Slab Post-Tensioning

Coles National Distribution Centre, Melbourne, Australia

Today's building owners and designers need to provide a high level of structural flexibility to meet changing user requirements.

Post-tensioning offers larger spans with reduced structural depth, resulting in larger column-free areas. Internal tenancy layouts are thus not restricted by tight column grids. Positive deflection and crack control and, if necessary, crack-free watertight slabs offer the designer the opportunity to break free of the limitations of the passive methods of reinforced concrete or structural steel.

VSL post-tensioning offers economies over other systems, especially when construction cycles are considered. There is less material handling on site, reducing site labour force which reduces site activity congestion.

Most importantly, there is the quality and service of VSL specialised high-performance site teams and unequalled back-up.

The VSL post-tensioning slab system has been used in many thousands of buildings and other structures throughout Australia. The system uses up to five strands in flat-shaped ducting and anchorages.

Strands are stressed individually and then gripped by wedge action. The entire duct is subsequently fully filled with cement grout injected under pressure so that the strands are fully bonded to the surrounding concrete.

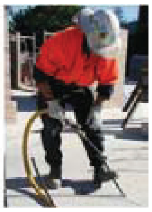
Austrak Industrial Park, Melbourne, Australia

CONSTRUCTION SEQUENCE

Installation

Concreting

Stressing



Grouting

STRAND PROPERTIES - TO AS 4672

Nominal Diameter	Nominal Steel Area	Nominal Mass	Minimum Breaking Load	Minimum Proof Load (0.2% Offset)	Min Elong Proof Load in 600mm	Relaxation After 1,000hrs at 0.7 Breaking Load	Modulus of Elasticity
(mm)	(mm^2)	(kg/m)	(kN)	(kN)	(%)	(%)	(MPa)
12.7 Super	100.1	0.786	184	156.4	3.5	2.5	
15.2 Super	143.3	1.125	250	212.5	3.5	2.5	$185\text{-}205 \times 10^3$
15.2 EHT	143.3	1.125	261	221.9	3.5	2.5	

TENDON PROPERTIES

Strand Type 12.7mm Super		
Tendon Unit	No. of Strands	Minimum Breaking Load kN
S5-1	1	184
S5-2	2	368
S5-3	3	552
S5-4	4	736
S5-5	5	920

Strand Type 15.2mm Super		
Tendon Unit	No. of Strands	Minimum Breaking Load kN
S6-1	1	250
S6-2	2	500
S6-3	3	750
S6-4	4	1000
S6-5	5	1250

For special applications other strand and tendon capacities are available. Please check with your local VSL office for details

SELECTED DESIGN CONSIDERATIONS

Tendon Supports

Recommended spacings:

- Conventional steel duct : 0.8 to 1.2m
- PT- PLUS® duct : 0.8 to 1.0m
- Minimum radius of curvature for flat ducts : About X axis 2.5m
  About Y axis 7.0m
- Minimum tangent length behind the anchorage 0.5m

Tendon Force Losses

The friction losses in the anchorage due to curvature of the strand and friction of the strand in the wedges usually amount to:

- Edge stressing 3% average
- Internal pocket stressing 5% average

Frictional losses along the tendon can vary fairly widely and depend upon several factors, including the nature and surface condition of the prestressing steel; the type, diameter and surface conditions of the duct and the installation method.

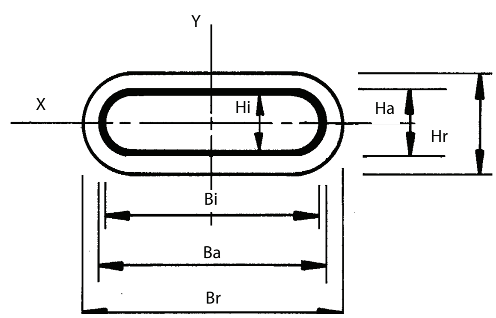
The following values may be assumed for design:

