

# Appendix K Cultural Heritage Archival Recordings







## 6. STRARCH HANGER

### 6.1 Description

#### Location

The STRARCH faces Ripon Road and is situated in the Heritage Park district, between the CUST Hut and Bicentenary Building, in the SME, Steele Barracks.

Map grid references (MGA datum):

NE corner	307627.6240717
NW corner	307597.6240722
SE corner	307622.6240687
SW corner	307593.6240691

#### Background

The building is 30m x 32m and 8.6m high. The structure comprises a post tensioned steel truss roof which is tied down to large concrete footings. The name of the building (STRARCH) comes from the stressed arch design. The ends of the building are open. Walls on the long axis of the building are clad in Colorbond corrugated sheeting, as is the roof.

The building is one of 24 similar hangars procured by the RAAF and which had been stored in the Northern Territory for over ten years before being erected at SME as a 'temporary' facility in 2008 by the SME Construction Wing. The structure is now a feature of the SME Heritage Park and houses large machinery and equipment from the RAE Museum collection. Whilst the design details do not specify the design life, it is at least 16 years old and could be expected to have a design life of 25 years (NOHC 2014c, Parsons Brinckerhoff 2014).

The recently completed 2014 structural assessment of the Hanger by Parsons Brinckerhoff (Parsons Brinckerhoff 2014) reports the following:

During a subsequent meeting with Construction Wing to request any available records..., a senior staff member who supervised the erection recalled the need to procure a set of specialised hydraulic jacks from an overseas supplier to post-tension the Starch Hangar as Starch had ceased trading. One jack failed during the erection activity. It is understood that the remainder are in storage at SME.

A plaque located on the interior of the northern wall is engraved as follows: "Re-deployable Starch Hangar constructed by Trade Training Troop, Construction Wing officially opened on 25 November 2008 by Lt Col D.A. Rye CO/CI SME."

This building is a unique example of a RAAF STRARCH re-deployable hangar. SME management believes the Hangar may be the only example of this design still in Defence ownership in Australia. This statement has not yet been confirmed in subsequent research. (NOHC 2014c). It is known that two hangars were seriously damaged after being impacted by cyclones in North Queensland (Captain Brian Collings quoted in Parsons Brinckerhoff 2014). It should be noted that examples of this type of design and construction occur elsewhere in Australia outside of Defence ownership for example Drage's AirWorld at Wodonga VIC and at Avalon Airport, Melbourne, VIC. The construction system is unique and was developed to provide prefabricated quick erection Hangars to house F111 fighters. The system was subsequently developed for non-Defence commercial use by a company called STRARCH Australia. It operated until 2004 when it went into receivership. This building, being still owned by Defence, consequently retains an historic connection to its original design use, to house the F111 Squadron when they first arrived in Australia.



## Structural description

The following structural description of the hangar comes from the 2014 structural assessment by Parsons Brinckerhoff (Parsons Brinckerhoff 2014).

The Starch Hangar's overall dimensions are 30m long, 32m wide and approximately 10m high. The hangar is open ended. The Starch drawings show the structural arrangement comprises a 2 pin curved post-tensioned arch truss. Five trusses are spaced at approximately 7.3m centres, spanning approximately 32m. Each truss is supported on a trussed column assembly. The base of each column assembly is horizontally pinned to allow rotation during erection. The base of the column assembly is connected to holding down bolts cast into a large concrete footing.

The truss components are covered with a white protective coating. Starch Drawing S001 Rev D shows that each truss comprises a 100 x100 x5 mm wall thickness painted square hollow steel section as the top chord, and painted twin 60.3 OD x 5.4 mm thick hollow steel tubular sections as the bottom chord containing the stressed steel tendons.

The SME design calculations show a cast-in-situ footing 1m deep reinforced concrete footing 2.2 m square designed to resist all horizontal and vertical forces imposed by the hangar including wind uplift. No "as-built" records were provided to show if they were constructed as designed. A 2.4m wide concrete slab connects the foundations under each column providing a level internal and external surface along each side of the hangar under the wall cladding

The strength of the stressed arch system relies on maintaining constant tension in the steel tendons in the bottom chords generated by post tensioning during erection. Without this force, the hangar would be unstable. Starch Hangar Drawing No S004 Rev D details the bottom chord tubes connected by an inner tubular sleeve (48.2 dia x 3.2mm wall thickness) creating a sliding joint inside the bottom chord. This allows the overall length of the bottom chord to shorten to its specified dimension during post tensioning as the truss lifts and assumes its arched profile. The detail includes rubber ring seals to retain grease applied to the steel tendons during installation.

The white colourbond cladding is supported by galvanised steel purlins and girts on the roof and side walls. The purlins supporting the roof cladding above the trusses comprise galvanised steel C sections spanning between the truss supports at various centres over the length of the trusses. The galvanised Z-section steel girts supporting the side wall cladding are bolted to cleats on the outer face of the column assemblies.

There is no roof bracing in the plane of the arched truss system. Uncoated steel reinforcing rods bolted to the columns at the side walls provide diagonal bracing of the hangar. A tubular strut is located in the eaves between bays for the entire length of the building along each wall and ties into panel points of the wall rod bracing.

Ten column assemblies support the 5 roof trusses. They each comprise a braced truss arrangement of 2 vertical channel section struts connected by cross bracing supporting the roof truss. The base of each column assembly is horizontally pinned to a 16mm thick fabricated steel channel section with an M24 bolt. The channel section is fixed between and bolted to two stiffened angle brackets. The angle brackets are each fixed by 3 holding down bolts cast into the reinforced concrete footing. The channel and the two angles are seated on a 10mm base plate over a 25mm grout levelling pad above the footing.

The SME design calculations show a cast-in-situ footing at each column as a 1m deep reinforced concrete foundation 2.2m square designed to resist all horizontal and vertical forces imposed by the hangar including wind uplift as specified in the Standards Australia Wind Code AS 1170.2. No "as-built" records were provided to show if they were constructed as designed.

A 2.4m wide concrete slab connects the foundations under each column providing a level internal and external surface along each side of the hangar under the wall cladding. The internal floor is unsealed.





