APOLLO® PVC-O PIPELINE DESIGN

iPLEX Pipelines

STRUCTURAL DESIGN

ALLOWABLE COVER HEIGHTS

In engineering terminology, Apollo® pipes are considered to be "flexible" pipes, therefore when buried they are designed to deform or deflect diametrically within specified limits without structural damage.

The external soil and live loadings above flexible pipes may cause a decrease in the vertical diameter and an increase in the horizontal diameter of the pipe. The horizontal movement of the pipe walls in the soil material at the sides develops a passive resistance within the soil to support the external load. That is, the pipeline performance is influenced by the soil type, density and height of water table. The higher the effective soil modulus at pipe depth, the less the pipe will deflect. Longterm deflections of up to 7.5% are permissible and will not affect the pressure rating of the pipe or the leak tightness of the BLUEseal rubber ring joint.

A complete design procedure is available for Apollo® pipes. Consult Iplex for further details or refer to AS/NZS 2566.1 'Buried flexible pipelines Part 1 Structural design'.
Iplex has developed a computer software program, which is available for download free of charge. It is based on AS/NZS2566.1 and in addition to Apollo®, covers all Iplex pipeline materials.

MINIMUM COVER HEIGHT (REF AS/NZS 2566.2)

For areas with no traffic loading a minimum cover height of 450mm to the top of the pipe should be adopted. Under carriageways, the minimum cover height is 600mm for sealed pavements and 750mm for unsealed pavements. In these installations the pipe embedment material in the bedding and side support zones should have a minimum compaction Density Index of 65% or Standard Dry Density Compaction of 90%.

After pipes are laid and centred in the trench, the embedment material should be compacted in 80-100mm layers to the specified density. The embedment should continue 80mm to 150mm above the pipe to provide protection from the backfill.

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AUSTRALIA'S PIPELINE SPECIALISTS EST. 1938

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THRUST BLOCK DESIGN FOR FITTINGS

For rubber ring jointed pipeline systems, provision must be made for potentially unrestrained forces at changes of size or direction. For e.g., bends, tees, reducers, valves and closed ends.

In buried installations, fittings are usually restrained by blocks of concrete cast in-situ. These thrust blocks are formed and sized to distribute the applied force from the fitting to a safe soil pressure concrete interface. The resistance provided will depend on the soil type and depth.

Where bends are in the vertical plane, convex and close to the surface, the mass of a concrete anchor block alone may have to be the restraining force.

AS/NZS 2566.2 and AS/NZS 2032 specify the use of thrust blocks for all in-line gate valves. Although no longer allowed, Water Agencies have in the past omitted valve restraints for small diameter (s DN200) reticulation pipelines.

Where there is risk of axial thrust, it is strongly recommended that only those DI fittings with full circle bearing surfaces at the base of the socket should be used. It is also beneficial if the Apollo® spigots are trimmed back and the chamfer reduced to DI chamfer lengths. This serves to increase the effective end bearing area for the PVC spigot inside the DI socket.

Installers should be alerted to the potential for catastrophic failure where there is insufficient buried pipe downstream of an unanchored valve to provide enough soil friction to resist the hydrostatic thrust when the valve is closed.

Concrete thrust blocks should be correctly oriented to transfer the hydraulic thrust to the specially trimmed undisturbed soil of the vertical trench walls perpendicular to the load.