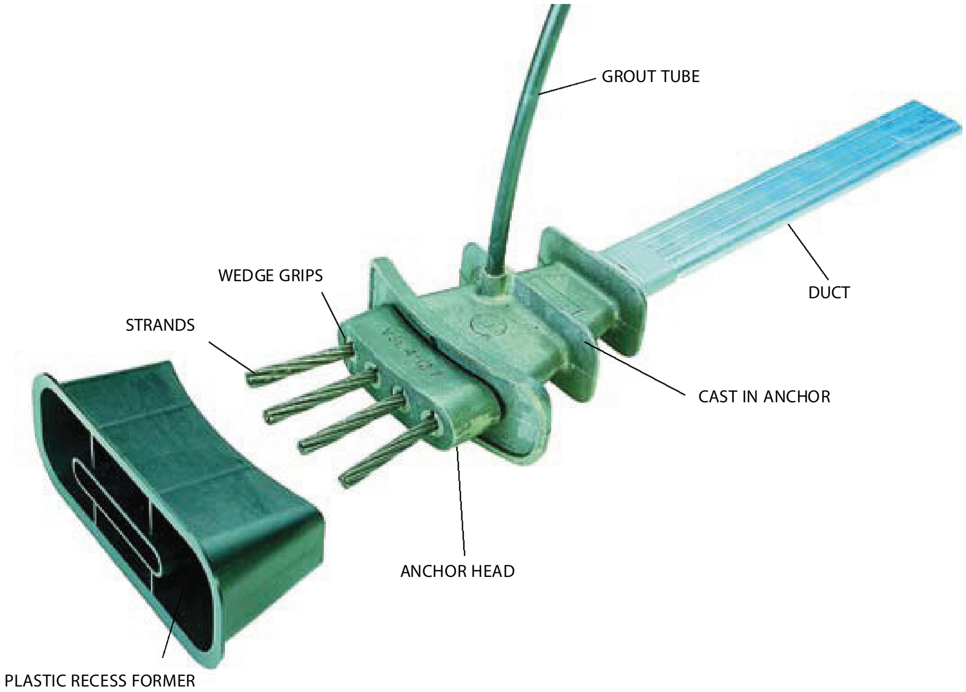
- Tendon in conventional steel ducts : $\mu = 0.20$
- Tendon in PT-PLUS® duct : $\mu = 0.14$

A loss due to wedge draw-in of nominally 6mm occurs at lock-off.

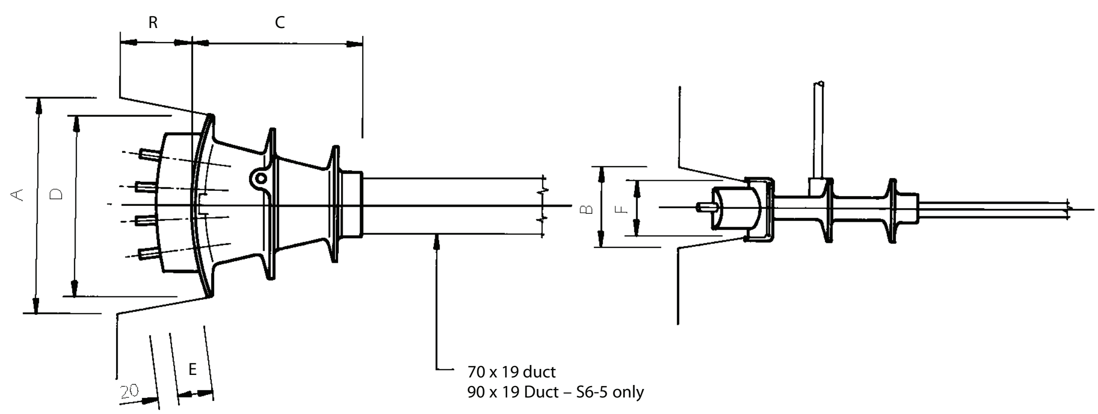
DIMENSION OF DUCTS

DUCT TYPE	Bi	Ba	Br	Hi	Ha	Hr
	Dimensions (mm)					
Galv. Steel						
S5-1/S6-1	20	21		20	21	
S5-2/S6-2	50	51		19	20	
S5-5	70	71		19	20	
S6-5	90	91		19	20	
PT-PLUS™ S5-5/S6-4 S6-5	72	76	86	21	25	35
	NOT AVAILABLE					



