PURLIN IN ROOF TRUSSES- DESIGN OF CHANNEL AND I SECTION PURLINS.

Purlins carry the roof deck or sheathing loads and are supported by large rafters and/or building walls, steel beams, etc. In comparison to closely spaced rafters, the use of purlins is common in pre-engineered metal construction systems and both the ancient post-and-beam and newer pole construction methodologies for frame construction.

Purlins pass roof loads to the major structural elements supporting the roof; the form and arrangement of purlins is a design factor that depends on the instance of roof loads as well as the limiting sheeting lengths to use. In the final analysis, local building codes should always be understood and implemented in the design of a concrete roof structure. Steel purlins are a substitute for conventional wood purlins. They are lightweight, stable in dimension, accurate and simple. In extreme temperature changes, they expand and contract moderately. Steel purlin is typically made of cold-formed material, which is thin enough to get through the screws. Cold-formed steel is rendered in the desired shape by rolling or pressing thin sheets of steel in. To the producer, it is less costly than hot-rolled steel and is, therefore, simpler to deal with. Though cold-formed steel is stronger than hot-formed steel when under strain, it is more likely to crack rather than bend.
Purlins are made of different metals. Some are simple Mild steel having normal strength and some are with zinc coating of different GSM. In harsh weather special coating can be applied over and above zinc coating.

1. Design an I section purlin for an industrial building to support a galvanized corrugated iron sheet roof.

Given:

Spacing of the trusses=5.0m

Spacing of purlins=1.5m

Inclination of main rafter to horizontal=300

Weight of galvanized sheet taking into account laps and connecting bolts=130N/m2

Imposed load=1.5kN/m2

Wind load= 1.0kN/m2

Solution:

DL = 130 N/m^2, spacing of purlins = 1.5

∴ DL per metre run of purlin = 130 × 1.5 = 195 N/m

Imposed load = 1.5 kN/m^2

∴ Imposed load per metre run of purlin = 1.5 × 1.5 = 2.25 kN/m.

∴ Factored vertical load = 1.5 (DL + LL)

= 1.5 (0.195 + 2.25) = 3.668 kN/m

∴ Component of load normal to sheets

$w_z = 3.668 \cos 30° = 3.177$ kN/m

Component of load parallel to sheets

$w_y = 3.668 \sin 30° = 1.834$ kN/m

Design for DL + IL

$$M_z = \frac{w_z L^2}{8} = 3.177 \times \frac{5^2}{8} = 9.928 \text{ kN-m}$$

$$M_y = \frac{w_y L^2}{8} = 1.834 \times \frac{5^2}{8} = 5.731 \text{ kN-m}$$

$$F_z = 3.177 \times \frac{5}{2} = 7.943 \text{ kN}$$

$$F_y = 1.834 \times \frac{5}{2} = 4.585 \text{ kN}$$

$$Z_{pz} \text{ required} = \frac{M_z}{f_y}\gamma_{mo} + 2.5 \times \frac{d}{b} \times \frac{M_y \gamma_{mo}}{f_y}$$

Trying ISMB 150,

$$d = 150 - 2(7.6 + 9.0) = 116.8 \text{ mm}$$

$$b = 80 \text{ mm}$$

$$Z_{pz} \text{ required} = \frac{9.928\times10^6}{250}\times1.1 + 2.5\times\frac{116.8}{80}\times\frac{5.731\times10^6}{250}\times1.1$$

$$= 135.723 \times 10^3 \text{ mm}^3$$

Z_{pz} of ISMB 150 is 110.5 × 10^3 mm^3

Hence try ISBM 175.

$$d = 175 - 2(7.4 + 10) = 140.2 \text{ mm}$$

$$b = 90 \text{ mm}$$

$$Z_{pz} \text{ required} = \frac{9.928\times10^6}{250}\times1.1 + 2.5\times\frac{140.2}{90}\times\frac{5.731\times10^6}{250}\times1.1$$

$$= 141.887 \times 10^3 \text{ mm}^3.$$

Z_{pz} of ISMB 175 is 161.1×10^3 mm^3. Hence adequate.

Check for shear:

$$V_{dz} = \frac{f_y}{\sqrt{3}} \frac{1}{\gamma_{mo}} h\, t_w = \frac{250}{\sqrt{3}} \times \frac{1}{1.1} \times 175 \times 5.5$$

$$= 152.817 \times 10^3 \text{ N} > F_z$$

$$V_{dy} = \frac{f_y}{\sqrt{3}} \times \frac{1}{\gamma_{mo}} \times \left(2b\, t_f \right) = \frac{250}{\sqrt{3}} \times \frac{1}{1.1} \times 2 \times 90 \times 86$$

$$= 203.122 \times 10^3 \text{ N} > F_y$$

Hence adequate.

Design capacity of the section:

Section classification:

$$\frac{b}{t_f} = \frac{90}{8.6} = 10.47 > 9.4 \text{ but} < 10.5$$

$$\frac{d}{t_w} = \frac{140.2}{5.5} = 25.49 < 84$$

Hence it belongs to compact (category 2) section.

$$M_{dz} = \beta_b \frac{Z_p\, f_y}{\gamma_{mo}} = \frac{1.0 \times 161.1 \times 10^3 \times 250}{1.1} = 36.614 \times 10^6 \text{ N-mm}$$

$$= 36.614 \text{ kN-m.}$$

Now, $$\frac{1.2 Z_e\, f_y}{\gamma_{mo}} = 1.2 \times \frac{145.3 \times 10^3 \times 250}{1.1} = 39.627 \times 10^6 \text{ N-mm}$$

$$\therefore \quad M_{dz} = 36.614 \text{ kN-m}$$

$$M_{dy} = Z_{py} \frac{f_y}{\gamma_{mo}}$$

Z_{py} = that due to flanges only.

$$= b\, t_f \frac{b}{2} = t_f \frac{b^2}{2} = 8.6 \times \frac{90^2}{2}$$

$$= 34830 \text{ mm}^3.$$

$$\therefore \quad M_{dy} = 34830 \times \frac{250}{1.1} = 7.916 \times 10^6 \text{ N-mm}$$

$$= 7.916 \text{ kN-m.}$$

$$\therefore \quad \frac{M_z}{M_{dz}} + \frac{M_y}{M_{dy}} = \frac{9.928}{36.614} + \frac{5.731}{7.916}$$

$$= 0.995 < 1.0$$

Hence adequate.