Annex O
(normative)

Under-Bottom Connections

This annex provides a number of design options requiring decisions by the Purchaser; standard requirements; recommendations; and information that supplements the basic standard. This annex becomes a requirement only when the Purchaser specifies an option covered by this annex or specifies the entire annex.

O.1 Scope

This Annex contains recommendations to be used for the design and construction of under-bottom connections for storage tanks. The recommendations are offered to outline good practice and to point out certain precautions that are to be observed. Reference should be made to Annex B for considerations involving foundation and subgrade.

O.2 Recommendations

O.2.1 The recommendations of this Annex are intended for use only where significant foundation settlement is not expected. It is not possible to establish precise limits, but if predicted settlement exceeds 13 mm ($^1/_2$ in.), the recommendations should be subjected to detailed engineering review for possible additions, modifications, or elimination of bottom connections. Particular consideration shall be given to possible differential settlement in the immediate area of the bottom connection and with respect to connecting piping.

- **O.2.2** The arrangement and details of bottom connections may be varied to achieve the utility, tightness, and strength required for the prevailing foundation conditions. The details shown in Figure O.1, Figure O.2, and Figure O.3 are examples. Figure O.1 and Figure O.2 show details used on a concrete ringwall foundation, but similar designs may be used on earth foundations. Figure O.3 shows another detail used on earth foundations. Other arrangements of foundation and connection (including combination sump and pipe) may be used under the provisions of O.2.6. When required by the Purchaser, seismic considerations (see Annex E) shall be included.

O.2.3 Support of the pipe by the soil and bottom connection shall be evaluated to confirm adequacy and resistance to liquid, static, and dynamic loads. Both deflection and stress shall be considered in the evaluation.

O.2.4 Consideration shall be given to predicted settlement that would affect the relative positions of the tank and pipe or pipe supports outside the tank (see O.2.1).

O.2.5 Bottom connections used in floating-roof tanks shall be provided with a baffle to prevent impingement of the inlet product stream directly against the floating roof.

- **O.2.6** All details are subject to agreement between the Purchaser and the Manufacturer.

O.3 Guideline Examples

O.3.1 Concrete Vault and Ringwall (See Figure O.1 and Figure O.2)

O.3.1.1 The concrete ceiling vault shown in Figure O.2 provides improved support of the tank bottom and shell and provides more uniform reinforcing-bar distribution around the ringwall opening than the details shown in Figure O.1 provide.

O.3.1.2 Particular attention is required for the backfill specifications and placement of the backfill around the vault area and around the inside of the entire ringwall. Compaction shall be adequate to prevent significant localized settlement.

O.3.1.3 Consideration should be given to the soil characteristics at the different elevations at the bottom of the ringwall and the vault, especially for the deeper vaults to accommodate the larger connections.

O.3.1.4 Recommended details and dimensions are shown in Figure O.1 and Figure O.2, and Table O.1a and Table O.1b. Dimension K is considered adequate to place the connection out of the influence of shell-to-bottom rotation when the tank is statically loaded. Seismic loading shall be analyzed for additional considerations. The method shall be a matter of agreement between the Manufacturer and the Purchaser. When the tank bottom has annular plates (thicker than the tank bottom), it is recommended either to provide at least 300 mm (12 in.) between the edge of the pipe connection or reinforcing plate and the inner edge of the annular plate or to locally extend the annular plate, thickened if necessary, to encompass the bottom connection. The dimensions in Tables O.1a and O.1b may be changed to achieve desired clearances for installations, inspections, and the like.

