

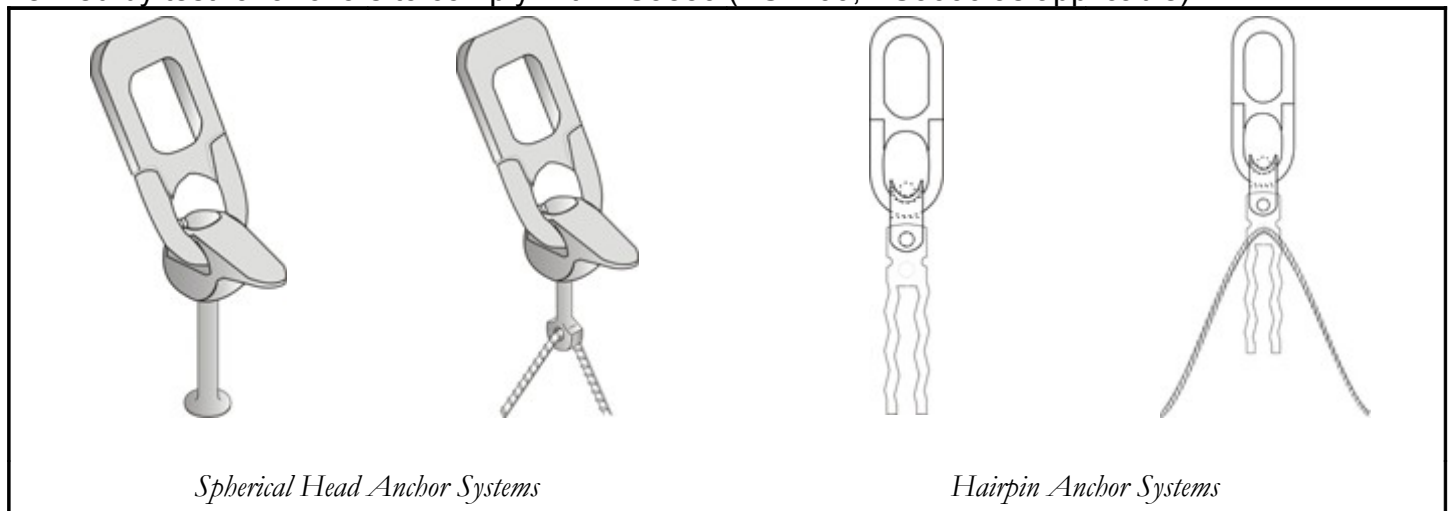
An anchor can fail by:

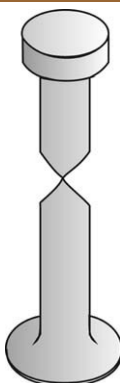

- **Anchor Failure** failure of the anchor itself or its reinforcing elements (e.g. hanger bars)
- **Concrete Failure** where the concrete surrounding and supporting the anchor fails

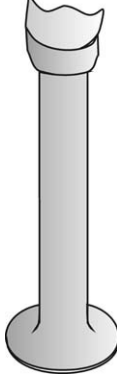
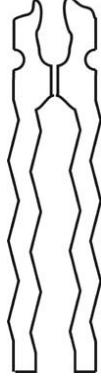
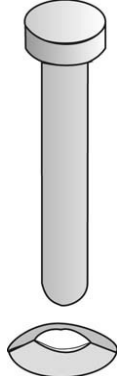

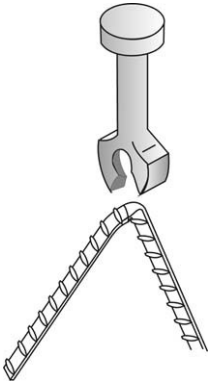
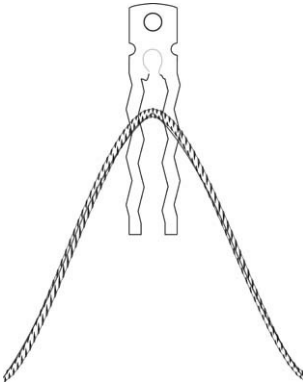
Safe design requires that all strength limit states for each type of failure be considered

Anchor Failure

The anchors may fail in a number of ways and the limit states must be assessed by design and / or verified by test for anchors to comply with AS3850 (AS4100, AS3600 as applicable).

