	24 x 7½*	100	.64	.984	.73	.36	29.4	2581.4	63.55	9.37	1.47	215.12	16.68	24 x 7½*
NBSB. 16	20 x 6½	65	.45	.820	.65	.32	19.12	1226.17	32.56	8.008	1.305	122.62	10.018	20 x 6½
NBSB. 13	15 x 6	45	.38	.655	.61	.30	13.24	491.91	19.87	6.096	1.225	65.59	6.624	15 x 6
~~BSB. 25~~	~~15 x 5~~	~~42~~	~~.42~~	~~.647~~	~~.52~~	~~.26~~	~~12.35~~	~~428.2~~	~~11.93~~	~~5.88~~	~~.983~~	~~57.09~~	~~4.775~~	~~15 x 5~~
BSB. 20	12 x 5	32	.35	.550	.45	.225	9.41	220.1	9.74	4.837	1.018	36.68	3.897	12 x 5
NBSHB. 7	10 x 8	55	.40	.783	.77	.38	16.18	288.69	54.74	4.224	1.840	57.74	13.686	10 x 8
BSB. 17	10 x 5	30	.36	.552	.46	.23	8.82	145.68	9.78	4.064	1.053	29.13	3.912	10 x 5
BSB. 14	8 x 6	35	.44	.597	.54	.27	10.29	110.59	17.929	3.278	1.320	27.65	5.976	8 x 6
NBSB. 6	7 x 3½	15	.25	.398	.41	.20	4.49	35.90	2.408	2.851	.738	10.26	1.376	7 x 3½
BSB. 10	6 x 5	25	.41	.52	.51	.255	7.35	43.64	9.105	2.436	1.113	14.547	3.642	6 x 5
NBSB. 5	6 x 3	12	.23	.377	.37	.18	3.53	20.99	1.461	2.437	.643	6.996	.974	6 x 3
NBSB. 4	5 x 2½	9	.20	.347	.33	.16	2.65	10.91	.789	2.030	.546	4.364	.631	5 x 2½
NBSHB. 1	4 x 3	10	.24	.347	.37	.18	2.94	7.786	1.326	1.627	.672	3.893	.884	4 x 3

*Nominal Size. Width about 7⅝". Note—This Section may be altered. Sizes and Properties are for NBS Beam with Thickened Web.

The Broken Hill Proprietary Company Limited.

Table 5 Compound Girders. Properties and Dimensions, Hand Book of Rolled Steel Sections and Other Products, BHP 1924

TABLE 7. TABLE 7.

COMPOUND GIRDERS (ONE I BEAM & FLATS). PROPERTIES & DIMENSIONS.

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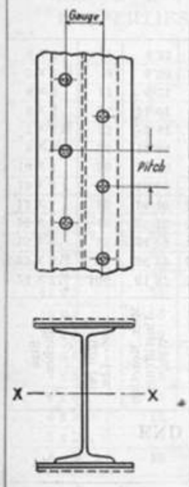