Table O.1a—Dimensions of Under-Bottom Connections (SI)

Inlet Diameter NPS *D*	mm										
	B/2	*E*	*F*	*G*	*H*	*J*	*K*	*L*	*W/2*	*T*[a]	*ST*[b]
6	525	225	350	750	575	300	1125	1975	925	16	ST4WF8.5
8	550	250	400	825	650	300	1150	2050	950	16	ST4WF8.5
12	600	300	450	875	750	300	1200	2150	1000	16	ST6WF13.5
18	675	375	500	950	900	300	1300	2325	1075	16	ST6WF13.5
24	750	450	600	1050	1075	300	1400	2550	1150	16	ST6WF13.5
30	850	525	750	1150	1300	300	1500	2750	1225	16	ST6WF13.5
36	925	625	925	1275	1550	300	1625	3000	1300	16	ST8WF18.0
42	1000	700	1075	1375	1775	300	1725	3200	1375	16	ST8WF18.0
48	1075	825	1225	1475	2025	300	1825	3400	1450	16	ST8WF18.0

[a] Applies only to Figure O.1. For tank heights greater than 19.2 mm to 21.6 mm inclusive, 19-mm plate shall be used. T shall not be less than the thickness of the annular plate.

[b] Other composite sections may be used to support the load.

NOTE See Figure O.1 and Figure O.2. For diameters not shown, the dimensions of the next larger size shall be used.

Table O.1b—Dimensions of Under-Bottom Connections (USC)

Inlet Diameter NPS *D*	in.										
	B/2	*E*	*F*	*G*	*H*	*J*	*K*	*L*	*W/2*	*T*[a]	*ST*[b]
6	21	9	14	30	23	12	44	78	36	$^5/_8$	ST4WF8.5
8	22	10	16	32	26	12	45	81	37	$^5/_8$	ST4WF8.5
12	24	12	18	34	30	12	47	85	39	$^5/_8$	ST6WF13.5
18	27	15	20	37	35	12	51	92	42	$^5/_8$	ST6WF13.5
24	30	18	24	41	42	12	55	100	45	$^5/_8$	ST6WF13.5
30	33	21	30	45	51	12	59	108	48	$^5/_8$	ST6WF13.5
36	36	25	36	50	61	12	64	118	51	$^5/_8$	ST8WF18.0
42	39	28	42	54	70	12	68	126	54	$^5/_8$	ST8WF18.0
48	42	32	48	58	80	12	72	134	57	$^5/_8$	ST8WF18.0

[a] Applies only to Figure O.1. For tank heights greater than 64 ft to 72 ft inclusive, $^3/_4$-in. plate shall be used. T shall not be less than the thickness of the annular plate.

[b] Other composite sections may be used to support the load.

NOTE See Figure O.1 and Figure O.2. For diameters not shown, the dimensions of the next larger size shall be used.

