with the coefficients tabulated in App.A.

3.6 Absolute lateral static stability method

3.6.1 Introduction

This section gives an absolute static requirement for lateral on-bottom pipelines based on static equilibrium of forces that ensures that the resistance of the pipe against motion is sufficient to withstand maximum hydrodynamic loads during a sea state, i.e. the pipe will experience no lateral displacement under the design extreme single wave induced oscillatory cycle in the sea state considered.

This requirement for absolute stability may be relevant for e.g. pipe spools, pipes on narrow supports, cases dominated by current and/or on stiff clay.

This requirement of zero displacement leads to a heavy pipe, especially so for cases dominated by wave induced flow velocity with small amplitude, i.e. *K* and *M* are small, where force reduction effects due to relative movement are significant even for small movements and the oscillating flow will not move a slightly lighter pipe a long distance. Note also that the peak loads presented below are measured in experiments and the horizontal component thus includes both the drag term and the inertia. Furthermore, with a zero displacement requirement, one cannot take advantage of the increased passive resistance that is built up due to the penetration caused by the pipe being rugged back and forth by the wave induced flow.

3.6.2 Design criterion

A pipeline can be considered to satisfy the absolute static stability requirement if:

$$\gamma_{SC} \cdot \frac{F_Y^* + \mu \cdot F_Z^*}{\mu \cdot w_s + F_R} \leq 1.0 \qquad (3.38)$$

and

$$\gamma_{SC} \cdot \frac{F_Z^*}{w_s} \leq 1.0 \qquad (3.39)$$

3.6.3 Safety factors

The safety factors γ_{SC} to be used for absolute stability in regular winter sea states are listed in Table 3-5 and Table 3-6.

Table 3-5 Safety factors, winter storms in North Sea

Soil type	*Low*	*Normal*	*High*
Sand and rock	0.98	1.32	1.67
Clay	1.00	1.40	1.83

Table 3-6 Safety factors, winter storms in Gulf of Mexico and Southern Ocean

Soil type	*Low*	*Normal*	*High*
Sand and rock	0.95	1.41	1.99
Clay	0.97	1.50	2.16

If cyclonic cases are governing for on-bottom stability design, the safety factors γ_{SC} to be used for absolute stability in cyclonic conditions are listed in Table 3-7 and Table 3-8.

Table 3-7 Safety factors, cyclonic conditions North West Shelf

Soil type	*Low*	*Normal*	*High*
Sand and rock	0.95	1.50	2.16
Clay	0.95	1.56	2.31

Table 3-8 Safety factors, cyclonic conditions Gulf of Mexico

Soil type	*Low*	*Normal*	*High*
Sand and rock	0.95	1.64	2.46
Clay	0.93	1.64	2.54

For other areas than those mentioned above, conservative assumptions should be made for the choice of safety factors.

3.6.4 Loads

Peak horizontal and vertical loads are:

$$F_Y^* = r_{tot,y} \cdot \frac{1}{2} \cdot \rho_w \cdot D \cdot C_Y^* \cdot \left(U^* + V^*\right)^2 \quad (3.40)$$

$$F_Z^* = r_{tot,z} \cdot \frac{1}{2} \cdot \rho_w \cdot D \cdot C_Z^* \cdot \left(U^* + V^*\right)^2 \quad (3.41)$$

Maximum wave induced water particle velocity, including reduction due to directionality and spreading, U^* and T^* can be taken from Equation (3.15) and Equation (3.16).

Current velocity, including reduction due to directionality and the boundary layer, V^*, can be taken from [3.4.2].

Peak load coefficients C_Y^* and C_Z^* are taken from Table 3-9 and Table 3-10. Load reductions due to a permeable seabed, soil penetration and trenching can be calculated according to [3.4.5].

Table 3-9 Peak horizontal load coefficients

C_Y^*		K^*										
		2.5	*5*	*10*	*20*	*30*	*40*	*50*	*60*	*70*	*100*	*≥140*
M^*	0.0	13.0	6.80	4.55	3.33	2.72	2.40	2.15	1.95	1.80	1.52	1.30
	0.1	10.7	5.76	3.72	2.72	2.20	1.90	1.71	1.58	1.49	1.33	1.22
	0.2	9.02	5.00	3.15	2.30	1.85	1.58	1.42	1.33	1.27	1.18	1.14
	0.3	7.64	4.32	2.79	2.01	1.63	1.44	1.33	1.26	1.21	1.14	1.09
	0.4	6.63	3.80	2.51	1.78	1.46	1.32	1.25	1.19	1.16	1.10	1.05
	0.6	5.07	3.30	2.27	1.71	1.43	1.34	1.29	1.24	1.18	1.08	1.00
	0.8	4.01	2.70	2.01	1.57	1.44	1.37	1.31	1.24	1.17	1.05	1.00
	1.0	3.25	2.30	1.75	1.49	1.40	1.34	1.27	1.20	1.13	1.01	1.00
	2.0	1.52	1.50	1.45	1.39	1.34	1.20	1.08	1.03	1.00	1.00	1.00
	5.0	1.11	1.10	1.07	1.06	1.04	1.01	1.00	1.00	1.00	1.00	1.00
	10	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 3-10 Peak vertical load coefficients

C_Z^*		K^*										
		≤ 2.5	*5*	*10*	*20*	*30*	*40*	*50*	*60*	*70*	*100*	*≥140*
M^*	0.0	5.00	5.00	4.85	3.21	2.55	2.26	2.01	1.81	1.63	1.26	1.05
	0.1	3.87	4.08	4.23	2.87	2.15	1.77	1.55	1.41	1.31	1.11	0.97
	0.2	3.16	3.45	3.74	2.60	1.86	1.45	1.26	1.16	1.09	1.00	0.90
	0.3	3.01	3.25	3.53	2.14	1.52	1.26	1.10	1.01	0.99	0.95	0.90
	0.4	2.87	3.08	3.35	1.82	1.29	1.11	0.98	0.90	0.90	0.90	0.90
	0.6	2.21	2.36	2.59	1.59	1.20	1.03	0.92	0.90	0.90	0.90	0.90
	0.8	1.53	1.61	1.80	1.18	1.05	0.97	0.92	0.90	0.90	0.90	0.90
	1.0	1.05	1.13	1.28	1.12	0.99	0.91	0.90	0.90	0.90	0.90	0.90
	2.0	0.96	1.03	1.05	1.00	0.90	0.90	0.90	0.90	0.90	0.90	0.90
	5.0	0.91	0.92	0.93	0.91	0.90	0.90	0.90	0.90	0.90	0.90	0.90
	10	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90

For K^* < 2.5 the peak horizontal load coefficient can be taken as $C^*_{Y,K=2.5} \cdot 2.5 / K^*$ where $C^*_{Y,K=2.5}$ is the relevant value in Table 3-9 under K^* = 2.5.