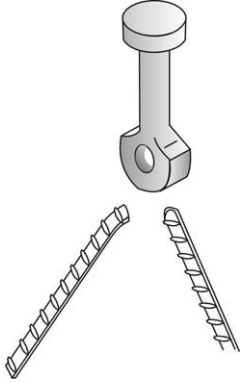
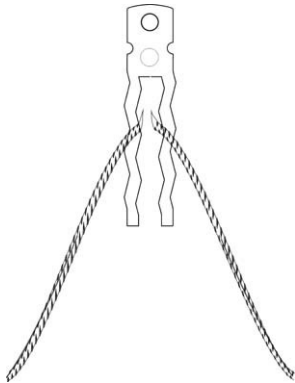
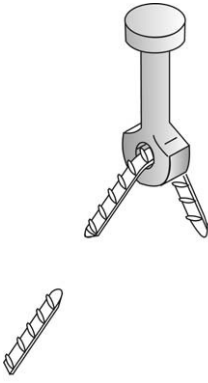
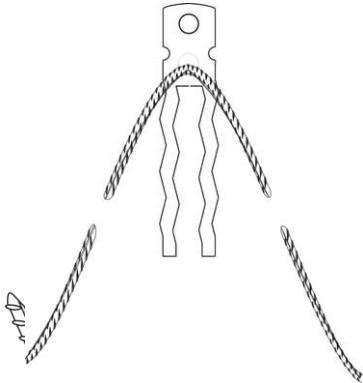


STRENGTH LIMIT STATE	FAILURE Spherical Head anchors	FAILURE Hairpin anchors	Design Calculation	Test method
Anchor body failure			AS4100 and AS3850 $WLL = \phi N_{tj} / 2.5$	AS3850 Appendix 2. Clutch+Anchor Tension Test

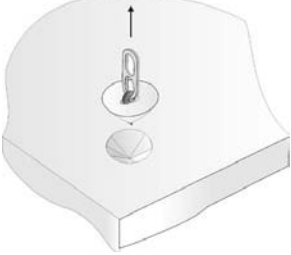
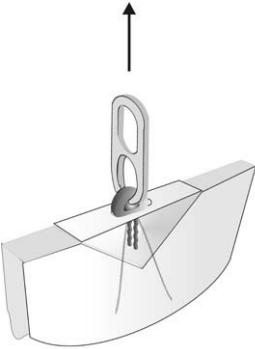
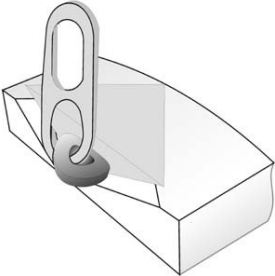
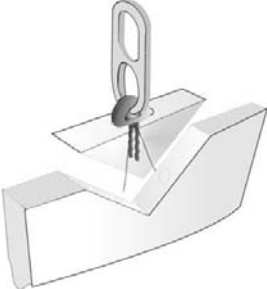
STRENGTH LIMIT STATE	FAILURE Spherical Head anchors	FAILURE Hairpin anchors	Design Calculation	Test method
Lifting attachment point failure			No reliable method	AS3850 Appendix 2. Clutch+Anchor Tension Test
Embedded part failure			AS4100 and AS3850 The Limit state is the ultimate bar strength N_{tf} . $WLL = \Phi N_{tf} / 2.5$	AS3850 Appendix 2. Clutch+Anchor Tension Test
Hanger attachment point failure "pull-through" of the bar			No reliable method to calculate the bending-shear failure strength of the anchor.	AS3850 Appendix 2. Clutch+Anchor +Rebar Tension Test

Anchor Failure: Hanger Bar failure

Hanger bars are required when the lifting load exceeds the WLL of the Concrete Strength.

STRENGTH LIMIT STATE	FAILURE Spherical Head "Eye" anchors with hanger	FAILURE Reinforced Hairpin anchors with hanger	Design Calculation	Test method
Hanger bar shear failure			<p>No reliable method AS3850 to calculate the bending-shear failure strength of the reinforcing bar.</p>	<p>AS3850 Appendix 2. Clutch+Anchor +Rebar Tension Test</p>
Hanger bar tension failure			<p>AS3600 and AS3850</p> <p>The Limit state is the ultimate bar strength N_{bf}.</p> $WLL = \Phi \cdot R_u / 2.5$ <p>where $R_u = N_{bf}$ (ultimate bar strength) $\Phi = 0.8$</p> $\Phi N_{bf} = A_b \times 1.05 \times f_{sy}$ <p>Total for 2 legs: $WLL_{hanger} = 2 \times \Phi N_{bf}$</p>	<p>Not required: use characteristic strength</p>

