

*Background: This new guideline explains the process for obtaining prior approval to use temporary wire rope guardrails, from a WorkSafeBC prevention officer when certain criteria are met, and from the Regulatory Practices department in all other cases. The guideline also sets out the engineering specifications to be considered in the design, installation, and use of a wire rope guardrail.*

### **G4.58(4)(b) Prior approval for wire rope guardrails**

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#### **Regulatory excerpt**

Section 4.58(4) of the *OHS Regulation* (“*Regulation*”) states:

Guardrails temporarily installed during the construction, demolition or renovation of a work area must

- (a) be able to withstand a load of 550 N (125 lbs) applied perpendicular to the span in a horizontal or vertically downward direction at any point on the top rail, or be built to the criteria of subsection (5), and
- (b) not be made of fibre or wire rope without the prior approval of the Board.

Section 4.54 of the *Regulation* provides the following definitions:

“guard” means a protective barrier around an opening in a floor or along the open sides of stairs or a ramp, landing, balcony, mezzanine, raised walkway or any other area to prevent a fall to a lower level, or inadvertent entry into a dangerous area;

“guardrail” means a guard consisting of a top rail 102 cm to 112 cm (40 in to 44 in) above the work surface, and an intermediate rail located approximately midway between the underside of the top rail and the top of the toeboard, if one is provided, or the work surface if no toeboard is provided.

#### **Purpose of guideline**

The purpose of this guideline is to explain the process for obtaining prior approval from WorkSafeBC for the use of temporary wire rope guardrails, and to set out the engineering specifications to be considered in the design, installation, and use of a wire rope guardrail.

#### **Background**

Section 4.58(4)(b) of the *Regulation* requires that approval be obtained from WorkSafeBC before guardrails made of fibre or wire rope are temporarily installed during the construction, demolition, or renovation of a work area. In cases where the wire rope system meets the set of criteria discussed in the first section of this guideline, a WorkSafeBC prevention officer may consider the employer’s request for prior approval and make a decision. Where those criteria are not met, the employer will need to submit an acceptance request in writing to the Regulatory Practices department of WorkSafeBC. The information required by Regulatory Practices to make a decision is listed in the second section below. The final section of this guideline sets out the engineering specifications to be considered in the design, installation, and use of a wire rope guardrail.

**Prior approval by a WorkSafeBC prevention officer**

A prevention officer may make a decision on behalf of WorkSafeBC under section 4.58(4)(b) of the *Regulation* if all of the following criteria are met:

- The wire rope to be used has a diameter of at least 3/8 in.
- The proper tensioning equipment will be used
- The wire ropes are maintained at such a tension that
  - When subjected to a load of 550 N (125 lb.) applied vertically downward at mid-span, the top rope remains between 102 and 112 cm (40-44 in.) above the work platform
  - The rope at mid-rail height equally divides the gap between the top rope and the work platform (or toe-board, if applicable)
  - A load of 550 N (125 lb.) applied horizontally at any point along either the top or mid-height rope does not deflect any part of the guardrail beyond the edge of the work platform
- The span between posts does not exceed 12 ft. (if the span between posts is between 8 and 12 ft., the prevention officer should consult with the Engineering department of WorkSafeBC before making a decision)
- Where lack of visibility could create a hazard, high-visibility coloured markers or flagging is installed on the top rope at intervals not exceeding 2 m (6.5 ft.)

If one or more of these conditions are not met, the employer will need to submit an acceptance request in writing to the Regulatory Practices department of WorkSafeBC, as discussed in the next section of this guideline.

The prevention officer may contact the Engineering or Regulatory Practices departments for advice, as needed. The prevention officer will record the decision made, including the terms of the decision and time period for which it is issued, in the text of an inspection report for the firm. The prevention officer will provide a copy of the decision to the employer, who is required to post it at the worksite as required by the *Regulation*. Once the decision is made, the prevention officer will forward a copy of the employer's request and the decision to Regulatory Practices.

**Making a submission to Regulatory Practices**

Where the temporary wire rope guardrail system does not meet all of the criteria listed above, the employer will need to submit an acceptance request in writing to the Regulatory Practices department of WorkSafeBC.