Size of I Beam.	Flats Size	Flats No.	Dimensions in Inches. Depth	Dimensions in Inches. Width	Gross Sectional Area Inches²	Total Weight per Foot Lbs.	Net Moment of Inertia.	Net Modulus of Section.	Diam. of Rivets.	Gauge of Rivets.	Vert. Shear x Pitch Inch-Tons. Rivet Shear Value at 5 Tons Sq. In.	Vert. Shear x Pitch Inch-Tons. Rivet Shear Value at 6 Tons Sq. In.	20 Times Depth Feet.	20 Times Width Feet.
24 x 7½ (Nominal) x 100 lb.	12 x ⅝	4	26½	12	59.4	202.0	6754	509.7	⅞"	4½	116.2	139.4	44.2	20
	12 x ½	4	26	12	53.4	181.6	5802	446.3	„	„	126.3	151.6	43.3	20
	12 x ⅝	2	25¼	12	44.4	151.0	4439	351.6	„	„	157.0	188.4	42.1	20
	12 x ½	2	25	12	41.4	140.8	4002	320.0	„	„	177.8	213.4	41.7	20
20 x 6½ x 65 lb.	12 x ⅝	4	22½	12	49.1	167.0	4214	374.6	⅞	3¾	86.3	103.6	37.5	20
	12 x ⅝	2	21¼	12	34.1	116.0	2559	240.9	„	„	108.0	129.6	35.4	20
	9 x ⅝	2	21¼	9	30.4	103.3	2160	203.3	„	„	125.1	150.1	35.4	15
15 x 6 x 45 lb.	9 x ⅝	4	17½	9	35.7	121.5	1767	201.9	¾	3½	47.0	56.3	29.2	15
	9 x ½	4	17	9	31.2	106.2	1466	172.5	„	„	49.5	59.3	28.3	15
	9 x ⅝	2	16¼	9	24.5	83.3	1048	129.0	„	„	57.9	69.5	27.1	15
	9 x ½	2	16	9	22.2	75.6	917	114.6	„	„	63.9	76.6	26.7	15
15 x 5 x 42 lb.	9 x ⅝	2	16¼	9	23.6	80.3	998	122.8	¾	2¾	55.2	66.2	27.1	15
	8 x ⅝	2	16¼	8	22.4	76.0	922	113.4	„	„	58.0	69.6	27.1	13.3
	8 x ½	2	16	8	20.4	69.2	805	100.6	„	„	63.9	76.7	26.7	13.3
12 x 5 x 32 lb.	9 x ⅝	2	13¼	9	20.7	70.3	599	90.4	¾	2¾	41.0	49.2	22.1	15
	8 x ⅝	2	13¼	8	19.4	66.0	549	82.9	„	„	42.8	51.4	22.1	13.3
	8 x ½	2	13	8	17.4	59.2	471	72.4	„	„	46.3	55.6	21.7	13.3

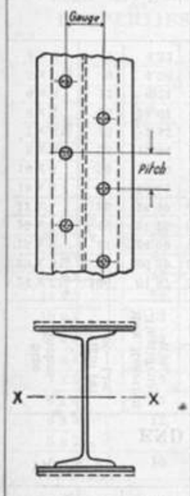
The Broken Hill Proprietary Company Limited.

Table 6 Compound Girders. Properties and Dimensions, Hand Book of Rolled Steel Sections and Other Products, BHP 1924

TABLE 7. TABLE 7.

COMPOUND GIRDERS (ONE I BEAM & FLATS). PROPERTIES & DIMENSIONS.