CONCRETE FAILURE

STRENGTH LIMIT STATE	All Anchors placed well away from edges - "cone" failure	Anchors placed in edges - "pie" shaped partial cone	Design Calculation	Test method
Concrete Cone failure			Empirical from tests	AS3850 Appendix 2.
				Embedded anchor Tension test
				AS3850 Appendix 2.
				Embedded anchor Tension test
Hanger bar pullout			<p>AS3850 and AS3600. Length to develop <u>bar in the concrete below the crack from the foot of the anchor.</u></p>	Not Required
			$\text{Leg } L_d = L_{syt}$ <p>where</p> $L_{syt} = k_1 k_2 f_{sy} A_b / (2*a + d_b) \sqrt{f'_c} \text{ and } L_{syt} \geq 25k_1 d_b$	

HANGER REINFORCING BAR DETAILING

Hangers must extend downwards below the crack to shed the load deep within the panel.

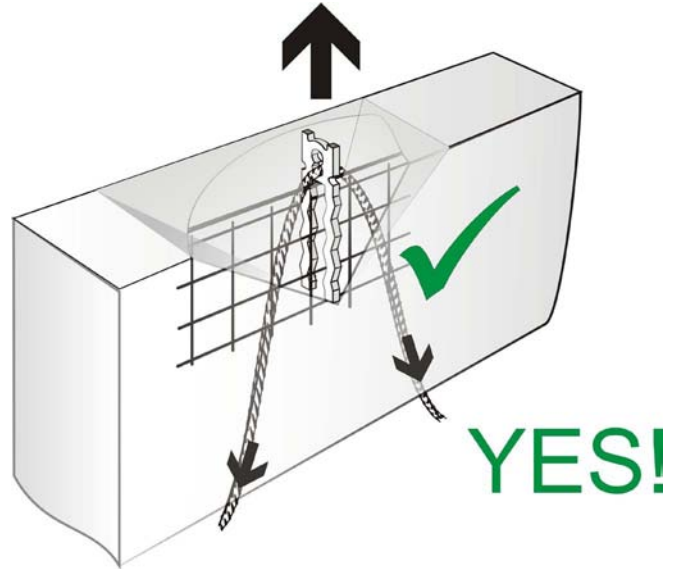
The required "leg length" is calculated according to AS3600 to develop the strength of the bar.

Note:

AS3850 requires that the strength of the anchor exceeds 2.5 X WLL of the anchor.

The bar forms part of the anchor itself and therefore its strength must meet this requirement for all its strength limit states.

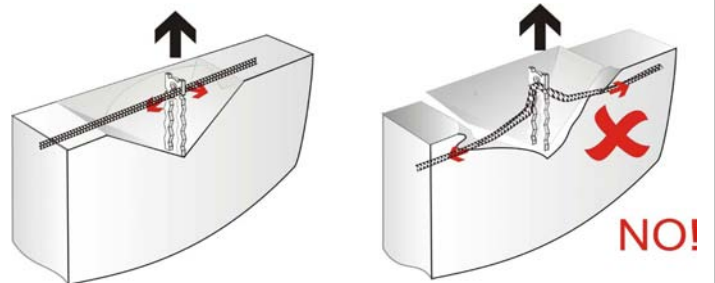
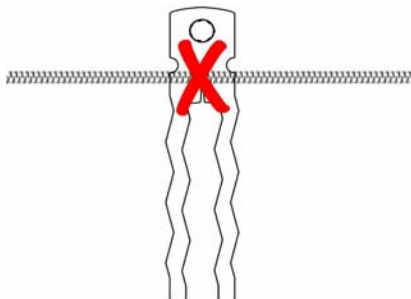
NB: the limit state strength of the bar may not be limited by its tensile strength only!
The bar strength is normally limited by shear at its attachment point, which must be checked!



DO NOT USE HORIZONTAL e.g. Trimmer bars!

Horizontal bars do not increase the pullout strength of the anchor!

NO!



After the concrete cracks, horizontal reinforcing progressively strips out of the panel edge at little or no increased load!

Typical hanger bar dimensions and how they are calculated.

The development depth required for each hanger leg to share the load is calculated using AS3600 clause 13.1.2.1 to develop the full strength of the bar.

- An N16 bar is required for anchor working loads up to 7.1Tonnes
- An N20 bar is required for anchor working loads up to 9Tonnes

Note: An N20 bar is used for WLL of 8Tonnes with reduced development length (CI 13.1.2.2)

The following diagram shows a hanger bar detail designed for lifting 150mm thick panels when demoulding at 10MPa.

This is *the recommended standard detail* for all 7, 8 and 9 tonne hanger bars, regardless of anchor type or make (applicable for both hairpin and spherical head “eye” anchors).