Unpainted 24mm diameter reinforcing rod diagonal bracing is provided along the interior of both side walls between columns and is welded to a cleat at the baseplate and bolted to each alternate column at eaves level.

Eaves bracing is provided along the full length of the structure by horizontal tubular struts.

During the recently conducted structural assessment of the STRARCH hanger (Parsons Brinkerhoff 2014), the following relevant documentation was sourced from the SME Construction Wing:

- RAAF Strarch Hangar Completion Report (October 1991) for two hangars erected at RAAF Base Learmonth, WA.
- A set of 80 design drawings including a Cover Sheet and Drawing Index of 79 engineering drawings titled "RAAF Strarch Re-deployable Shelter (30x32m) issued by Strarch International Limited all dated 28 May 1993.
- User Manual (64 pages plus Appendices) - issued by Strarch International Limited, dated May 1993 (supersedes version dated November 1990) titled "Royal Australian Air Force – Assembly / Erection Manual).

Section 1 contains an introduction describing the RAAF requirement for deployable shelters and how the Strarch Re-deployable Shelter meets these requirements. Key points include:

1.1 "The Royal Australian Air Force deploys Fighter and Strike / Reconnaissance aircraft at strategic air bases throughout Australia. These are expensive aircraft and need shelter against the deteriorating effects of rain, wind and solar radiation. The forward air bases have a requirement for shelters. [to be] capable of rapid initial deployment and subsequent dismantling and re-deployment."

1.2 "The Strarch Re-deployable Shelter was developed to meet this requirement for a forward base shelter. (It) can be fully erected or dismantled (without end walls) by a team of ten (10) persons within a 96 hour period".

- SME Construction Wing Strarch Hangar (15pp) foundation design structural calculations dated 27 March 2008 by Captain K Reynolds
- 8 Construction Engineer Regiment calculations "Foundation Design Check for Strarch Hangar at SME" (11 pp) dated 23 May 2008 by Lt. Johnson. This notes that "Building Squadron, Construction Wing, School of Military Engineering are to erect a 30 x 32m hangar in the vicinity of the military engineering heritage area at SME. This particular hangar is a proprietary product, designed, certified and manufactured by Strarch International Limited, The hangar was originally designed to be constructed in the Northern Territory over ten years ago. Since this time, it has been in storage in the Northern Territory. Currently, Construction Wing are to design the footings required." It also contains a list of references to Strarch drawings, a soils report, and Australian Standards AS 1170.1 Load Combinations, AS 1170.2 Structural Design Actions Part 2:Wind Actions, AS 3600 Concrete Code and AS 4100 Steel Code.

Digitised copies of these documents have been made available and are included in the attached data disk which forms part of this record.