128



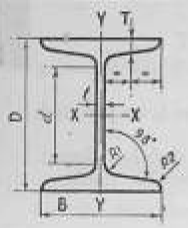
Size of I Beam.	Flats Size	Flats No.	Dimensions in Inches. Depth	Dimensions in Inches. Width	Gross Sectional Area Inches²	Total Weight per Foot Lbs.	Net Moment of Inertia.	Net Modulus of Section.	Diam. of Rivets.	Gauge of Rivets.	Vert. Shear x Pitch Inch-Tons. Rivet Shear Value at 5 Tons Sq. In.	Vert. Shear x Pitch Inch-Tons. Rivet Shear Value at 6 Tons Sq. In.	20 Times Depth Feet.	20 Times Width Feet.
24 x 7½ (Nominal) x 100 lb.	12 x ⅝	4	26½	12	59.4	202.0	6754	509.7	⅞"	4½	116.2	139.4	44.2	20
	12 x ½	4	26	12	53.4	181.6	5802	446.3	„	„	126.3	151.6	43.3	20
	12 x ⅝	2	25¼	12	44.4	151.0	4439	351.6	„	„	157.0	188.4	42.1	20
	12 x ½	2	25	12	41.4	140.8	4002	320.0	„	„	177.8	213.4	41.7	20
20 x 6½ x 65 lb.	12 x ⅝	4	22½	12	49.1	167.0	4214	374.6	⅞	3¾	86.3	103.6	37.5	20
	12 x ⅝	2	21¼	12	34.1	116.0	2559	240.9	„	„	108.0	129.6	35.4	20
	9 x ⅝	2	21¼	9	30.4	103.3	2160	203.3	„	„	125.1	150.1	35.4	15
15 x 6 x 45 lb.	9 x ⅝	4	17½	9	35.7	121.5	1767	201.9	¾	3½	47.0	56.3	29.2	15
	9 x ½	4	17	9	31.2	106.2	1466	172.5	„	„	49.5	59.3	28.3	15
	9 x ⅝	2	16¼	9	24.5	83.3	1048	129.0	„	„	57.9	69.5	27.1	15
	9 x ½	2	16	9	22.2	75.6	917	114.6	„	„	63.9	76.6	26.7	15
15 x 5 x 42 lb.	9 x ⅝	2	16¼	9	23.6	80.3	998	122.8	¾	2¾	55.2	66.2	27.1	15
	8 x ⅝	2	16¼	8	22.4	76.0	922	113.4	„	„	58.0	69.6	27.1	13.3
	8 x ½	2	16	8	20.4	69.2	805	100.6	„	„	63.9	76.7	26.7	13.3
12 x 5 x 32 lb.	9 x ⅝	2	13¼	9	20.7	70.3	599	90.4	¾	2¾	41.0	49.2	22.1	15
	8 x ⅝	2	13¼	8	19.4	66.0	549	82.9	„	„	42.8	51.4	22.1	13.3
	8 x ½	2	13	8	17.4	59.2	471	72.4	„	„	46.3	55.6	21.7	13.3

