2 Loads

2.1 BACKGROUND

The loads to be considered in the design of portal frame buildings are dead, live, wind, seismic and occasionally snow loads, and combinations of these. Live loads generally represent peak loads which have a 95% probability of not being exceeded over a 50 year return period, while for wind and earthquake loads, different return periods are used for the strength and serviceability limit states.

The relevant loading codes are:

- AS/NZS 1170.0:2002 Part 0: *General principles* [1]
- AS/NZS 1170.1:2002 Part 1: *Permanent, imposed and other actions* [2]
- AS/NZS 1170.2:2011 Part 2: *Wind actions* [3]
- AS/NZS 1170.3:2003 Part 3: *Snow and ice actions* [4]
- AS 1170.4-2007 Part 4: *Earthquake actions in Australia* [5]

The determination of dead loads G, live loads Q, wind loads W and seismic loads E is discussed in Sections 2.2, 2.3, 2.4 and 2.5 respectively. Snow loads S are not treated in any detail in this book. Overhead travelling crane loads are treated in Chapter 8 and the calculation of monorail crane loads is presented in Chapter 9.

The load combinations stipulated in AS/NZS 1170 Part 0 to obtain the factored design loads for the strength and serviceability limit states have also been determined on a probabilistic basis, and these combinations are discussed in Section 2.6.

2.2 DEAD LOADS

The dead (or permanent) loads acting on a portal framed industrial building arise from its self-weight including finishes, and from any other permanent construction or equipment. The dead load will vary during construction, but will remain constant thereafter, unless significant modifications are made to the structure or its permanent equipment.

As a guide for preliminary analysis, a dead load of 0.1 kPa can be allowed for the roof sheeting and purlins. An allowance of say 0.05 kPa for roof bracing and miscellaneous items such as insulation and light roof vents is advisable for preliminary design, and this allowance can be refined up or down as the design develops. The presence of mechanical equipment, suspended ceilings and any acoustic insulation layers should, of course, be specifically allowed for. The self-weight of the rafter needs to be included, but the weight of cleats and connections is not usually considered as being significant.

2.3 LIVE LOADS

The live (or imposed) loads acting on the roof of a portal frame building arise mainly from maintenance loads where new or old roof sheeting may be stacked in concentrated areas.

The roof live loads for cladding, purlins and rafters are specified in the loading code AS/NZS 1170.1, the roofs of industrial buildings generally being of the non-trafficable category. Roof cladding must be designed to support a concentrated load of 1.1 kN in any position, but this is usually taken account of by the sheeting manufacturer who nominates the maximum spans that will sustain this load.

For purlins and rafters, the code provides for a distributed load of 0.25 kPa where the supported area A is greater than 14 m^2, the area A being the plan projection of the inclined roof surface area. For areas A less than 14 m^2, the code specifies the distributed load w_Q to be

$$w_Q = \left(\frac{1.8}{A} + 0.12 \right) \text{ kPa} \tag{2.1}$$

This formula is equivalent to a distributed load of 0.12 kPa plus a load of 1.8 kN distributed over the span of the member, and ensures that the minimum load to be supported by short members such as purlin cantilevers and end wall fascia members is at least 1.8 kN. Presumably, such a load would cater for the case of a heavy worker standing on the edge of the roof or at the edge of an opening, and lifting materials on to the roof.

Some industrial buildings, particularly those with large roof catchments, have eave gutters with bases or sole widths greater than 200 mm. The rainwater goods code AS/NZS 2179.1 [6] requires these gutters to be able to support a concentrated load of 1.1 kN plus its water load. This requirement is not widely known and is relevant for the design of gutter brackets, fascia purlins and any special bridging which might be required between the fascia purlin and its adjacent purlin to support each gutter bracket.

In addition to the distributed live load, the loading code also specifies that structural elements be designed for a concentrated load of 1.4 kN. The concentrated load of 4.5 kN that was required at any point in the previous code AS 1170.1-1989 is no longer required.

It should be noted that the distributed live load given in Equation 2.1 need not be considered acting simultaneously with any wind load (see Section 2.6). The load combinations in AS/NZS 1170.0 effectively require that a portal frame building with a non-trafficable roof be designed to support either the roof live load or the wind load, whichever produces the worse effect. Note that the distributed live load of 0.25 kPa is significantly less than the live load in parts of Australia, New Zealand and in other countries where snow loads must be considered.

2.4 WIND LOADS

2.4.1 Regional Wind Speed

The wind loading specified in AS/NZS 1170.2 is generally the major loading influence in the design of industrial buildings, even in low wind areas. It is therefore important to evaluate the wind loading carefully. The *regional three second gust wind speeds* V_R are clearly specified

Design of Portal Frame Buildings

including
Crane Runway Beams and Monorails

Fourth Edition

S.T. Woolcock
Director, Bonacci Group
Consulting Engineers

S. Kitipornchai
Honorary Professor, School of Civil Engineering
The University of Queensland

M.A. Bradford
Scientia Professor of Civil Engineering
The University of New South Wales

G.A. Haddad
Associate, Bonacci Group
Consulting Engineers

Published by
Australian Steel Institute
Level 13, 99 Mount Street
North Sydney NSW 2060
www.steel.org.au

AUSTRALIAN STEEL INSTITUTE
(ABN)/ACN (94) 000 973 839

DESIGN OF PORTAL FRAME BUILDINGS
including Crane Runway Beams and Monorails

Published by
AUSTRALIAN STEEL INSTITUTE

Enquiries should be addressed to the publisher:

Business address – Level 13, 99 Mount Street, North Sydney, NSW 2060 Australia
Postal address – P.O. Box 6366, North Sydney, NSW 2059 Australia
Email address – enquiries@steel.org.au
Website – www.steel.org.au

Previously published as:

Design of Portal Frame Buildings, 1st edition, 1987 (to AS 1250)
Limit State Design of Portal Frame Buildings, 1st edition, 1991 (to AS 4100)
Limit State Design of Portal Frame Buildings, 2nd edition, 1993 (to AS 4100)
Design of Portal Frame Buildings, 3rd edition, 1999 (to AS 4100)
Design of Portal Frame Buildings, 3rd edition, 2003 (reprint with ASI)

National Library of Australia Cataloguing-in-Publication entry:

Design of portal frame buildings: including crane runway beams and monorails/ S.T. Woolcock … [et al.]

4th ed.
ISBN 9781921476266 (pbk.)
Includes bibliographical references and index.

Industrial buildings – Design and construction.
Building, Iron and steel – Design and construction.
Woolcock, S.T.
Australian Steel Institute.

693.71

Contents