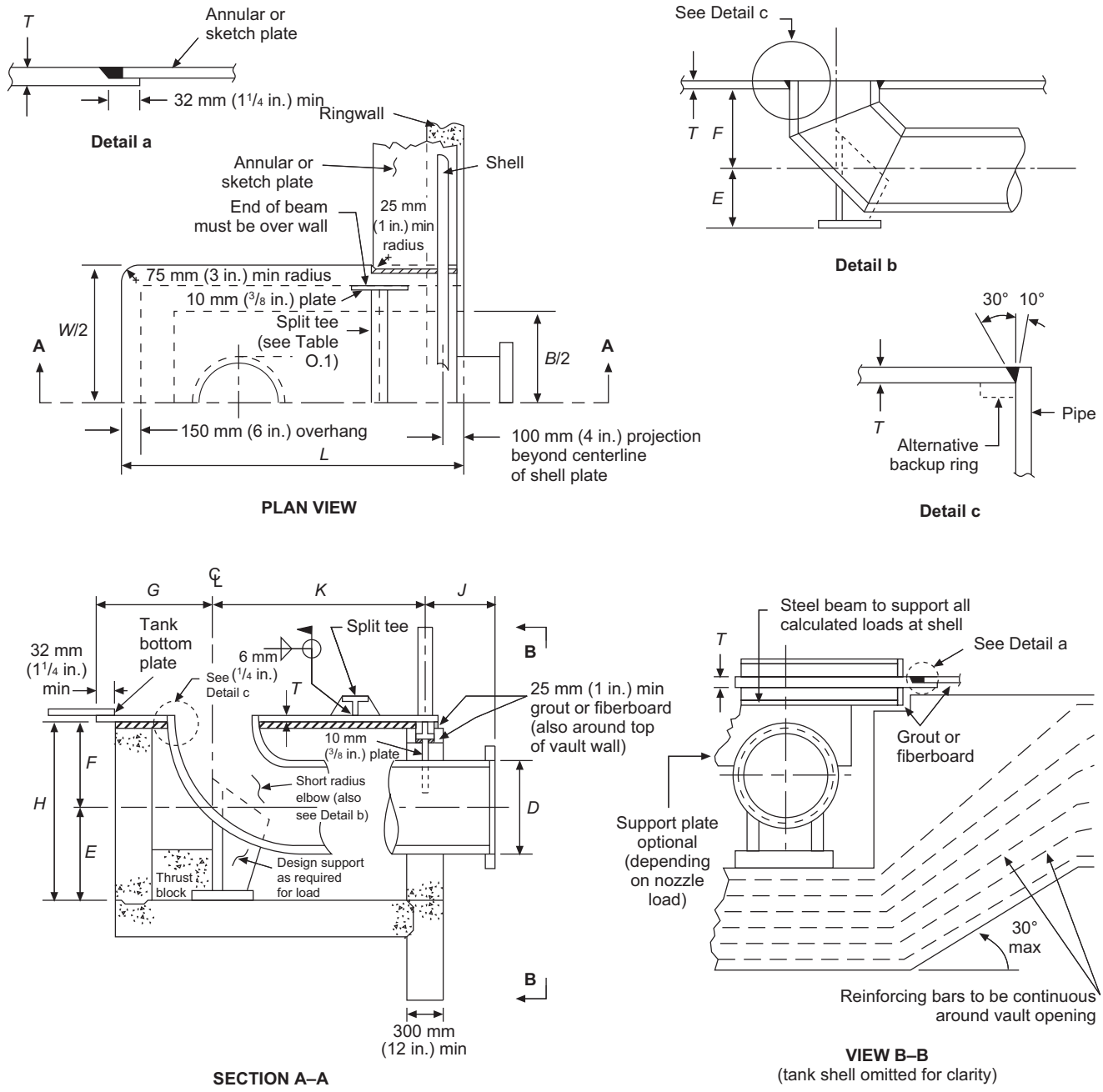


Figure O.1—Example of Under-Bottom Connection with Concrete Ringwall Foundation

O.3.1.5 Concrete walls, floors, and ceilings shall be designed to meet the minimum requirements of ACI 318 and local soil conditions.