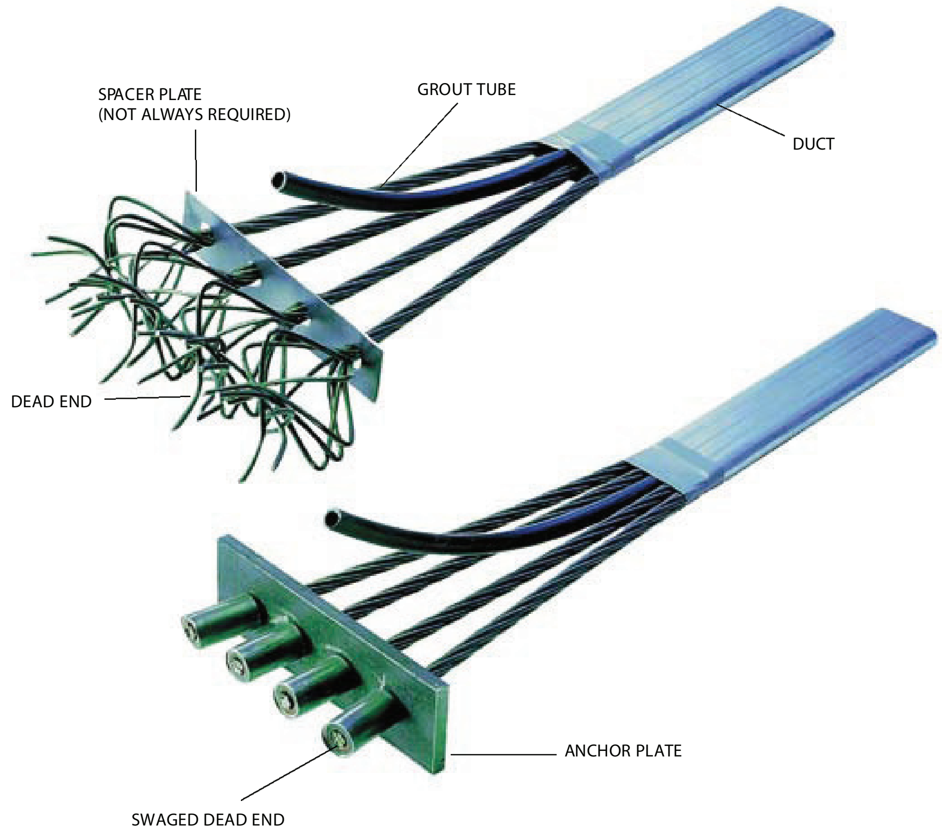


VSL STRESSING ANCHORAGE TYPE S5 - S6 LIVE END

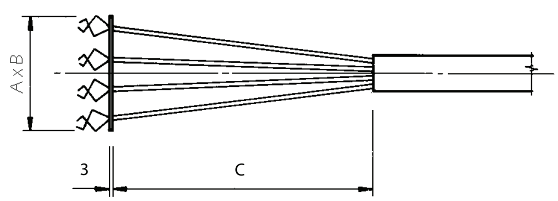


STRAND TYPE	TENDON UNIT	A	B	C	D Dimensions (mm)	E	F	R
12.7mm	S5-3	265	100	215	225	45	70	90
	S5-4	265	100	215	225	45	70	90
	S5-5	265	100	215	225	45	70	90
15.2mm	S6-2	265	100	215	225	45	70	90
	S6-3	265	100	215	225	45	70	90
	S6-4	265	100	215	225	45	70	90
	S6-5	265	100	238	265	45	70	90

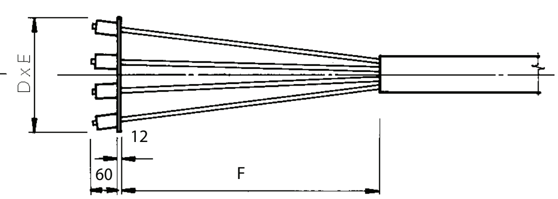
Note: 1. S6-2 supplied with barrels and wedges in lieu of cast anchor head