The Broken Hill Proprietary Company Limited.

A2 Tables from 1952 BHP Handbook

Table 7 Rolled Steel Beams - Dimensions and Properties, Shapes and Sections, BHP 1952

THE BROKEN HILL PROPRIETARY COMPANY LIMITED — AUSTRALIA



ROLLED STEEL BEAMS

DIMENSIONS AND PROPERTIES

Reference Number	Size D x B Inches	Weight per Foot in Lbs.	Standard Thickness Inches		Radii Inches		Straight portion of Web d Inches
			Web t	Flange T	Root R_1	Toe R_2	
	24 x 7½*	100	.64	.984	.73	.36	20.30
ASB 126	24 x 7½	95	.57	1.011	.73	.36	20.25
ASB 125	22 x 7	75	.50	.834	.69	.34	18.68
ASB 124	20 x 6½	65	.45	.820	.65	.32	16.80
ASB 123	18 x 6	55	.42	.757	.61	.30	15.03
ASB 121	16 x 6	50	.40	.726	.61	.30	13.09
ASB 120	15 x 6	45	.38	.655	.61	.30	12.25
ASB 119	14 x 5½	40	.37	.627	.57	.28	11.39
ASB 118	13 x 5	35	.35	.604	.53	.26	10.53
ASB 117	12 x 8	65	.43	.904	.77	.38	8.30
ASB 116	12 x 5	30	.33	.507	.53	.26	9.74
ASB 115	10 x 8	70	.60	.970	.70	.35	6.33
ASB 114	10 x 8	55	.40	.783	.77	.38	6.60
ASB 113	10 x 6	40	.36	.709	.61	.30	7.09
ASB 112	10 x 4½	25	.30	.505	.49	.24	7.84
ASB 111	9 x 7	50	.40	.825	.69	.34	5.61
ASB 110	9 x 4	21	.30	.457	.45	.22	7.03
ASB 109	8 x 6	35	.35	.648	.61	.30	5.36
ASB 108	8 x 4	18	.28	.398	.45	.22	6.15
ASB 107	7 x 3½	15	.25	.398	.41	.20	5.25
ASB 106	6 x 5	25	.33	.561	.53	.26	3.71
ASB 105	6 x 3	12	.23	.377	.37	.18	4.40
ASB 104	5 x 2½	9	.20	.347	.33	.16	3.60
ASB 103	4 x 3	10	.24	.347	.37	.18	2.50
ASB 102	4 x 1¾	5	.17	.239	.27	.13	2.86
	3 x 2²¹⁄₆₄	5.7	.17	.262	.27	.10	1.85

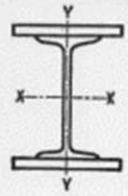
* Nominal size. Actual width is 7.62 inches.