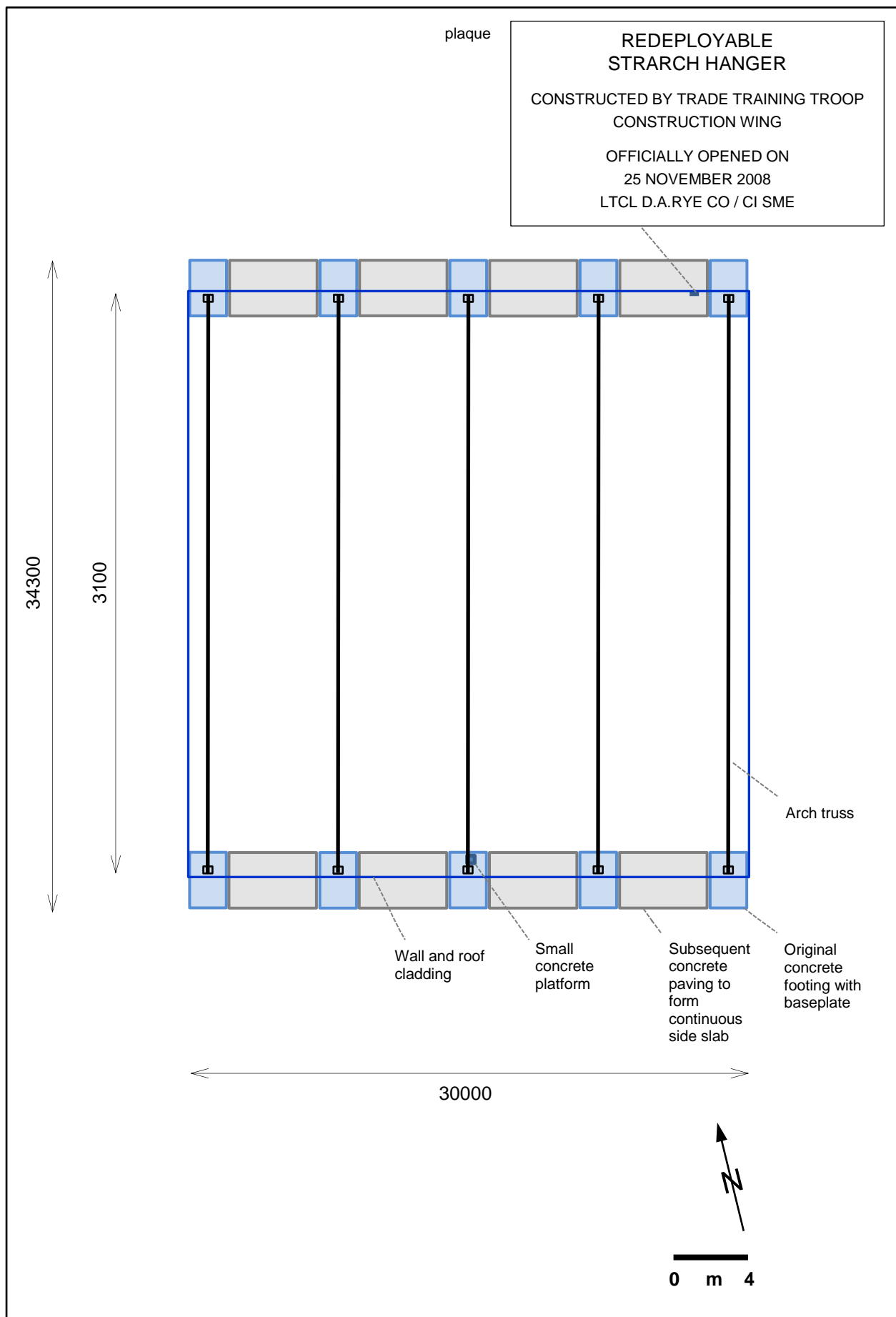


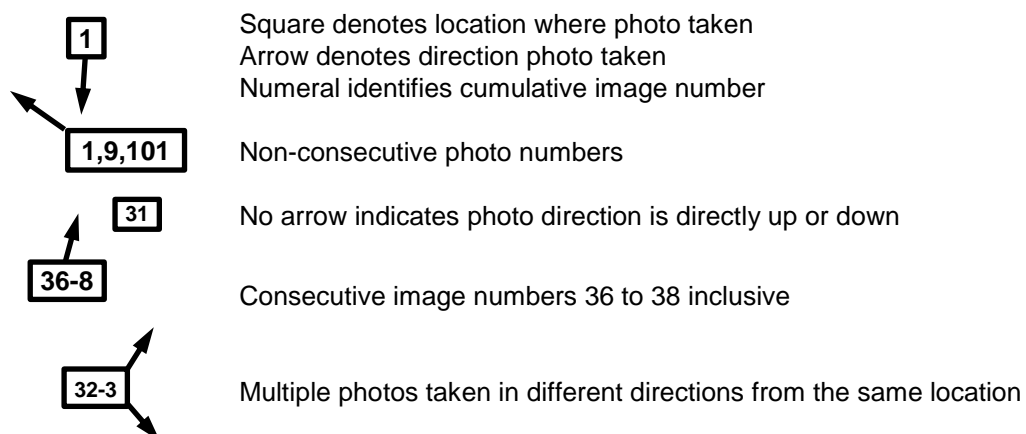
Figure 6.1 Ground plan of STRARCH Hanger