VSL DEAD END ANCHORAGES TYPE H - TYPE P



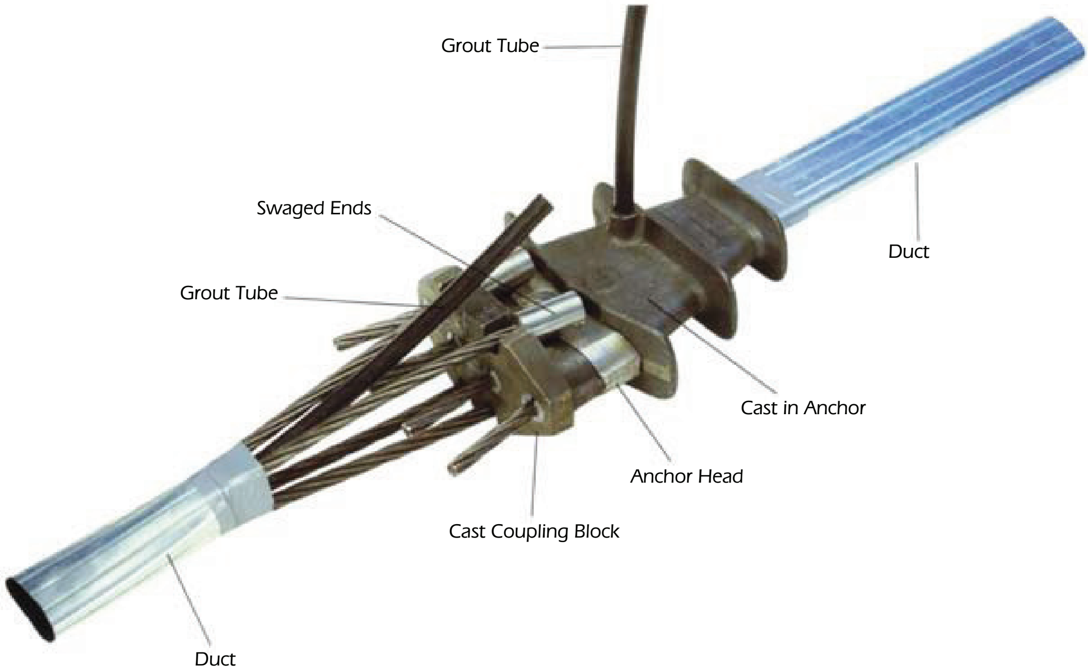
Dead End Anchorage Type H



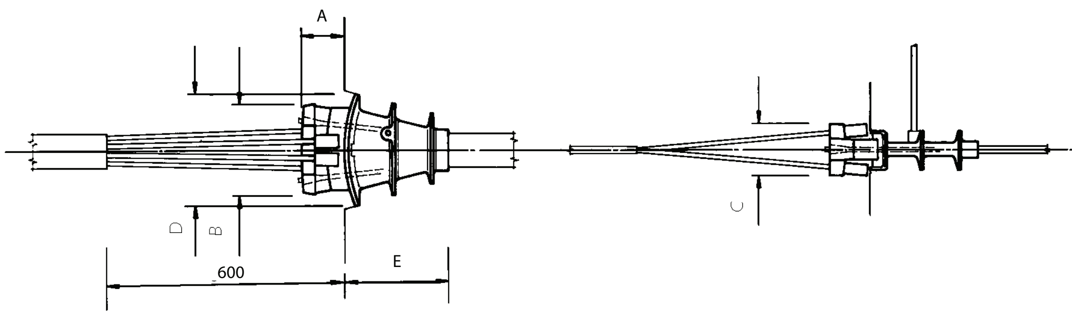
Dead End Anchorage Type P

Strand Type		Tendon Unit Type H	A	B	C
			Dimensions (mm)		
Strand Type	12.7mm	5-3	230	50	800
		5-4	270	50	800
		5-5	350	50	800
	15.2mm	6-2	135	50	800
		6-3	230	50	800
		6-4	270	50	800
		6-5	350	50	800

Strand Type		Tendon Unit Type P	D	E	F
			Dimensions (mm)		
Strand Type	12.7mm	5-3	200	75	300
		5-4	250	75	400
		5-5	300	75	500
	15.2mm	6-2	150	75	150
		6-3	225	75	300
		6-4	300	75	400
		6-5	350	75	500