Table 8 Conversion of imperial dimensions to metric

BHP Ref		Transport House Ref	Size		Weight	Thickness		Root radius		Web Depth
			D	B		Web	Flange	R1	R2	
			mm	mm	kg/m	mm	mm	mm	mm	mm
		24 · 7½ · 100	609.6	193.5	148.8	16.3	25.0	18.5	9.1	515.6
ASB	**126**	**24 · 7½ · 95**	609.6	190.5	141.4	14.5	25.7	18.5	9.1	514.4
ASB	**125**	**22 · 7 · 75**	558.8	177.8	111.6	12.7	21.2	17.5	8.6	474.5
ASB	**124**	**20 · 6½ · 65**	508.0	165.1	96.7	11.4	20.8	16.5	8.1	426.7
ASB	**123**	**18 · 6 · 55**	457.2	152.4	81.8	10.7	19.2	15.5	7.6	381.8
ASB	**121**	**16 · 6 · 50**	406.4	152.4	74.4	10.2	18.4	15.5	7.6	332.5
ASB	**120**	**15 · 6 · 45**	381.0	152.4	67.0	9.7	16.6	15.5	7.6	311.2
ASB	**119**	**14 · 5½ · 40**	355.6	139.7	59.5	9.4	15.9	14.5	7.1	289.3
ASB	**118**	**13 · 5 · 35**	330.2	127.0	52.1	8.9	15.3	13.5	6.6	267.5
ASB	**117**	**12 · 8 · 65**	304.8	203.2	96.7	10.9	23.0	19.6	9.7	210.8
ASB	**116**	**12 · 5 · 30**	304.8	127.0	44.6	8.4	12.9	13.5	6.6	247.4
ASB	**115**	**10 · 8 · 70**	254.0	203.2	104.2	15.2	24.6	17.8	8.9	160.8
ASB	**114**	**10 · 8 · 55**	254.0	203.2	81.8	10.2	19.9	19.6	9.7	167.6
ASB	**113**	**10 · 6 · 40**	254.0	152.4	59.5	9.1	18.0	15.5	7.6	180.1
ASB	**112**	**10 · 4½ · 25**	254.0	114.3	37.2	7.6	12.8	12.4	6.1	199.1
ASB	**111**	**9 · 7 · 50**	228.6	177.8	74.4	10.2	21.0	17.5	8.6	142.5
ASB	**110**	**9 · 4 · 21**	228.6	101.6	31.3	7.6	11.6	11.4	5.6	178.6
ASB	**109**	**8 · 6 · 35**	203.2	152.4	52.1	8.9	16.5	15.5	7.6	136.1
ASB	**108**	**8 · 4 · 18**	203.2	101.6	26.8	7.1	10.1	11.4	5.6	156.2
ASB	**107**	**7 · 3½ · 15**	177.8	88.9	22.3	6.4	10.1	10.4	5.1	133.4
ASB	**106**	**6 · 5 · 25**	152.4	127.0	37.2	8.4	14.2	13.5	6.6	94.2
ASB	**105**	**6 · 3 · 12**	152.4	76.2	17.9	5.8	9.6	9.4	4.6	111.8
ASB	**104**	**5 · 2½ · 9**	127.0	63.5	13.4	5.1	8.8	8.4	4.1	91.4
ASB	**103**	**4 · 3 · 10**	101.6	76.2	14.9	6.1	8.8	9.4	4.6	63.5
ASB	**102**	**4 · 1¾ · 5**	101.6	44.5	7.4	4.3	6.1	6.9	3.3	72.6
		3 · 2.3 · 5.7	76.2	59.1	8.5	4.3	6.7	6.9	2.5	47.0