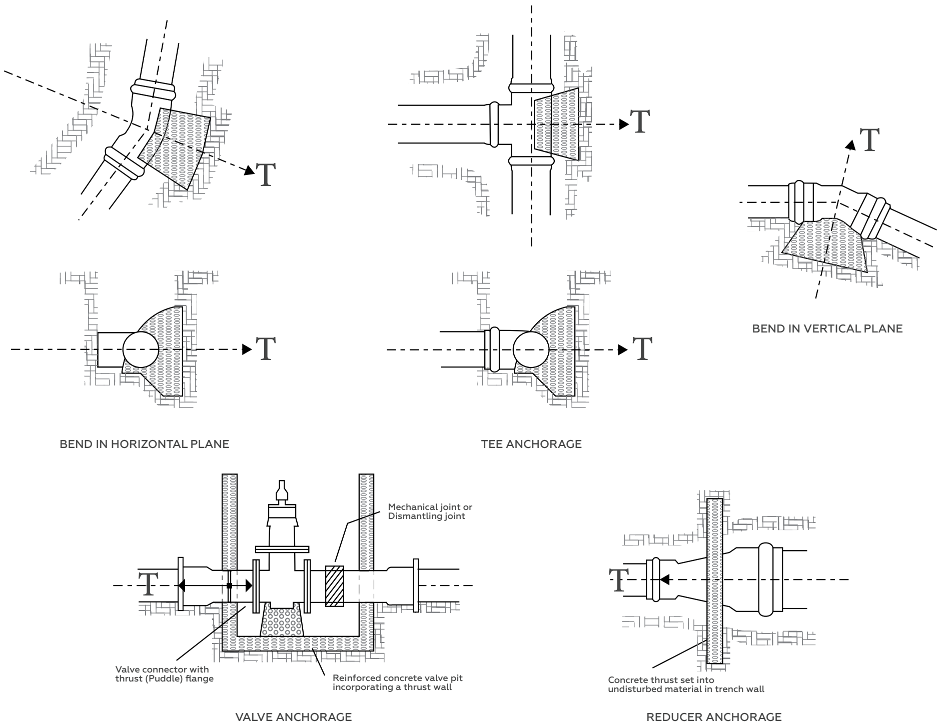

Figure 1.0 Typical Thrust Block Arrangements (Reference AS/NZS 2566.2)

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TABLE 1.0 HYDROSTATIC FORCES (KN) ON RUBBER RING JOINTED FITTINGS PER 10 METRES OF HYDROSTATIC HEAD

PIPE DN	PIPE OD	BEND 90°	BEND 45°	BEND 22 ½°	BEND 11 ¼°	TEE/ CLOSED END / VALVE
100	122	1.62	0.88	0.45	0.22	1.15
150	177	3.41	1.85	0.94	0.47	2.41
200	232	5.86	3.18	1.61	0.81	4.14
225	259	7.31	3.96	2.01	1.01	5.17
250	286	8.91	4.83	2.45	1.23	6.30
300	345	12.96	7.02	3.57	1.79	9.16

Note: For concentric reducers the resultant thrust will be the difference between the "closed end" forces for the two pipe sizes.

TABLE 1.1 SOIL BEARING CAPACITIES (kPa) - APPLY MINIMUM FACTOR OF SAFETY OF 1.1

SOIL GROUP DESCRIPTION AS PER AS 1786	MINIMUM SOIL COVER ABOVE CENTRE LINE OF THRUST BLOCK IN METRES			
	0.75	1.0	1.25	1.5
GW, SW	57	76	95	114
GP, SP	48	64	80	97
GM, SM	48	64	80	96
GC, SC	79	92	105	119
CL	74	85	95	106
ML	69	81	93	106
OH	0	0	0	0

Thrust blocks must be configured to distribute the hydrostatic force to a 'wall' of undisturbed soil, which is approximately perpendicular to the imposed load.

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The equation for this calculation is:

A = (T / b) x f

Where:

A = Area perpendicular to force (m²)

T = Hydrostatic thrust (kN)

b = Soil bearing capacity (kPa)

f = Factor of safety (in the order of 1.1 to 1.5)

Example

Question 1

A DN300 Apollo® pipelines has a maximum operating head (include field test heads) of 150 metres. What is the minimum area for a thrust block for a 90° ductile iron bend buried with 1 metre cover to the centre-line in a type SC soil?

Solution

From Table 1.0 - the hydrostatic thrust 'T' is 12.96kN x 15 = 194.4 kN.

From Table 1.1 – 'b' = 92 kPa

Therefore:

A = (194.4 / 92) x 1.1 = 2.32m²