

4. Crane Loads

4.1. Load determination

The determination of loads induced by cranes is covered by Australian Standard AS 1418 Part 1. The crane loads are divided into three main groups: principal, additional and special. The principal loads include the self-weight of the crane, the hoisted load, loads induced by acceleration of crane and hoist, and loads arising from eccentricity of the point of load application with respect to the vertical plane passing through bearing centreline. Dynamic effects apply all these loads and this is taken into account by the so-called dynamic factors.

The second category, additional loads, includes the in-service wind, snow and ice, forces due to temperature and the oblique travel. The third category includes loads due to out-of-service wind loads, accidents and load testing of crane.

Cranes produce dynamic loads in all three directions. These loads can be regarded as having two parts: the steady state component and the dynamic component. In AS 1418.1 the dynamic loads are treated as a product of steady-state nominal loads computed for static loading condition, and a dynamic factor. The term dynamic factor must not be confused with the *load factor* in limit states design.

4.2. Load combinations

AS 1418.1 table 4.8, Load Combinations summarises the load types and dynamic factors. The most common typical load combinations are indicated in the Table 2, herein.

The method of calculation is simple as long as all load components and mechanical parameters are at hand. The first thing is to obtain steady state (static, nominal) loads, ideally from the manufacturer of the cranes to be installed. To account for dynamic forces AS 1418.1 gives methods for evaluating dynamic factors to be applied to arrive at peak dynamic forces.

The load combination table is constructed on basis of statistical/probabilistic reasoning. It takes into account the expected behaviour of the crane in service. Not all load types are associated with the same values of dynamic factors to reflect the fact that only one or two load types have coinciding peaks at the instant of time while other loads may not be dynamically magnified at all.

The loads are divided into three main groups: principal loads, additional loads and special loads. The load combinations are also grouped into three types of combinations: frequently occurring, infrequently occurring and rarely occurring. The frequently occurring load combinations numbered 1,2 and 3 are the ones that are to be subject to fatigue assessment.

At the bottom of the load combination table is a row named 'load combination factor'. Its function is to relax the combinations involving large number of load types, on account of a low probability of occurrence in an instant of time.

Table 2. Load combinations – Excerpt from AS 1418.1, Table 4.8

Only the first six load combinations are shown
See AS 1418.1 for complete table

Load Group	#	Load Type	Load Combination Number						Limit state Partial load factor ϕ_p †
			Frequently occurring				Infrequently occurring		
			1	2	3	4	5	6	
Principal	1	Dead loads : - Crane							
			ϕ_1	1	0.9	ϕ_1	ϕ_1	0.9	1.25
	1A	- Runway	1	1	1	1	1	1	1.25
	2	Hoisted loads	ϕ_2	1	ϕ_3	ϕ_2	ϕ_1	ϕ_3	1.50
	3	Inertia loads	ϕ_4	ϕ_4	1	ϕ_4	ϕ_1	1	1.50
	4	Induced loads *	1	1	1	1	1	1	1.50
Additional	5	Wind, in-service	na	na	na	1	na	1	1.00
	6	Snow, ice	na	na	na	1	1	na	1.00
	7	Temperature	na	na	na	1	1	na	1.00
	8	Oblique travel	na	na	na	na	1	na	1.50
Special Loads	See AS 1418.1, Table 4.6.								
Load combination factors, ψ			1.0	1.0	1.0	0.9	0.9	0.9	

na Not applicable

* Induced loads stands for runway loads induced by the building structure.

† Load factors recommended by this author.

The way to apply the load combination table is illustrated below.

For Load Combination 5:

$$\Psi \{ \phi_p P_1 \phi_1 + \phi_p P_2 \phi_2 + \dots \}$$

where: ϕ_p is the limit state design partial load factor
 Ψ is the load combination factor
 P_i is the load
 ϕ_1, ϕ_2 are the dynamic factors as described below

$$0.9 \{ 1.25 P_1 \times \phi_1 + 1.25 P_{1A} \times 1.0 \\ + 1.5 (P_2 \times \phi_2 + P_3 \times \phi_1 + P_4 \times 1.0) \\ + 1.0 (P_6 \times 1.0 + P_7 \times 1.0) + 1.5 P_8 \times 1.0 \}$$

Note: **Bold** figures denote load factors and the load combination factors are in *Italics*.



Crane Runway Girders

Limit States Design

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