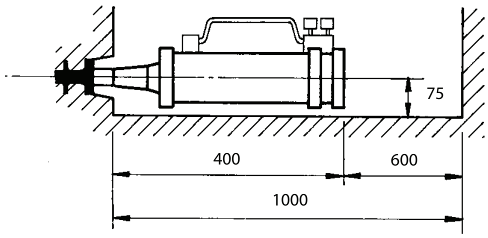


VSL SLAB COUPLING ANCHORAGE TYPE S

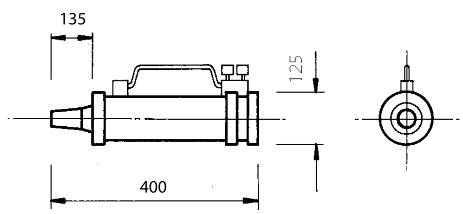


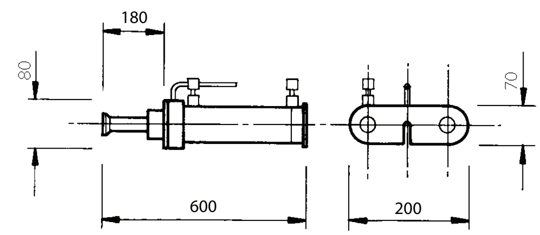
Strand Type	Tendon Unit	A	B	C Dimensions (mm)	D	E
12.7mm	S5-4	95	190	110	240	215
	S5-5	95	235	110	240	215
15.2mm	S6-4	95	190	110	240	215
	S6-5	95	235	110	265	238

JACK CLEARANCE REQUIREMENTS



STRESSING JACK DETAILS





VSL MS JACK

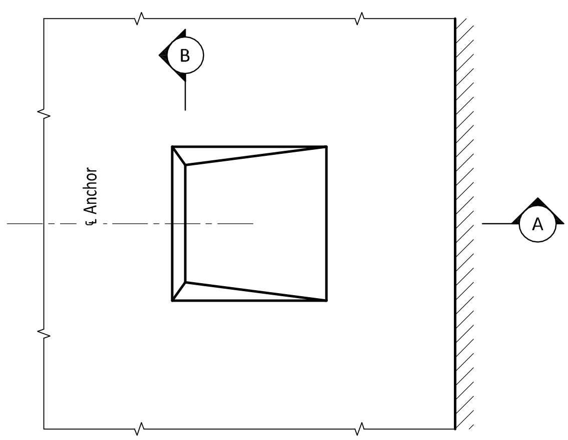
Max. Capacity .... 250 kN
Mass .... 20 kg
Stroke .... 200 mm
Max. hydraulic pressure .... 65 MPa

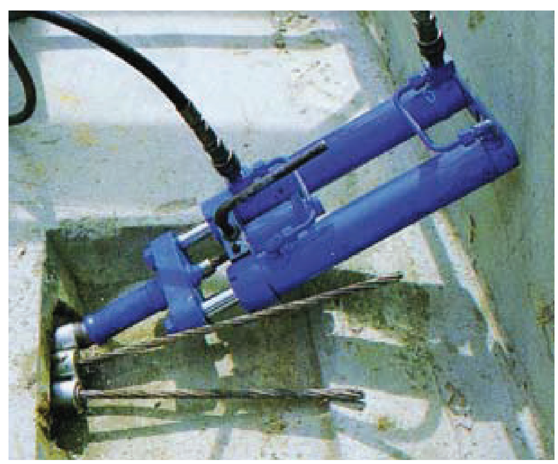
VSL TCH JACK

Max. Capacity .... 290 kN
Mass .... 26 kg
Stroke .... 250 mm
Max. hydraulic pressure .... 68 MPa

INTERNAL STRESSING POCKET

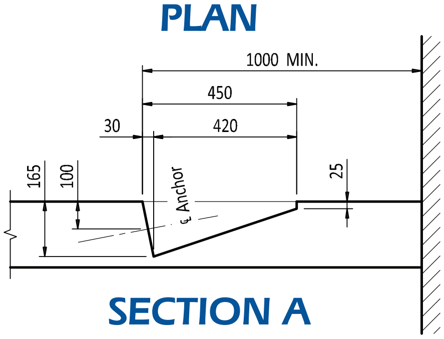
12.7mm Strand 15.2mm Strand
Details shown are typical and may vary for particular applications