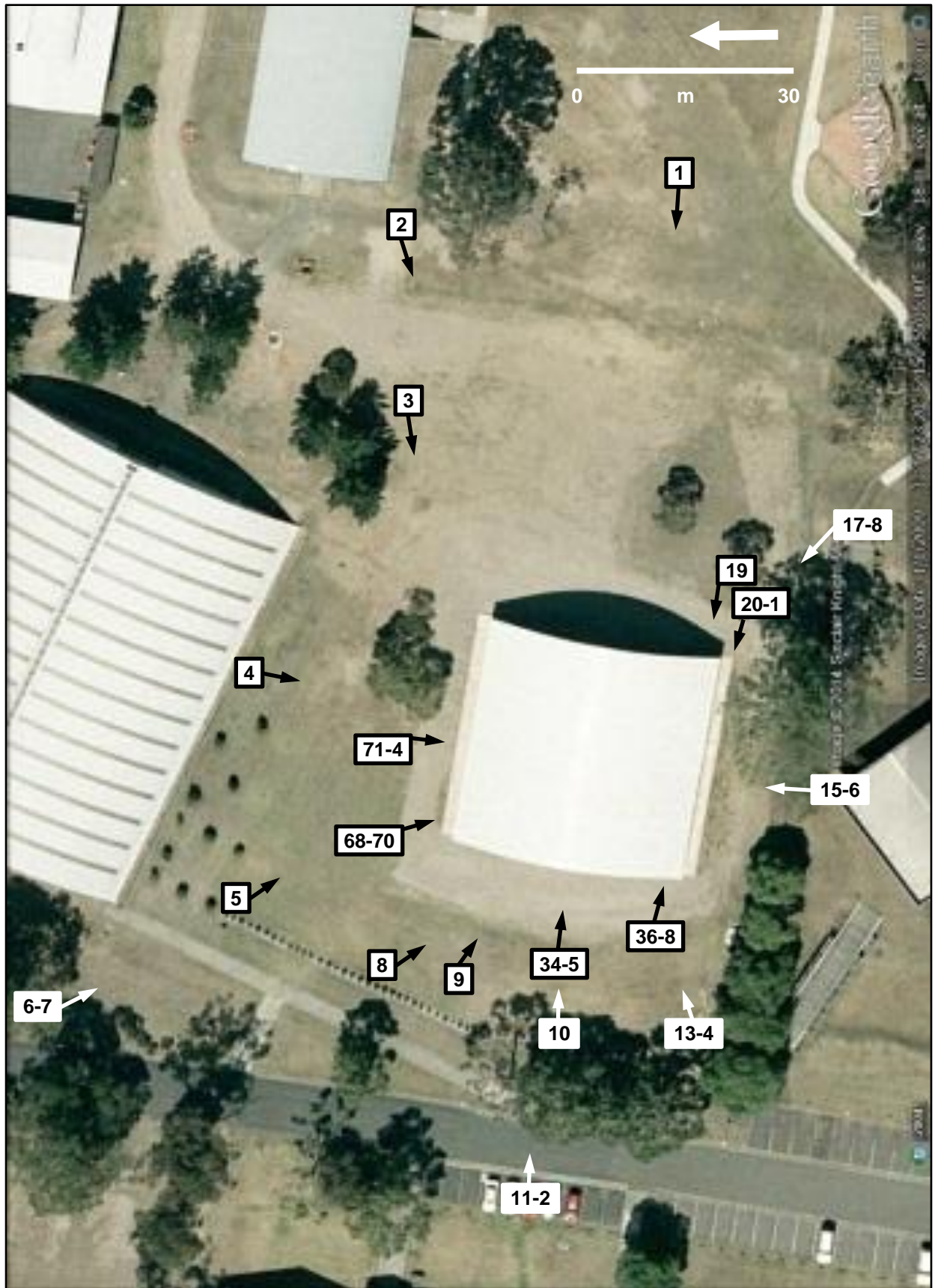


## 6.2 Plans of Photograph Locations

### KEY

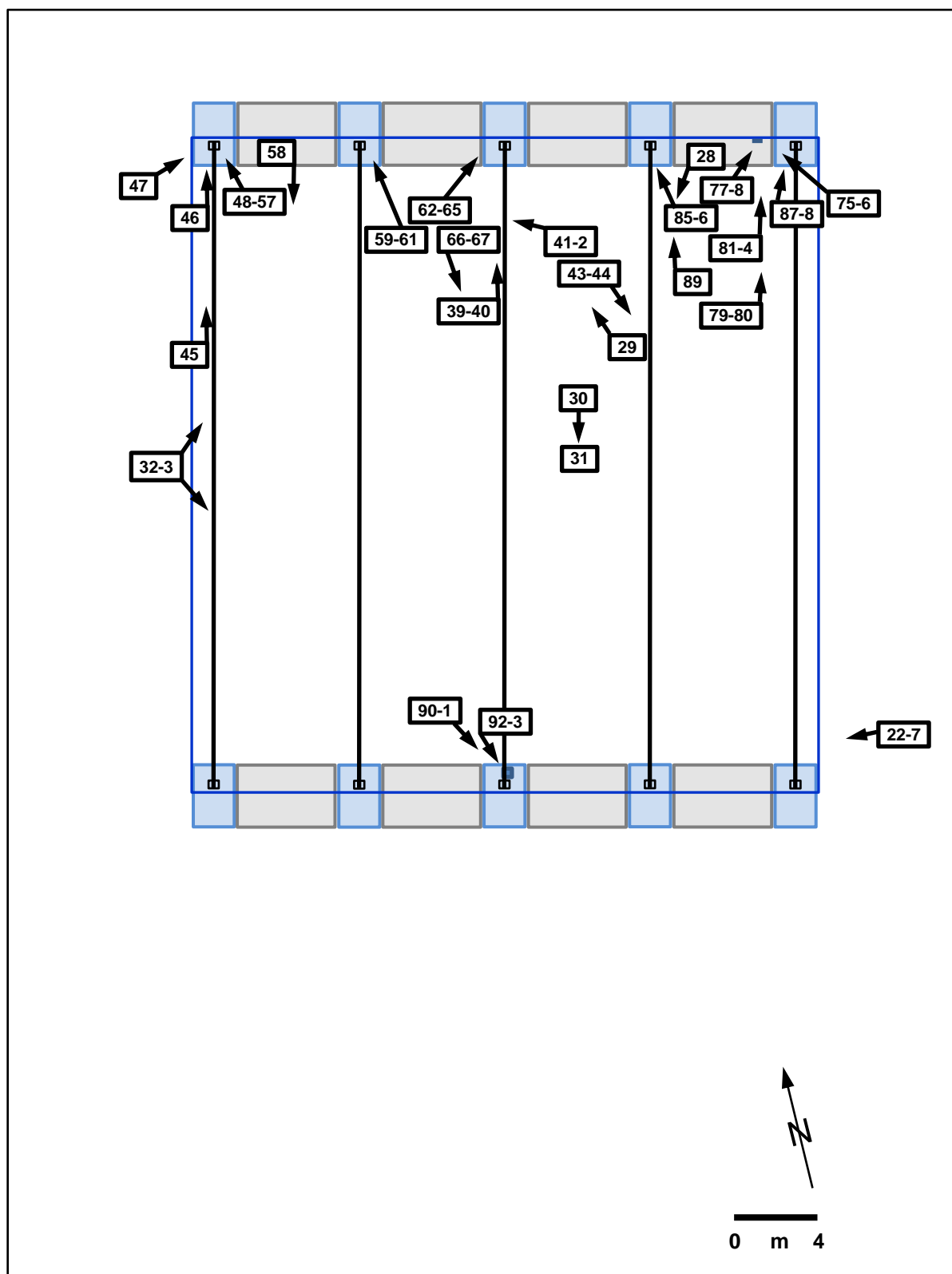
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**Figure 6.2 Aerial photo of STRARCH Hanger area, showing location of exterior STRARCH Hanger photo locations. All numbers have a 'STRARCH' prefix. (Base image from Google Earth Pro 2014, image date: 1/1/2009).**





**Figure 6.3 Plan of interior STRARCH Hanger photo locations. All numbers have a 'STRARCH' prefix.**



## 6.3 Digital Image Catalogue

Image ID		Date	Subject	Direction looking	Exp. variant	Flash lighting	Lens focal length
Archive no. (prefix: STRARCH)	Field no.						
0000	000	00-00-00	xxxxxxx	XXX	+/-	✓	000
0001	1	04-07-14	General view of east side of hangar	E			20
0002	2	04-07-14	General view looking southwest of northeast side of hangar	SW			20
0003	3	04-07-14	General view of northeast side of hangar	SW			20
0004	4	04-07-14	View of north side of hangar	S			20
0005	5	04-07-14	General view	SE			20
0006	6	04-07-14	Wide view of hangar from northwest				20
0007	7	04-07-14	Wide view of hangar with street context	SSW			10
0008	8	04-07-14	General view west-northwest looking at west side				13
0009	9	04-07-14	View from west	E			13
0010	10	04-07-14	Looking at west side straight on	E			
0011	11	04-07-14	Wide view with street context	E			10
0012	12	04-07-14	Wide view with street context	E			20
0013	13	04-07-14	View of southwest corner - General view of hangar with scale	NE	+		16
0014	14	04-07-14	View of southwest corner - General view of hangar with scale	NE			16
0015	15	04-07-14	General view from south side	N	+		12
0016	16	04-07-14	General view from south side	N			12
0017	17	04-07-14	General view from southeast	NW			13
0018	18	04-07-14	General view from southeast	NW			20
0019	19	04-07-14	Close view of southeast corner showing upright at base of truss arch				20
0020	20	04-07-14	Detail of concrete slab along south wall, from southeast corner along exterior wall				16
0021	21	04-07-14	Detail of concrete slab along south wall, from southeast corner along exterior wall			✓	16
0022	22	04-07-14	Detail of concrete slab from southeast corner, on interior of wall				16
0023	23	04-07-14	Detail of concrete slab from southeast corner, on interior of wall			✓	16
0024	24	04-07-14	From same position as above, looking at truss support (upright position)				10
0025	25	04-07-14	From same position as above, looking at truss support (upright position)			✓	10
0026	26	04-07-14	From same position as above, looking at truss support (upright position), with scale				10
0027	27	04-07-14	From same position as above, looking at truss support (upright position), with scale			✓	10
0028	28	04-07-14	Detail of roof trusses from inside shed, north wall				10