Table 9 One Rolled Steel Beam and Two Flats – Composition a and Properties, Shapes and Sections, BHP 1952

THE BROKEN HILL PROPRIETARY COMPANY LIMITED — AUSTRALIA



ONE ROLLED STEEL BEAM AND TWO FLATS

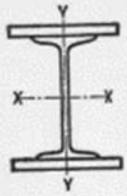
COMPOSITION AND PROPERTIES

Composition		Properties of Gross Combined Sections								
One Rolled Steel Beam	Flats. Each Flange To Form	Weight per Foot in Lbs.	Area Inches²	Moments of Inertia Inches⁴ About X-X	Moments of Inertia Inches⁴ About Y-Y	Radii of Gyration Inches About X-X	Radii of Gyration Inches About Y-Y	Moduli of Section Inches³ About X-X	Moduli of Section Inches³ About Y-Y	Deflection Coefficient Cd About X-X
24 × 7½ × 100	18 × 1½	283.60	83.34	11370	1522	11.68	4.27	842	169	.000744
24 × 7½ × 100	18 × ⅞	207.20	60.84	7456	914	11.07	3.88	579	102	.000780
24 × 7½ × 100	16 × 1¼	236.00	69.34	8962	917	11.37	3.64	676	115	.000758
24 × 7½ × 100	16 × ¾	181.60	53.34	6258	576	10.83	3.28	491	71.9	.000788
24 × 7½ × 100	14 × 1¼	219.00	64.34	8165	635	11.26	3.14	616	90.7	.000758
24 × 7½ × 100	14 × ⅝	159.50	46.84	5235	349	10.57	2.73	415	49.9	.000796
24 × 7½ × 100	12 × 1	181.60	53.34	6333	352	10.90	2.57	487	58.6	.000773
24 × 7½ × 100	12 × ½	140.80	41.34	4382	208	10.30	2.24	351	34.6	.000804
24 × 7½ × 100	10 × 1	168.00	49.34	5708	230	10.76	2.16	439	46.0	.000773
24 × 7½ × 100	10 × ⅜	125.50	36.84	3696	126	10.02	1.85	299	25.2	.000812
24 × 7½ × 100	8 × 1	154.40	45.34	5083	149	10.59	1.81	391	37.2	.000773
24 × 7½ × 100	8 × ⅜	120.40	35.34	3473	95.6	9.91	1.64	281	23.9	.000812
24 × 7½ × 95	18 × 1½	278.60	81.94	11322	1521	11.75	4.31	839	169	.000744
24 × 7½ × 95	18 × ⅞	202.20	59.44	7408	913	11.16	3.92	575	101	.000780
24 × 7½ × 95	16 × 1¼	231.00	67.94	8914	916	11.45	3.67	673	114	.000758
24 × 7½ × 95	16 × ¾	176.60	51.94	6210	575	10.93	3.33	487	71.8	.000788
24 × 7½ × 95	14 × 1¼	214.00	62.94	8116	634	11.36	3.17	613	90.6	.000758
24 × 7½ × 95	14 × ⅝	154.50	45.44	5187	348	10.68	2.77	411	49.8	.000796
24 × 7½ × 95	12 × 1	176.60	51.94	6285	351	11.00	2.60	483	58.4	.000773
24 × 7½ × 95	12 × ½	135.80	39.94	4334	207	10.42	2.27	347	34.4	.000804
24 × 7½ × 95	10 × 1	163.00	47.94	5660	229	10.87	2.19	435	45.8	.000773
24 × 7½ × 95	10 × ⅜	120.50	35.44	3647	125	10.14	1.88	295	25.0	.000812
24 × 7½ × 95	8 × 1	149.40	43.94	5034	148	10.70	1.83	387	37.0	.000773
24 × 7½ × 95	8 × ⅜	115.40	33.94	3424	94.5	10.04	1.67	277	23.6	.000812
22 × 7 × 75	18 × 1½	258.60	76.06	9142	1499	10.96	4.44	731	167	.000804
22 × 7 × 75	18 × ⅞	182.20	53.56	5800	892	10.41	4.08	488	99.1	.000846
22 × 7 × 75	16 × 1¼	211.00	62.06	7088	894	10.69	3.80	579	112	.000820
22 × 7 × 75	16 × ¾	156.60	46.06	4783	553	10.19	3.47	407	69.1	.000855
22 × 7 × 75	14 × 1¼	194.00	57.06	6411	613	10.60	3.28	523	87.5	.000820
22 × 7 × 75	14 × ⅝	134.50	39.56	3917	327	9.95	2.87	337	46.7	.000864
22 × 7 × 75	12 × 1	156.60	46.06	4853	329	10.26	2.67	404	54.8	.000837
22 × 7 × 75	12 × ½	115.80	34.06	3196	185	9.69	2.33	278	30.8	.000873
22 × 7 × 75	10 × 1	143.00	42.06	4323	208	10.14	2.22	360	41.5	.000837
22 × 7 × 75	10 × ⅜	100.50	29.56	2616	104	9.41	1.87	230	20.7	.000883
22 × 7 × 75	8 × 1	129.40	38.06	3794	126	9.98	1.82	316	31.6	.000837
22 × 7 × 75	8 × ⅜	95.40	28.06	2428	73.1	9.30	1.61	213	18.3	.000883