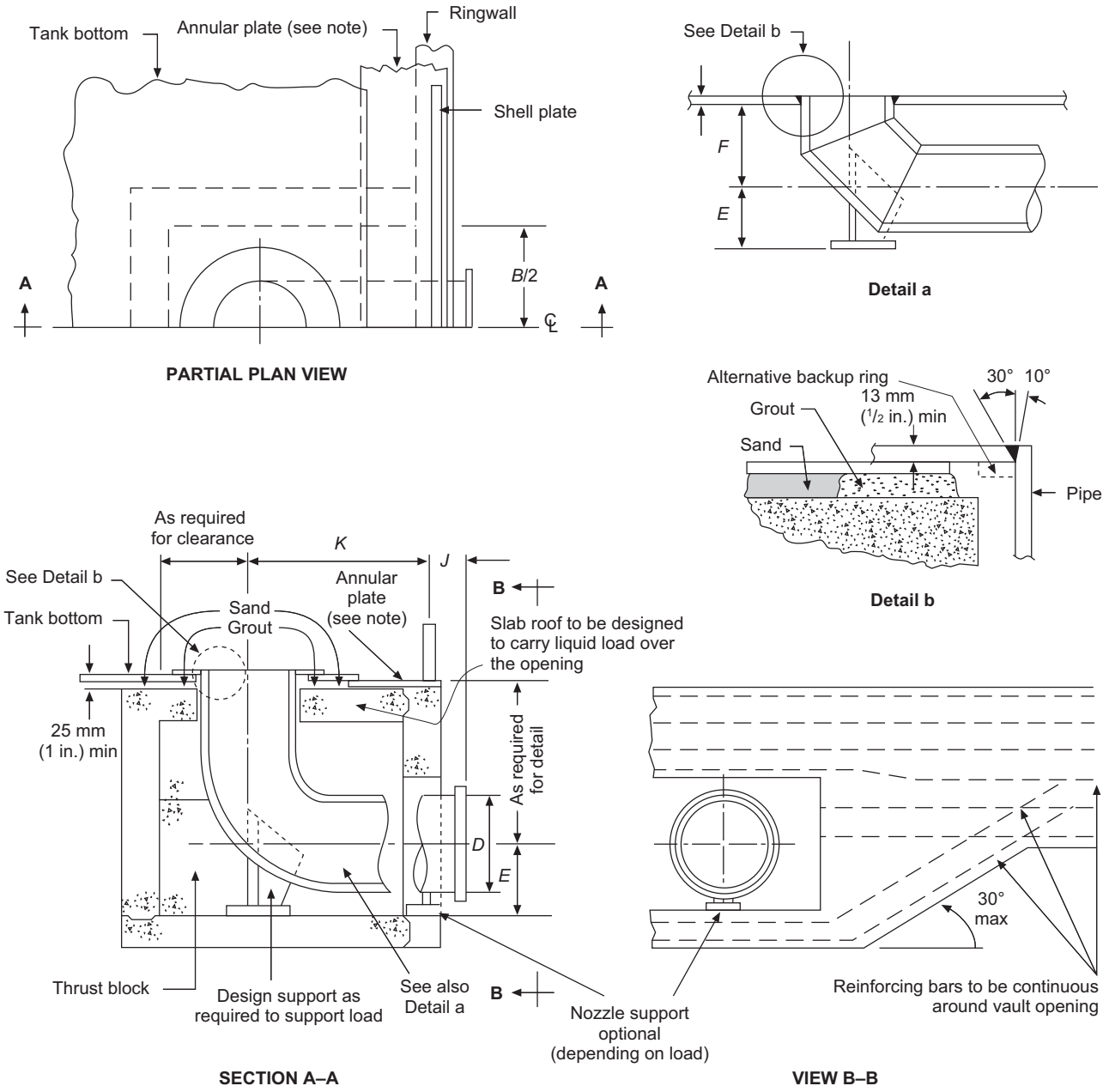
O.3.2 Earth Foundation (See Figure O.3)

O.3.2.1 The detail shown in Figure O.3 provides an alternative arrangement for tanks where a concrete ringwall is not provided.

O.3.2.2 Soil and backfill support capability shall be evaluated to ensure that reasonably uniform settlement (if any) will occur under the loads imposed.