Image ID		Date	Subject	Direction looking	Exp. variant	Flash lighting	Lens focal length
Archive no. (prefix: STRARCH)	Field no.						
0029	29	04-07-14	Interior wall northwest portion from inside hangar				10
0030	30	04-07-14	South wall interior, and roof interior				10
0031	31	04-07-14	Directly up at centre of roof, from centre east of hangar				10
0032	32	04-07-14	North wall and roof span	NE			10
0033	33	04-07-14	Same position, looking southeast at roof trusses	SE			10
0034	34	04-07-14	View of while interior from west		+		10
0035	35	04-07-14	View of while interior from west				10
0036	36	04-07-14	Southwest corner viewing upright pylon and interior wall roof section		+		20
0037	37	04-07-14	Southwest corner viewing upright pylon and interior wall roof section, exposure corrected				
0038	38	04-07-14	Southwest corner viewing upright pylon and interior wall roof section, exposure corrected			✓	
0039	39	04-07-14	Middle upright truss on north wall, from south interior	N		✓	
0040	40	04-07-14	Middle upright truss on north wall, from south interior	N			
0041	41	04-07-14	Angled shot of central upright northern wall, from SE	NW			
0042	42	04-07-14	Angled shot of central upright northern wall, from SE			✓	
0043	43	04-07-14	Eastern end of interior showing truss arch				
0044	44	04-07-14	Eastern end of interior showing truss arch			✓	
0045	45	04-07-14	Northwest corner interior of upright, detail of base				35
0046	46	04-07-14	Northwest corner of truss, detail of base from above				40
0047	47	04-07-14	Northwest corner of truss, detail of base from above, oblique angle from southwest				40
0048	48	04-07-14	Northwest corner of upright, detail of base (1st of series)				40
0049	49	04-07-14	Northwest corner of upright, centre of upright (2nd of series)				40
0050	50	04-07-14	Northwest corner of upright, top of upright (3rd of series)				40
0051	51	04-07-14	Northwest corner of upright, top of upright (4th of series)				40
0052	52	04-07-14	Northwest corner of upright, top of upright (5th of series)				40
0053	53	04-07-14	Northwest corner of upright, top of upright (6th of series)				40
0054	54	04-07-14	Northwest corner of upright, top of upright (7th of series)				40
0055	55	04-07-14	Northwest corner of upright, looking up at arch (8th of series)				40
0056	56	04-07-14	Northwest corner of upright, looking up at centre of arch (9th of series)				40
0057	57	04-07-14	Northwest corner of upright, looking up at arch (10th of series)				40
0058	58	04-07-14	Detail of roof interior from north wall	S			35
0059	59	04-07-14	Detail of top of upright, end of arch and cable end-caps	W			70



Image ID		Date	Subject	Direction looking	Exp. variant	Flash lighting	Lens focal length
Archive no. (prefix: STRARCH)	Field no.						
0060	60	04-07-14	Detail of top of upright, end of arch and cable end-caps with scale	W			70
0061	61	04-07-14	Detail of top of upright, end of arch and cable end-caps with scale	W		✓	70
0062	62	04-07-14	Detail of upright and arch end	E		✓	
0063	63	04-07-14	Detail of upright and arch end	E			
0064	64	04-07-14	Detail of slab and upright footing				28
0065	65	04-07-14	Detail of slab and upright footing			✓	28
0066	66	04-07-14	Interior of roof and arches looking upwards	S			105
0067	67	04-07-14	Interior of roof and arches looking upwards	S		✓	105
0068	68	04-07-14	Detail of panelling on north wall at northwest end				35
0069	69	04-07-14	Detail of panelling on north wall at northwest end with roof				35
0070	70	04-07-14	Close up detail of exterior panelling on north wall at northwest end showing corner of wall and roof				
0071	71	04-07-14	View of north wall and roof showing pattern of bolts securing cladding. Note bolts on truss (sparse) and random piece of wire. Vertical format	N			
0072	72	04-07-14	View of north wall and roof showing pattern of bolts securing cladding. Note bolts on truss (sparse) and random piece of wire. Horizontal format				
0073	73	04-07-14	View of exterior concrete slab showing foundation block and adjacent paving				
0074	74	04-07-14	Detail of expansion joint between concrete footing and adjacent paving. Note paving is much thinner than block				
0075	75	04-07-14	Detail of cable routed through concrete foundation at northeast corner. Earth (?) or power cable (?) from south-southeast	NNW			
0076	76	04-07-14	Detail of cable routed through concrete foundation at northeast corner. Earth (?) or power cable (?) from south-southeast	NNW		✓	
0077	77	04-07-14	Detail of cable routed through concrete foundation at northeast corner. Earth (?) or power cable (?) from southwest	SE			
0078	78	04-07-14	Detail of cable routed through concrete foundation at northeast corner. Earth (?) or power cable (?) from southwest	SE		✓	
0079	79	04-07-14	View of plaque and surrounding wall of northeast corner of building			✓	
0080	80	04-07-14	View of plaque and surrounding wall of northeast corner of building				
0081	81	04-07-14	Detail of plaque on north wall near northeast corner				
0082	82	04-07-14	Detail of plaque on north wall near northeast corner			✓	
0083	83	04-07-14	Detail of plaque on north wall near northeast corner with scale				
0084	84	04-07-14	Detail of plaque on north wall near northeast corner with scale			✓	
0085	85	04-07-14	Detail of upper end fastening on diagonal strut on north wall				





Image ID		Date	Subject	Direction looking	Exp. variant	Flash lighting	Lens focal length
Archive no. (prefix: STRARCH)	Field no.						
0086	86	04-07-14	Detail of upper end fastening on diagonal strut on north wall, viewed more straight-on				
0087	87	04-07-14	Detail of lower end weld joint on diagonal strut on north wall, northeast corner				
0088	88	04-07-14	Detail of lower end weld joint on diagonal strut on north wall, northeast corner			✓	
0089	89	04-07-14	Wider context shot of diagonal strut on north wall (west end of strut)				
0090	90	04-07-14	Raised concrete block on footing of central upright	SE			
0091	91	04-07-14	Raised concrete block on footing of central upright	SE		✓	
0092	92	04-07-14	Detail of raised block on footing at central south wall			✓	
0093	93	04-07-14	Detail of raised block on footing at central south wall				