Max. Deflection ins. = Cd × L^2 feet. For Explanation of Table see Page 86.

Table 10 One Rolled Steel Beam and Two Flats – Composition a and Properties, Shapes and Sections, BHP 1952

THE BROKEN HILL PROPRIETARY COMPANY LIMITED — AUSTRALIA



ONE ROLLED STEEL BEAM AND TWO FLATS

COMPOSITION AND PROPERTIES

Composition		Properties of Gross Combined Sections								
One Rolled Steel Beam	Flats Each Flange To Form	Weight per Foot in Lbs.	Area Ins.^{2}	Moments of Inertia Ins.^{4}		Radii of Gyration Inches		Moduli of Section Ins.^{3}		Deflection Coefficient Cd About X-X
				About X-X	About Y-Y	About X-X	About Y-Y	About X-X	About Y-Y	
20 × 6½ × 65	18 × 1½	248.6	73.12	7477	1491	10.11	4.52	650	166	.000873
20 × 6½ × 65	18 × 1	187.4	55.12	5198	1005	9.71	4.27	473	112	.000913
20 × 6½ × 65	16 × 1¼	201.0	59.12	5747	886	9.86	3.87	511	111	.000893
20 × 6½ × 65	16 × ⅞	160.2	47.12	4278	630	9.53	3.66	393	78.7	.000924
20 × 6½ × 65	14 × 1¼	184.0	54.12	5182	604	9.79	3.34	461	86.3	.000893
20 × 6½ × 65	14 × ¾	136.4	40.12	3488	376	9.32	3.06	324	53.7	.000934
20 × 6½ × 65	12 × 1	146.6	43.12	3874	321	9.48	2.73	352	53.4	.000913
20 × 6½ × 65	12 × ⅝	116.0	34.12	2822	213	9.09	2.50	266	35.4	.000945
20 × 6½ × 65	10 × 1	133.0	39.12	3433	199	9.37	2.26	312	39.8	.000913
20 × 6½ × 65	10 × ½	99.0	29.12	2277	116	8.84	1.99	217	23.2	.000957
20 × 6½ × 65	8 × 1	119.4	35.12	2992	118	9.23	1.83	272	29.5	.000913
20 × 6½ × 65	8 × ⅜	85.4	25.12	1849	64.6	8.58	1.60	178	16.1	.000968
18 × 6 × 55	16 × 1¼	191.0	56.18	4553	877	9.00	3.95	444	110	.000980
18 × 6 × 55	16 × ⅞	150.2	44.18	3337	621	8.69	3.75	338	77.6	.001017
18 × 6 × 55	14 × 1¼	174.0	51.18	4089	595	8.94	3.41	399	85.0	.000980
18 × 6 × 55	14 × ¾	126.4	37.18	2688	367	8.50	3.14	276	52.4	.001030
18 × 6 × 55	12 × 1	136.6	40.18	3010	312	8.65	2.78	301	51.9	.001004
18 × 6 × 55	12 × ⅝	106.0	31.18	2143	204	8.29	2.56	223	33.9	.001044
18 × 6 × 55	10 × 1	123.0	36.18	2648	190	8.56	2.29	265	38.1	.001004
18 × 6 × 55	10 × ½	89.0	26.18	1698	107	8.05	2.02	179	21.4	.001057
18 × 6 × 55	8 × 1	109.4	32.18	2287	109	8.43	1.84	229	27.2	.001004
18 × 6 × 55	8 × ⅜	75.4	22.18	1348	55.6	7.80	1.58	144	13.9	.001071
16 × 6 × 50	14 × 1¼	169.0	49.71	3226	594	8.06	3.46	349	84.9	.001086
16 × 6 × 50	14 × ¾	121.4	35.71	2092	365	7.65	3.20	239	52.2	.001148
16 × 6 × 50	12 × 1	131.6	38.71	2354	310	7.80	2.83	262	51.7	.001116
16 × 6 × 50	12 × ⅝	101.0	29.71	1655	202	7.46	2.61	192	33.7	.001165
16 × 6 × 50	10 × 1	118.0	34.71	2065	189	7.71	2.33	229	37.8	.001116
16 × 6 × 50	10 × ½	84.0	24.71	1299	106	7.25	2.07	153	21.2	.001182
16 × 6 × 50	8 × 1	104.4	30.71	1775	108	7.60	1.87	197	27.0	.001116
16 × 6 × 50	8 × ⅜	70.4	20.71	1020	54.5	7.02	1.62	122	13.6	.001199
15 × 6 × 45	12 × 1	126.6	37.24	2030	308	7.38	2.88	239	51.3	.001182
15 × 6 × 45	12 × ⅝	96.0	28.24	1408	200	7.06	2.66	173	33.3	.001236
15 × 6 × 45	10 × 1	113.0	33.24	1774	187	7.30	2.37	209	37.3	.001182
15 × 6 × 45	10 × ½	79.0	23.24	1093	103	6.86	2.11	137	20.6	.001256
15 × 6 × 45	8 × 1	99.4	29.24	1517	105	7.20	1.90	178	26.3	.001182
15 × 6 × 45	8 × ⅜	65.4	19.24	847	51.9	6.63	1.64	108	13.0	.001276

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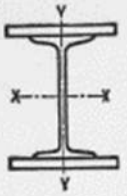
Table 11 One Rolled Steel Beam and Two Flats – Composition a and Properties, Shapes and Sections, BHP 1952