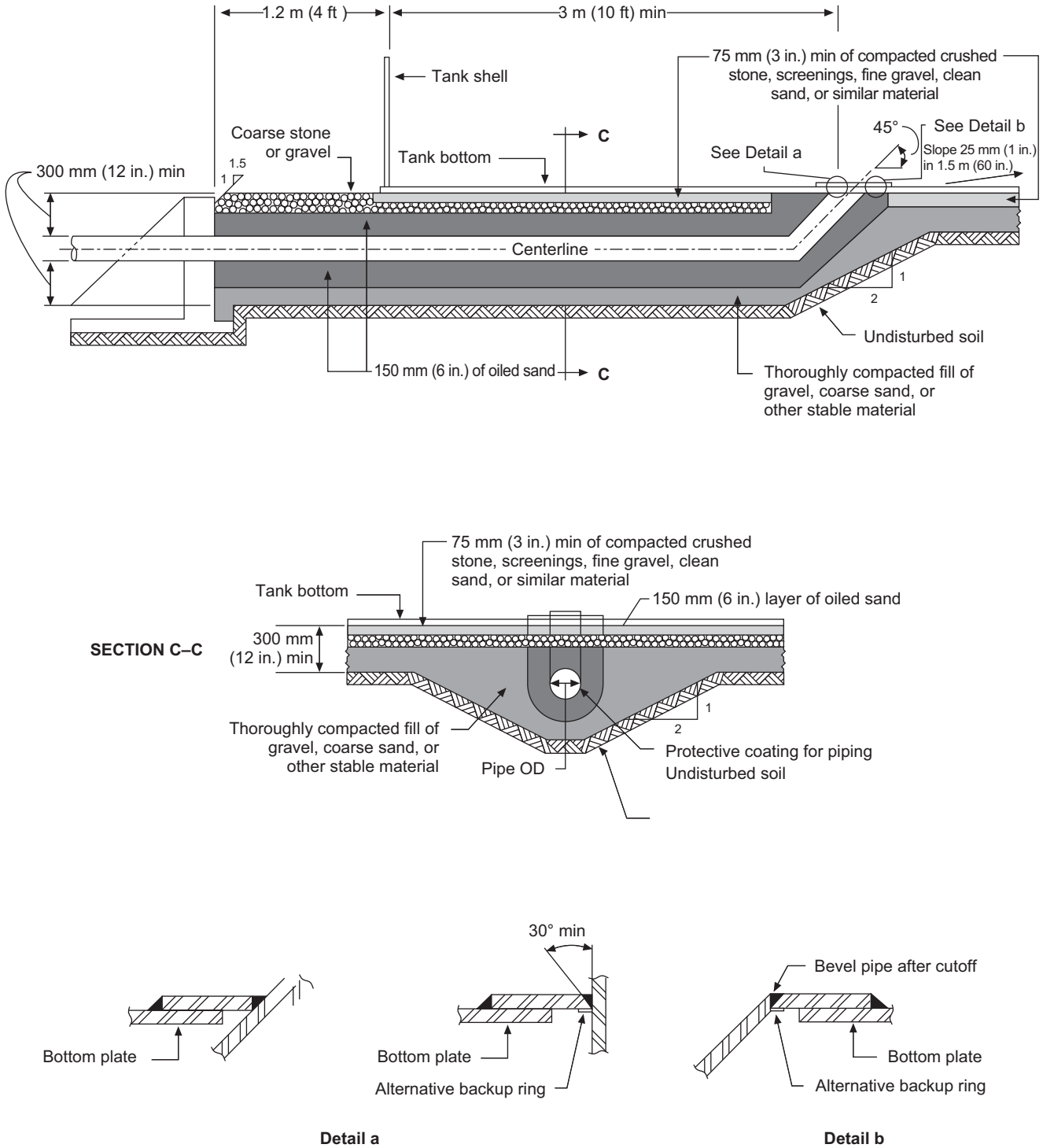
O.3.2.3 When the pipe is connected to the bottom at an angle, consideration should be given to design for unbalanced forces if the pipe is trimmed flush with the bottom.

O.3.2.4 When seismically-induced loadings are specified, such loadings under the tank bottom and shell shall be considered when the depth and type of backfill around and over the pipe are selected.



Note: If sketch plates are used, a full plate shall be located over the vault.

Figure O.2—Example of Under-Bottom Connection with Concrete Ringwall Foundation and Improved Tank Bottom and Shell Support



Note: This type of connection shall not be used for tanks with a diameter of less than 6 m (20 ft).

Figure O.3—Example of Under-Bottom Connection with Earth-Type Foundation