## 6.4 Photographic Thumbnail Compendium



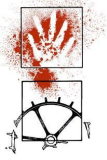
		
STRARCH 001	STRARCH 002	STRARCH 003
		
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STRARCH 0013	STRARCH 0014	STRARCH 0015

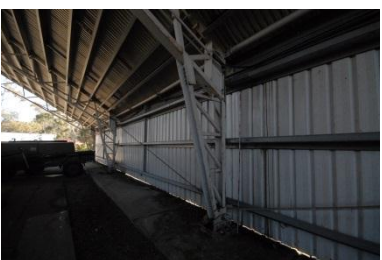




		
STRARCH 0016	STRARCH 0017	STRARCH 0018
		
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STRARCH 0028	STRARCH 0029	STRARCH 0030






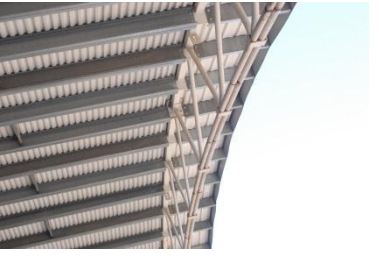

















		
STRARCH 0031	STRARCH 0032	STRARCH 0033
		
STRARCH 0034	STRARCH 0035	STRARCH 0036
		
STRARCH 0037	STRARCH 0038	STRARCH 0039
		
STRARCH 0040	STRARCH 0041	STRARCH 0042
		
STRARCH 0043	STRARCH 0044	STRARCH 0045





		
STRARCH 0046	STRARCH 0047	STRARCH 0048
		
STRARCH 0049	STRARCH 0050	STRARCH 0051
		
STRARCH 0052	STRARCH 0053	STRARCH 0054
		
STRARCH 0055	STRARCH 0056	STRARCH 0057
		
STRARCH 0058	STRARCH 0059	STRARCH 0060



		
STRARCH 0061	STRARCH 0062	STRARCH 0063
		
STRARCH 0064	STRARCH 0065	STRARCH 0066
		
STRARCH 0067	STRARCH 0068	STRARCH 0069
		
STRARCH 0070	STRARCH 0071	STRARCH 0072
		
STRARCH 0073	STRARCH 0074	STRARCH 0075





		
STRARCH 0076	STRARCH 0077	STRARCH 0078
		
STRARCH 0079	STRARCH 0080	STRARCH 0081
		
STRARCH 0082	STRARCH 0083	STRARCH 0084
		
STRARCH 0085	STRARCH 0086	STRARCH 0087
		
STRARCH 0088	STRARCH 0089	STRARCH 0090





		
STRARCH 0091	STRARCH 0092	STRARCH 0093



## 6.5 Sample Set of Photographic Prints



**Figure 6.4 General view of eastern hanger entrance, looking W, (Image no. STRARCH 0001)**



**Figure 6.5 General view of hanger side, looking S, Image no. STRARCH 0004)**





**Figure 6.6 The western hanger entrance, looking E, (image no. STRARCH 0010)**



**Figure 6.7 The western hanger entrance, looking NE, (image no. STRARCH 0013)**





**Figure 6.8 General side view of end trussed column assembly at SE corner of hangar, looking W, (image no. STRARCH 00019)**

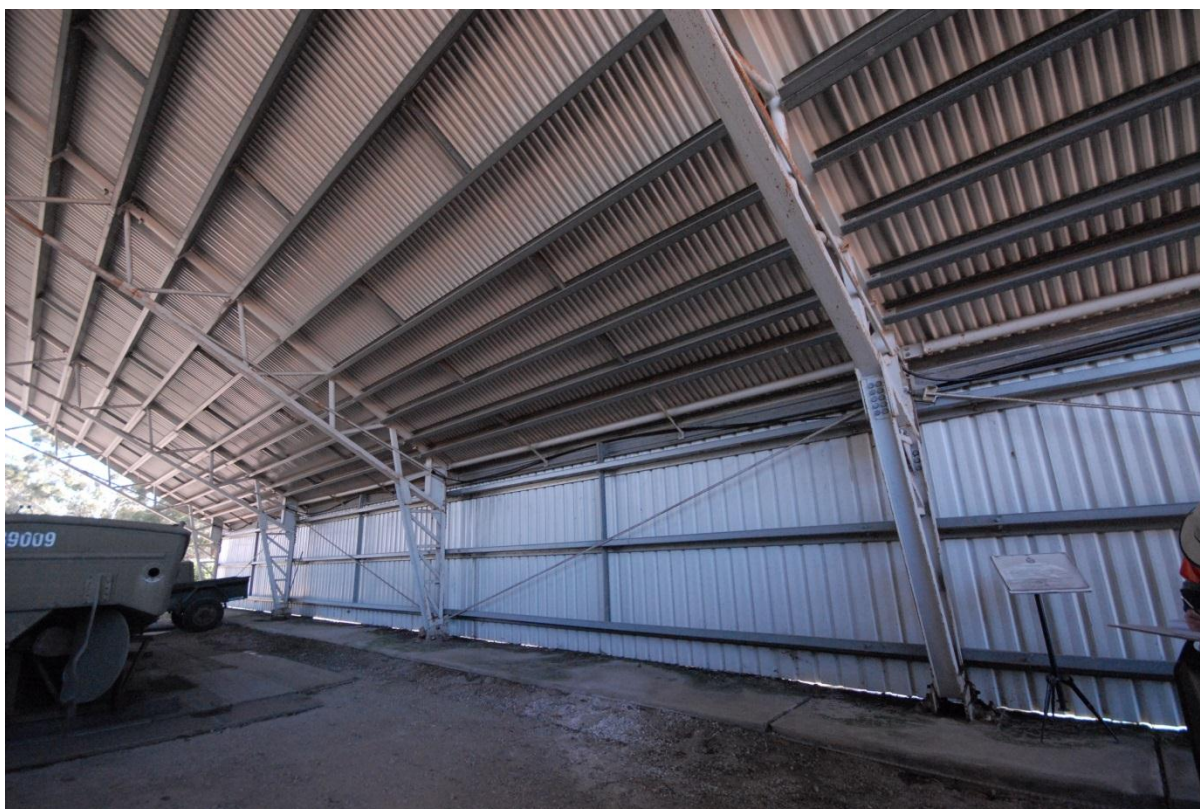


**Figure 6.9 Detail view of SE corner of hangar showing lower column assembly, baseplate and concrete footing, (image no. STRARCH 0023)**



