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ENGINEERING GEOLOGY & GEOTECHNICAL MODELS

ENGINEERING GEOLOGY

Rock Mass Classifications

Rock Mass Classifications

- Terzaghi
- Q
- RMR
- RMR Variations
- Sydney Sandstone Classification
- USE ALL WITH CAUTION

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Sydney Opera House Car Park

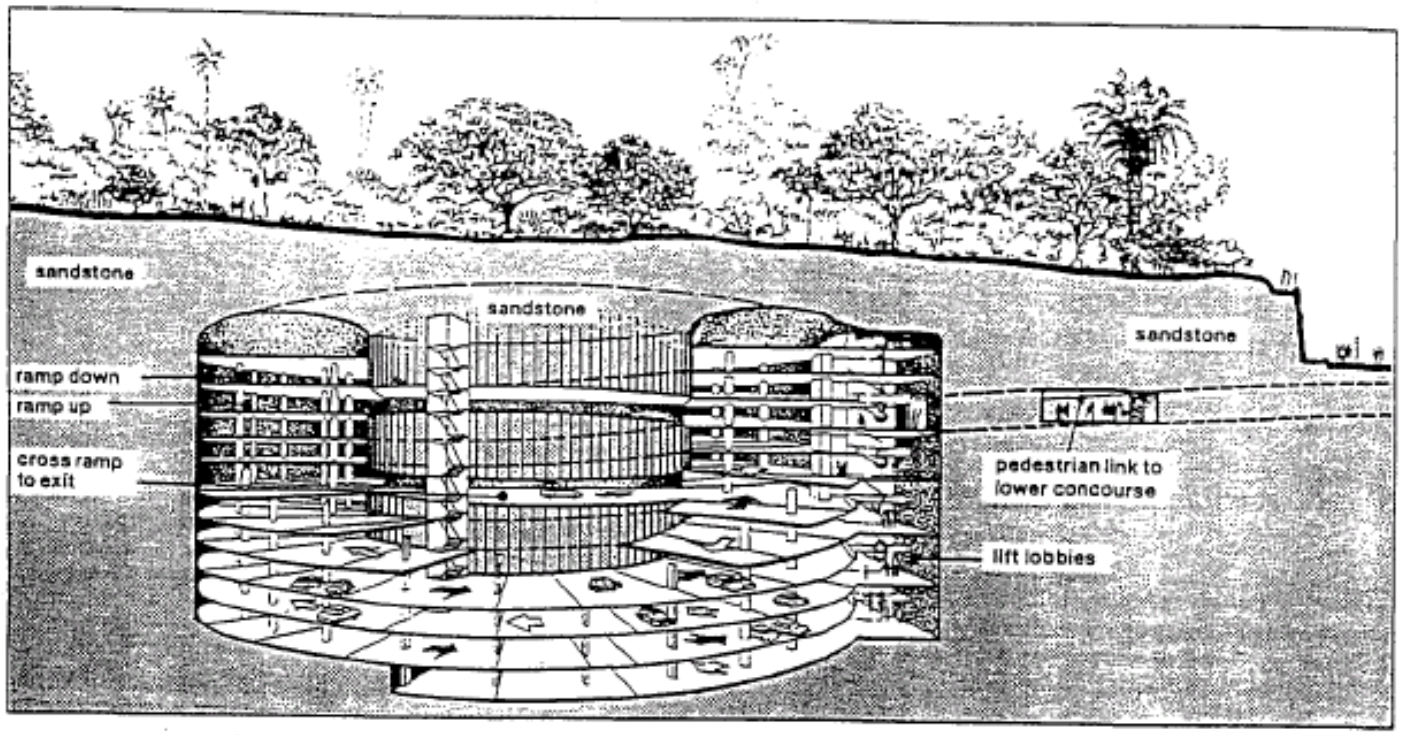

FIGURE 2 : THE SYDNEY OPERA HOUSE CAR PARK

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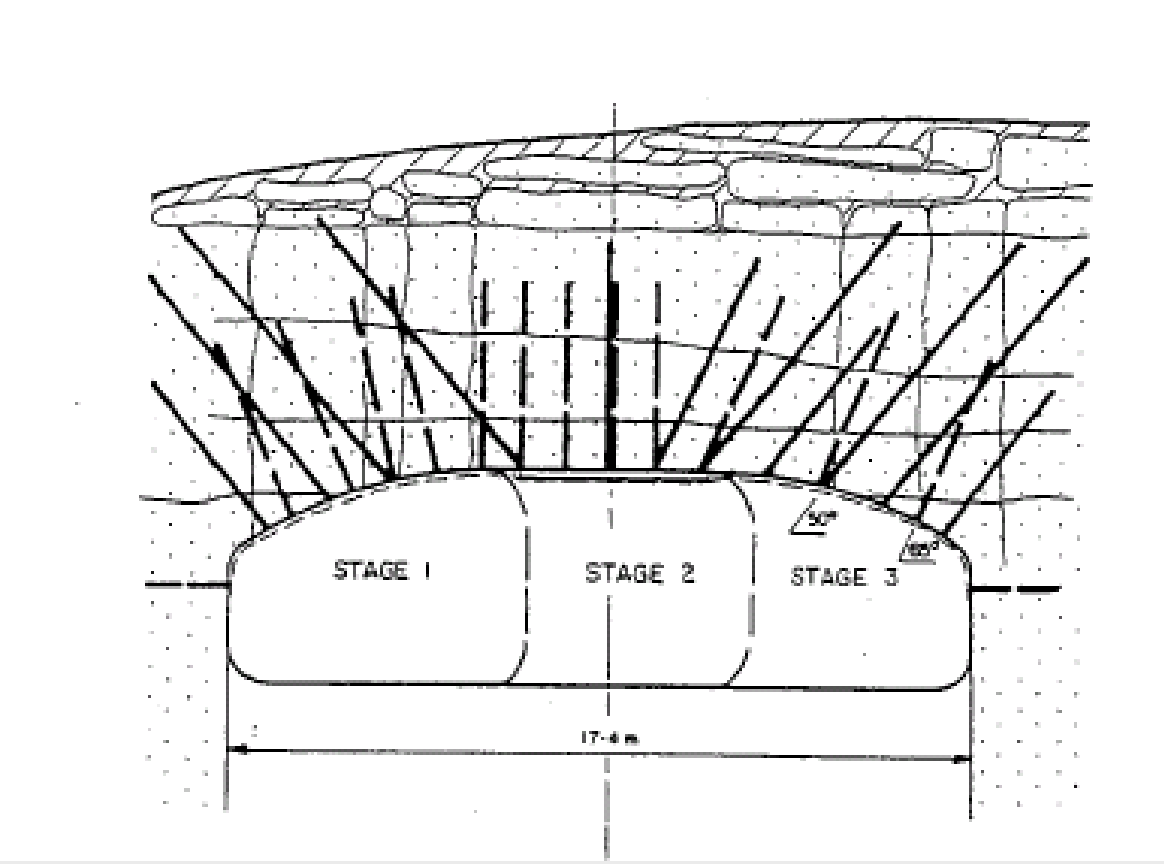
Sydney Opera House Car Park



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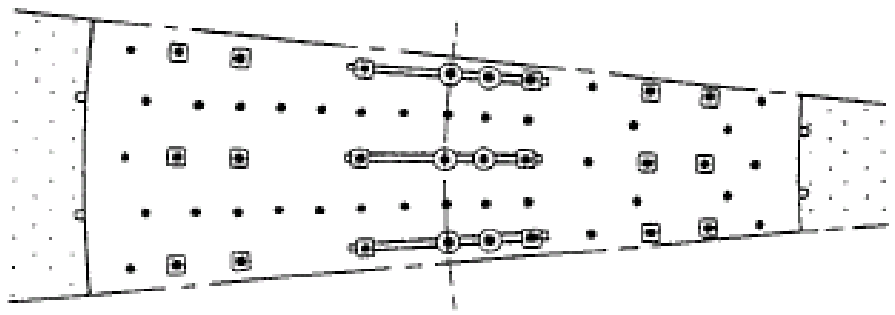
Sydney Opera House Car Park