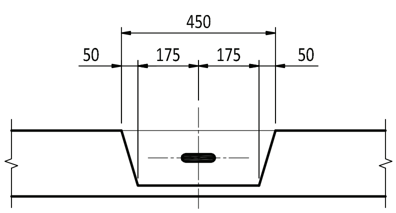




PLAN

STRESSING POCKET

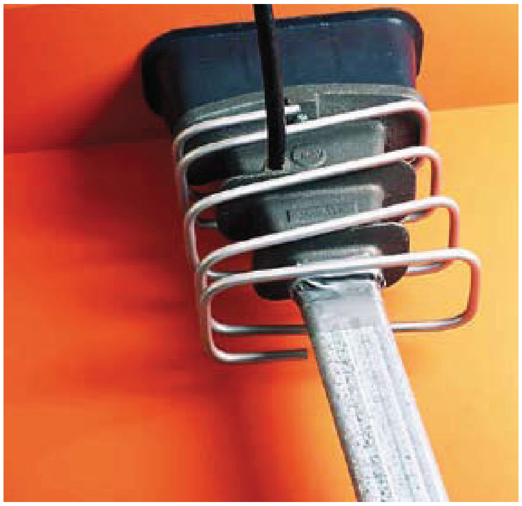




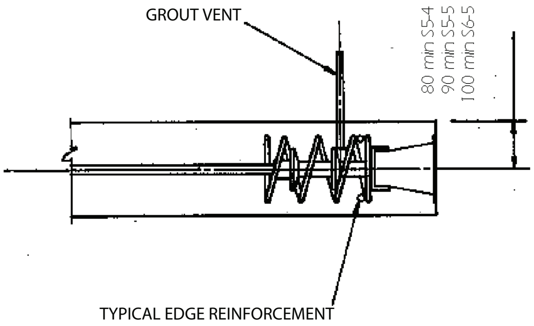
SECTION A

SECTION B

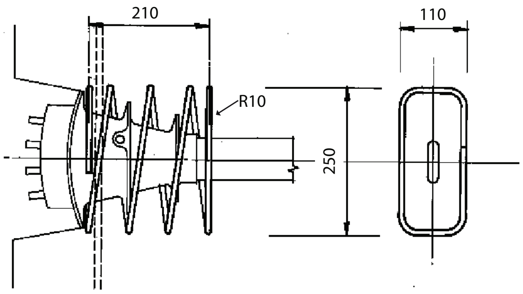
ANCHORAGE REINFORCEMENT - HELIX



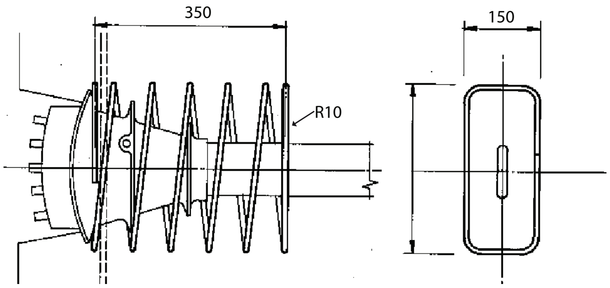
ANCHORAGE AT SLAB EDGE



DETAIL AT SLAB EDGE



S5-3, S5 - 4, S5-5 ANCHORS
S6-3, S6 - 4 ANCHORS

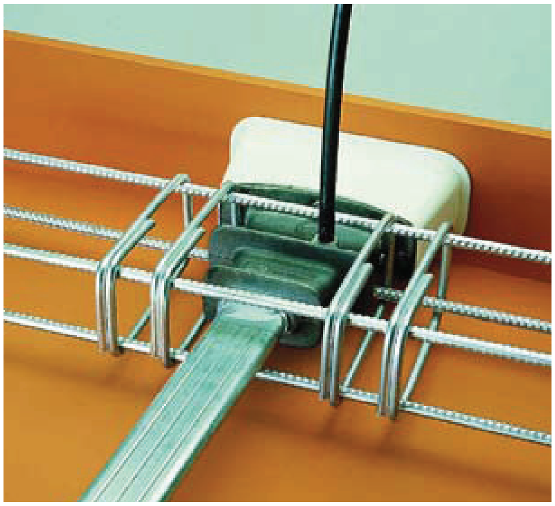


S6-5 ANCHOR

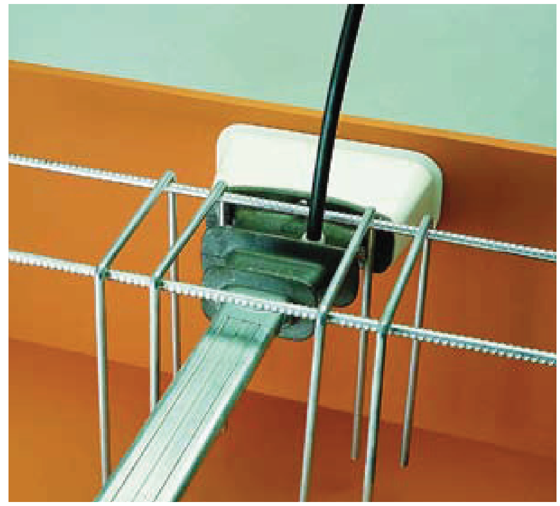
Note: 1. Reinforcement shown is indicative, actual anchorage reinforcement is to be as detailed by the consulting engineer, anchorage reinforcement shall be located centrally about and hard up against cast in anchor as shown