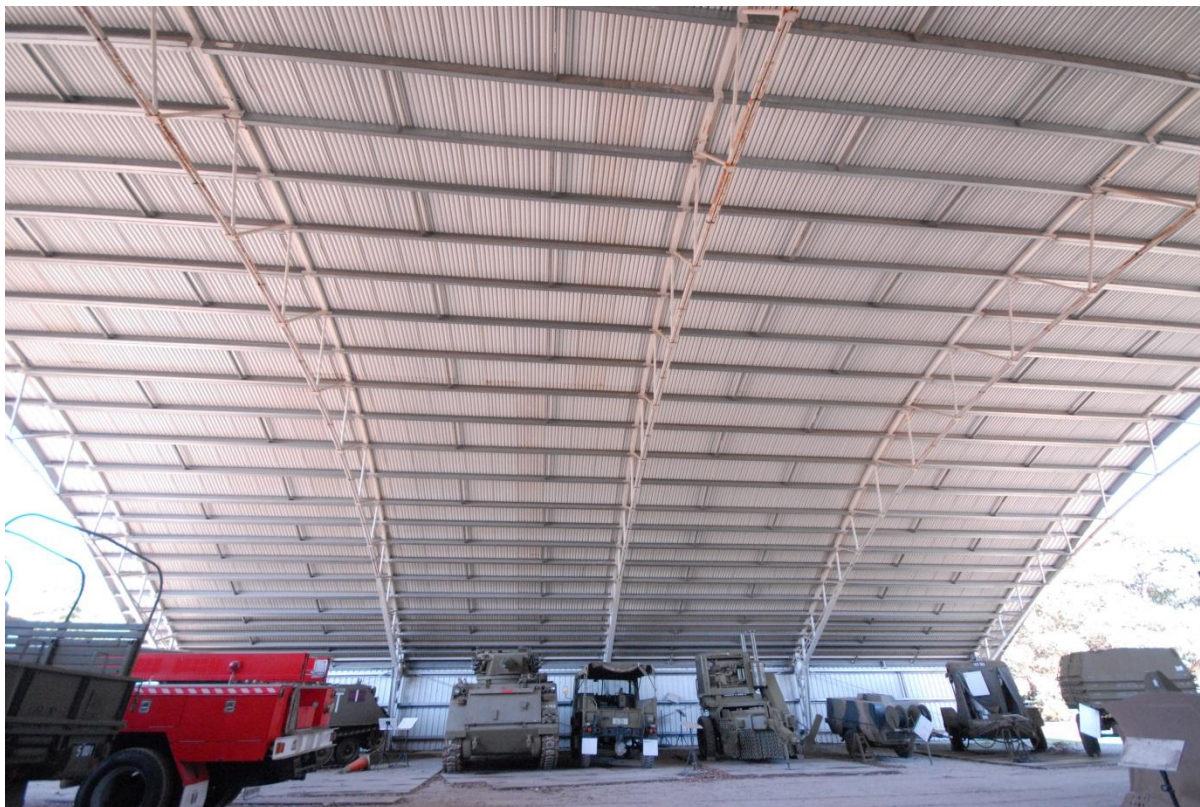


**Figure 6.10 General interior view, looking SW, showing arch trusses, and columns, (image no. STRARCH 0028)**

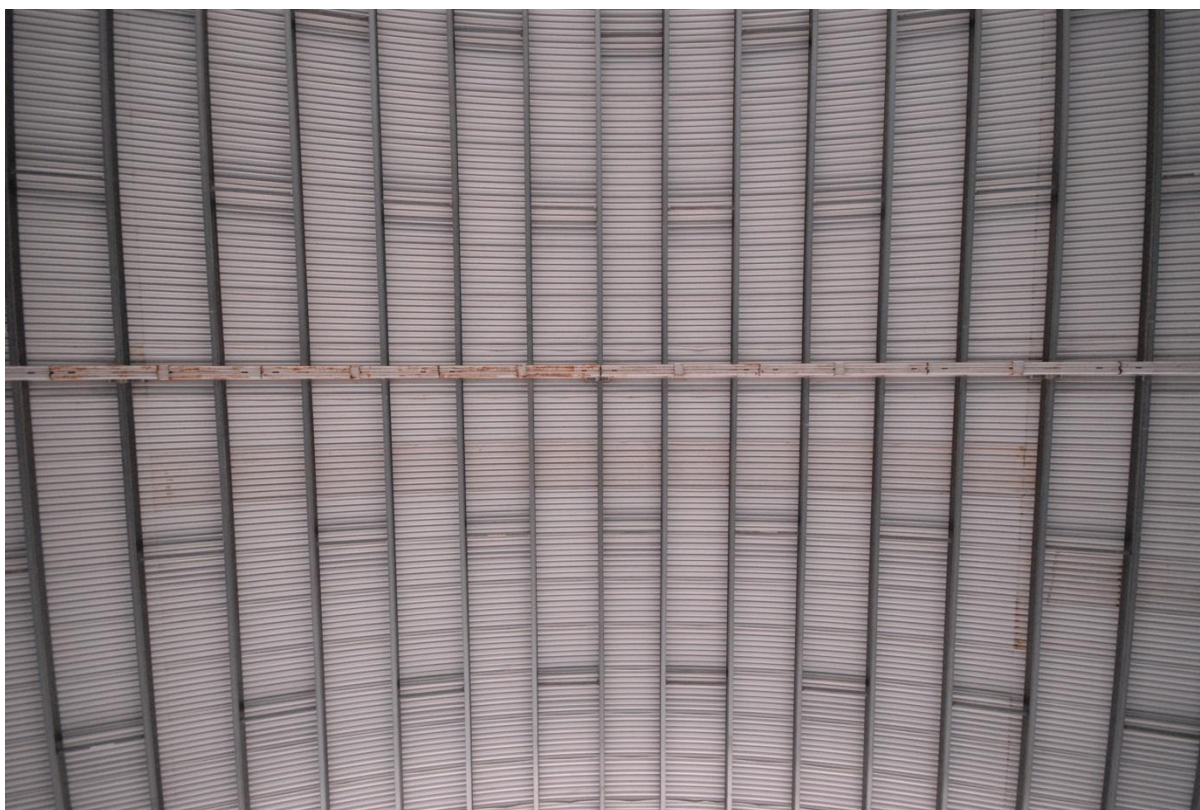


**Figure 6.10 General interior view of northern wall, looking NW, showing column assemblies and cross bracing, (image no. STRARCH 0029)**





**Figure 6.11 General interior view of roof, looking S, (image no. STRARCH 0030)**



**Figure 6.12 General view of roof, looking directly up, (image no. STRARCH 0031)**





**Figure 6.13 End-on view of column assembly, showing also cross bracing, (image no. STRARCH 0040)**



**Figure 6.14 Detail of baseplate (image no. STRARCH 0046)**





**Figure 6.15 Side view of baseplate and horizontal pinning of column, (image no. STRARCH 0047)**



**Figure 6.16 Detail of upper column, showing tensioning tendon and cross bracing strut, (image no. STRARCH 0060)**



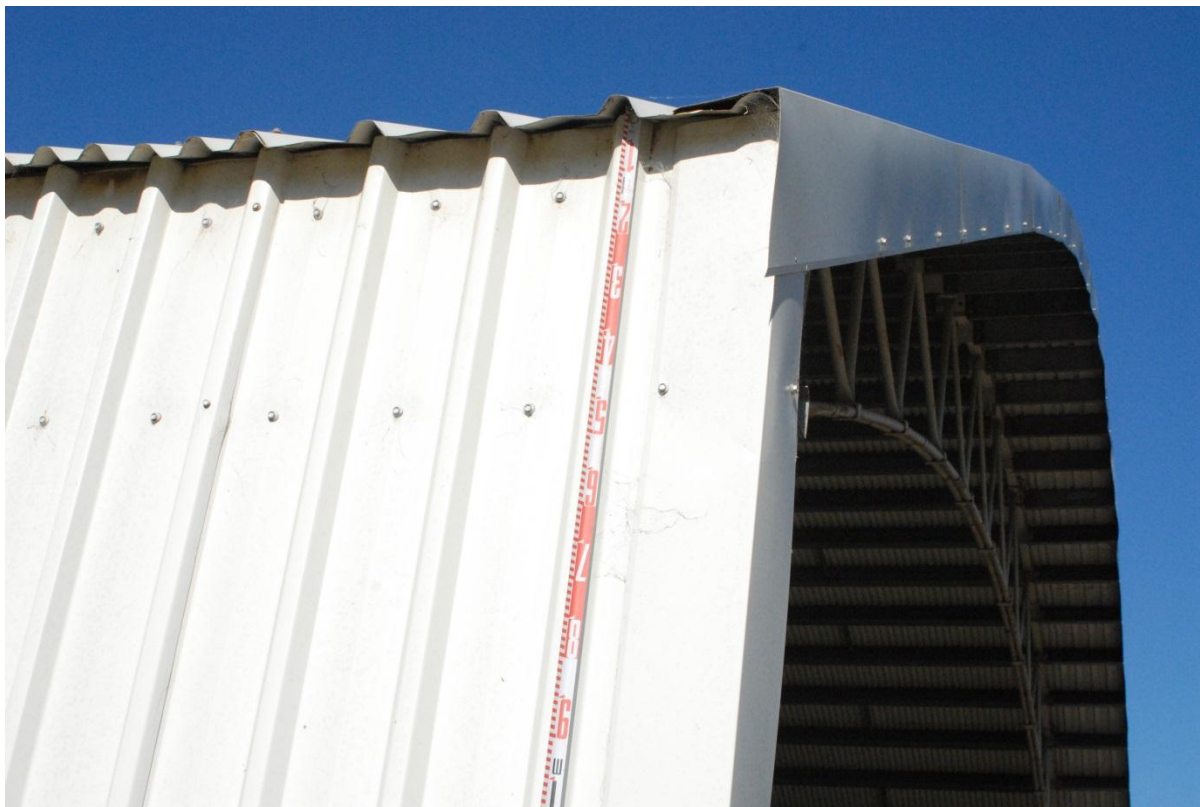


**Figure 6.17 General interior view of column footings along northern wall, looking E, (image no. STRARCH 0065)**



**Figure 6.18 Detail of roof truss and purlins, (image no. STRARCH 0066)**





**Figure 6.19 Detail of exterior cladding and edge finish at NW corner of hanger, looking S, (image no. STRARCH 0070)**



**Figure 6.20 Detail of exterior wall and roof cladding, looking parallel to, and in the area of a truss, looking S, (image no. STRARCH 0072)**



**Figure 6.21 Exterior detail of a concrete footing with later paving 'infill' on either side, (image no. STRARCH 0073)**



**Figure 6.22 Unidentified in-situ feature at NE corner of hanger (image no. STRARCH 0076)**





**Figure 6.23 General context view of commemorative plaque, looking N, (image no. STRARCH 0079)**



**Figure 6.24 Commemorative plaque (image no. STRARCH 0083)**





**Figure 6.25 Detail of cross-bracing strut attachment to upper column assembly, (image no. STRARCH 0085)**



**Figure 6.26 Detail of cross-bracing strut attachment to lower column assembly, (image no. STRARCH 0088)**





**Figure 6.27 General context view of small interior concrete platform near southern hanger wall, looking SE, (image no. STRARCH 0091)**



**Figure 6.28 Detail of small interior concrete platform near southern hanger wall, looking SE, (image no. STRARCH 0093)**