LEGEND

- MACALLOY BARS 7·5m
- MACALLOY BARS 5·5m
- 4·4m Y24 DOWEL
- 2·0m Y24 DOWEL IN SIDEWALL
- 152 x 76 GALVANISED CHANNEL
- F41 MESH & 50mm SHOTCRETE

FIGURE 5 : ROOF SUPPORT FOR OPERA HOUSE CAVERN

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Sydney Opera House Car Park

The design and construction of this cavern is described in detail in (Refs 12 and 13). The crown of the cavern comprised 6m to 8m of Class I and Class II sandstone, (using the Sydney System). This rock classified as:

Q- system	20 to 60;	design value = 50	(ESR = 0.8)
RMR-system	60 to 55;	design value = 65	

TABLE 6
CLASSIFICATION BASED SUPPORT DESIGN
FOR THE 18m SPAN OPERA HOUSE CAVERN

SYSTEM	RATING	PREDICTED PRIMARY SUPPORT
RMR*	65	3m bolts at 2.5m centres with occasional mesh and 50mm shotcrete where required.
Q	50	6m bolts at about 3m centres, no shotcrete.

*Recommendations only really apply for 10m span

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Sydney Opera House Car Park

The design comprised 3.6m (230 kN) and 7.5m (450 kN) dowels and stressed anchors at an average spacing of 1.3m, plus 100mm x 100mm x 4mm weldmesh and 150mm shotcrete.

Comparing this support with the predictions in Table 6 suggests that either the designers of the cavern were very conservative (which the author does not believe to be true) or predictions based only on the classification systems were dangerous.

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NGI Q System

CLASSIFICATION OF TYPICAL RANGE OF
SYDNEY SANDSTONE USING NGI Q-SYSTEM

ITEM	PARAMETER	SANDSTONE CLASS ACCORDING TO SYDNEY SYSTEM				
		I	II	III	IV	V
1	RQD	90	80	65	25	5
2	J_n*	2	4	4	6	12
3	J_r	3	3	1.5	1	1
4	J_a	0.75	1.0	20.	3.0	6.0
5	J_w	0.8	0.8	0.8	0.66	0.66
6	SRF	2.5	2.5	1.0	5.0	7.5
	Q-value	57.6	19.2	9.75	0.18	0.006
	Description	Very Good	Good	Fair	Very Poor	Exceptionally Poor

*Practitioners in Sydney find this parameter difficult to assess.

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Hawkesbury Sandstone Bedding

Facies Bedding

This defines the major near horizontal bedding discontinuities which have a spacing of between 1m and 2.5m. These may be continuous for hundreds of metres and may be marked by continuous partings, clay seams or petrographic changes. Facies bedding marks major depositional horizons. Local increase in the dip of the Facies Bedding occurs where sand has been deposited in channel structures. Minor shale bands or shale breccias frequently occur in the base of these channel structures.

Clay seams typically between 5 and 25mm thick are very common within the sequence. The origin of these seams is not clearly understood but they provide the major weakness within the Hawkesbury Sandstone sequence.

Cross Bedding

Cross bedding (also termed current bedding) is almost an ubiquitous feature and forms the close layering (2mm to 20mm) observed within each major unit or facies. Cross bedding planes are often marked by the deposition of flakes of mica, graphite, and carbonaceous matter which settle as the current velocity decreased between influxes of sand. The cross bedding usually does not represent planes of weakness in fresh or slightly weathered sandstone. However, in moderate to highly weathered sandstone the cross beds can form surfaces of incipient parting or relatively low shear strength ($\phi' = 35°$).

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