2. Min. concrete cylinder strength at jacking = 22MPa Generally and 25 MPa for S6-5. Reinforcement for helix is round bar with fy = 250MPa

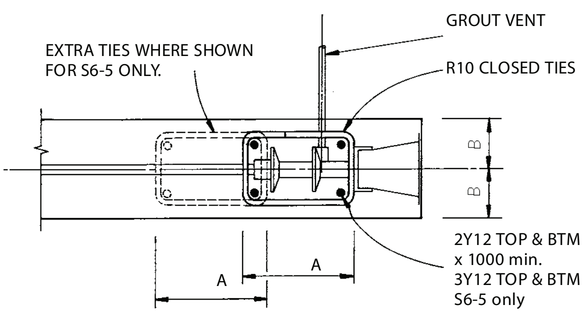
ANCHORAGE REINFORCEMENT - TIES



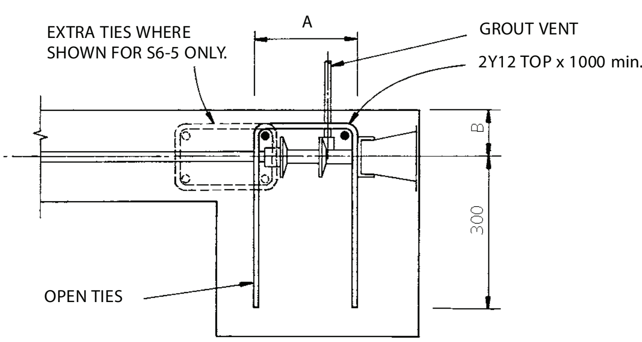
ANCHORAGE AT SLAB EDGE



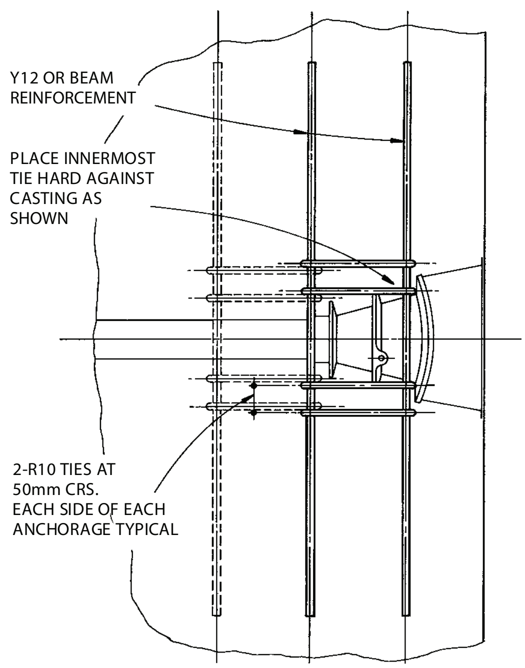
ANCHORAGE AT SLAB BEAM



DETAIL AT SLAB EDGE



DETAIL AT SLAB BEAM



PLAN

Strand Type	Tendon Unit	No. of Ties each side	A	B
			Dimensions (mm)	
12.7mm	S5-2	1	100	60
	S5-3, S5-4	2	200	80
	S5-5	2	200	90
15.2mm	S6-2, S6-3	2	200	90
	S6-4	2	200	90
	S6-5	2+2	200	100