THE BROKEN HILL PROPRIETARY COMPANY LIMITED — AUSTRALIA



ONE ROLLED STEEL BEAM AND TWO FLATS

COMPOSITION AND PROPERTIES

Composition		Properties of Gross Combined Sections								
One Rolled Steel Beam	Flats Each Flange To Form	Weight per Foot in Lbs.	Area Inches²	Moments of Inertia Ins.⁴		Radii of Gyration Inches		Moduli of Section Ins.³		Deflection Coefficient Cd About X-X
				About X-X	About Y-Y	About X-X	About Y-Y	About X-X	About Y-Y	
14×5½×40	12×1	121.60	35.77	1729	303	6.95	2.91	216	50.5	.001256
14×5½×40	12×⅝	91.00	26.77	1180	195	6.64	2.70	155	32.5	.001317
14×5½×40	10×1	108.00	31.77	1504	181	6.88	2.39	188	36.3	.001256
14×5½×40	10×½	74.00	21.77	903	98.1	6.44	2.12	120	19.6	.001339
14×5½×40	8×1	94.40	27.77	1278	100	6.78	1.90	160	25.0	.001256
14×5½×40	8×⅜	60.40	17.77	687	46.8	6.22	1.62	93.2	11.7	.001362
14×5½×40	6×1	80.80	23.77	1053	50.8	6.66	1.46	132	16.9	.001256
14×5½×40	6×⅜	55.30	16.27	610	28.3	6.12	1.32	82.7	9.43	.001362
13×5 ×35	12×1	116.60	34.30	1462	299	6.53	2.95	195	49.8	.001339
13×5 ×35	12×⅝	86.00	25.30	980	191	6.22	2.75	138	31.8	.001410
13×5 ×35	10×1	103.00	30.30	1265	177	6.46	2.42	169	35.5	.001339
13×5 ×35	10×½	69.00	20.30	739	94.1	6.03	2.15	106	18.8	.001435
13×5 ×35	8×1	89.40	26.30	1069	96.1	6.37	1.91	143	24.0	.001339
13×5 ×35	8×⅜	55.40	16.30	552	42.8	5.82	1.62	80.3	10.7	.001461
13×5 ×35	6×1	75.80	22.30	873	46.8	6.26	1.45	116	15.6	.001339
13×5 ×35	6×⅜	50.30	14.80	485	24.3	5.72	1.28	70.5	8.10	.001461
12×5 ×30	10×1	98.00	28.83	1054	175	6.05	2.47	151	35.1	.001435
12×5 ×30	10×½	64.00	18.83	598	92.1	5.63	2.21	92.0	18.4	.001545
12×5 ×30	8×1	84.40	24.83	884	94.1	5.97	1.95	126	23.5	.001435
12×5 ×30	8×⅜	50.40	14.83	437	40.8	5.43	1.66	68.5	10.2	.001576
12×5 ×30	6×1	70.80	20.83	715	44.8	5.86	1.47	102	14.9	.001435
12×5 ×30	6×⅜	45.30	13.33	379	22.3	5.33	1.29	59.5	7.42	.001576
10×6 ×40	10×1	108.00	31.77	811	188	5.05	2.44	135	37.7	.001674
10×6 ×40	10×½	74.00	21.77	481	105	4.70	2.20	87.4	21.0	.001826
10×6 ×40	8×1	94.40	27.77	690	107	4.99	1.96	115	26.8	.001674
10×6 ×40	8×⅜	60.40	17.77	366	53.8	4.54	1.74	68.2	13.4	.001869
9×4 ×21	10×1	89.00	26.18	583	171	4.72	2.55	106	34.2	.001826
9×4 ×21	10×½	55.00	16.18	307	87.5	4.36	2.33	61.4	17.5	.002009
9×4 ×21	8×1	75.40	22.18	482	89.5	4.66	2.01	87.7	22.4	.001826
9×4 ×21	8×⅜	41.40	12.18	213	36.2	4.18	1.72	43.7	9.04	.002060
9×4 ×21	6×1	61.80	18.18	382	40.2	4.58	1.49	69.5	13.4	.001826
9×4 ×21	6×⅜	36.30	10.68	180	17.7	4.11	1.29	36.9	5.88	.002060
8×4 ×18	8×1	72.40	21.30	381	88.8	4.23	2.04	76.2	22.2	.002009
8×4 ×18	8×⅜	38.40	11.30	161	35.5	3.77	1.77	36.8	8.88	.002296
8×4 ×18	6×1	58.80	17.30	300	39.5	4.16	1.51	59.9	13.2	.002009
8×4 ×18	6×⅜	33.30	9.80	135	17.0	3.71	1.32	30.8	5.67	.002296

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