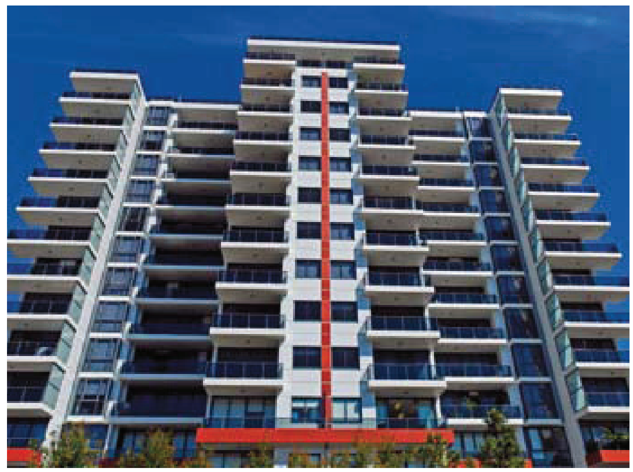
Note: 1. Reinforcement shown is indicative, actual anchorage reinforcement is to be as detailed by the consulting engineer, anchorage reinforcement shall be located centrally about and hard up against cast in anchor as shown

2. Min. concrete cylinder strength at jacking = 22MPa Generally and 25 MPa for S6-5. Reinforcement for helis is round bar with fy = 250 MPa

Slab Post-Tensioning

Mount Street, North Sydney, Australia

Container Storage Pavement, Melbourne, Australia



90 George Street, Hornsby, Australia

Stadium Australia, Sydney, Australia

Kens, *Sydney, Australia*

Quay West, *Auckland, New Zealand*

AC1, *Waterloo, Australia*

Coles Myer, Eastern Creek, Australia

Austrak Industrial Park, Melbourne, Australia

SLAB ON GRADE

The VSL post-tensioning system is widely used in the construction of slabs on grade. Warehouses, distribution centres, container terminals, airports, pavements, residential slabs and recreational slabs for tennis courts and skating rinks are common applications.

ELIMINATE JOINTS

Joints in reinforced concrete slabs on grade have long been a cause of cost and delay to owners because of the constant maintenance requirements. Owners and operators of facilities with slabs on grade can eliminate these costs by eliminating the joints themselves. The VSL post-tensioned concrete slab on grade is cast in very large areas, often exceeding 2,500m^2 with no joints. In certain applications, slabs in the order of 10,000m^2 have been constructed without movement joints.

CRACK - FREE PERFORMANCE

VSL post-tensioning axially compresses the concrete slab to counteract tensile stresses which would otherwise cause cracking under the worst combinations of temperature and applied loads. The prestress applied can even control initial concrete shrinkage preventing shrinkage cracking.

Lion Nathan Brewery, Auckland, New Zealand

Mornington Tank, Victoria, Australia

trak Industrial Park, Melbourne, Australia

Lion Nathan Brewery, Auckland, New Zealand

THINNER SLAB

VSL post-tensioned slabs are much thinner than equivalent reinforced concrete slabs. The VSL slab generally contains no reinforcement except at the perimeter and for trimming at penetrations.

INITIAL COST

The thinner slab, absence of reinforcement and costly internal joints and the cost saving available from the construction program time saved by casting large areas, all contribute to a competitive initial cost.

FUTURE MAINTENANCE

During the life of the slab, the joint maintenance costs which the owner no longer need endure, will reap great improvements in the efficiency of the facility.

A life cycle analysis can be readily undertaken to demonstrate that future savings to the owner more than justify the selection of a VSL slab on grade.

tainer Terminal, Port Botany, Australia

Tank Slab, Longreach, Australia