A complete submission package will include the following information:

- The name of and contact information for the employer
- The address and location of the worksite where the system is to be used
- A description of the work to be performed
- A sketch or drawing showing the arrangement of the guardrail system
- A plan showing the position of posts, their distance from the edges of the work platform, and the elevation of the work platform
- The specifications of the wire rope that will be used
- The tension required in the wire rope and the means to achieve it
- The means for testing rope tension during inspections of the system
- The specifications of the debris net, if one will be used

- A fall protection plan, if the work platform is elevated more than 10 ft. above ground
- Photographs of the work platform and the posts, if available

### **Engineering considerations**

Some of the typical engineering factors to be considered in the design, installation, and use of a wire rope guardrail system are

- The configuration of the guardrail system
- The specified loads to be used for design calculations
- The spans between posts
- The tension required in the wire ropes to ensure that the deflection and height of the guardrail remain within the specified limits
- The design of posts and connections to resist the specified requirements for lateral loading and deflection
- Consideration for posts at corners, and where wire rope terminations occur

These factors are discussed below.

#### Configuration of a temporary wire rope guardrail system

An acceptable wire rope guardrail system will contain a minimum of two ropes, with the rope at mid-rail height equally dividing the gap between the top rope and the work platform (or toe-board, if applicable). The typical wire rope size is 10 mm (3/8 in.) in diameter. Sufficient tension will need to be maintained so that, when subjected to a load of 550 N (125 lb.) applied vertically downward at mid-span, the top rope remains between 102 and 112 cm (40 to 44 in.) above the work platform along the entire span. In addition, when a load of 550 N (125 lb.) is applied horizontally at any point along either the top or mid-height rope, no part of the guardrail will deflect beyond the edge of the work surface. It should be noted that when a load is applied on the guardrail, the post may also deflect and will have to be considered as contributing to the total deflection.

A rope guardrail system provides protection against falling by “fall restraint” in that it prevents a person from travelling beyond the edge of the work surface the person is standing on. A rope guardrail system is not a horizontal lifeline and may not be used for such purposes. OHS guideline G11.7 addresses the design and installation of temporary horizontal lifelines.

#### Specified loads to be used for design calculations

Under section 4.58(4)(a) of the *Regulation*, temporary guardrails used during the construction, demolition, or renovation of a work area are required to be able to withstand a load of 550 N (125 lb.) applied horizontally or vertically. This refers to a *specified* load. Load factors need to be applied to the specified load, in accordance with the Limit States Design (“LSD”) method used in structural engineering, in order to obtain the factored *design* load. Following the LSD method, the specified load of 550 N (125 lbs) would result in a factored design load of approximately 900 N (200 lbs.).

Section 4.1.3 of the *National Building Code of Canada 2005* (“NBCC 2005”) and of the *British Columbia Building Code 2006* provides an outline of the LSD method and definitions of the various applicable factors. The NBCC 2005 sets forth the fundamental safety criteria that need to be met in LSD:

$$\text{Factored Resistance} \geq \text{Effect of Factored Loads}$$
$$\phi R \geq \alpha (\text{Specified Loads})$$

The resistance factor ( $\phi$ ) is applied to a specified material property or to the resistance of a member, connection, or structure to recognize the limit state under consideration, due to the variability of dimensions and material properties, workmanship, type of failure, and uncertainty in the prediction of resistance. The load factor ( $\alpha$ ) is applied to the specified loads to recognize that loads higher than those anticipated may occur. It also takes into account the approximations used in the analysis of the effects these loads have on the structure.

#### Design calculations for posts and rails

Structural design calculations are considered separately for posts and wire rope rails. The load applied to a length of wire rope guardrail is considered as either (i) a concentrated load applied to the top rope at any point in any direction, or (ii) a linear uniformly distributed load applied to the top rope either laterally or vertically downward. These two types of loads are not specified to act concurrently. For many applications, uniform loading conditions for temporary wire rope guardrails are minimal.

#### *Posts:*

Lateral loads that are applied to the top rope of a guardrail system produce the maximum bending moment on the posts. The post acts as a vertical cantilevered member in resisting the lateral load applied to the rope rails or posts. A concentrated load applied laterally to the rope is distributed to the adjacent posts. An end post also needs to resist loads imposed at wire rope terminations.

#### *Wire rope rails:*

A concentrated load applied to the top rope at any point and in any direction creates the maximum tension and deflection in the rope when applied at mid-span. The number of spans in a rope rail system between terminations of wire rope depends on how terminations are configured. In a tensioned wire rope guardrail, WorkSafeBC considers a deflection of 100 mm (4 in.) to be the maximum allowable.

A complete design for a wire rope guardrail system will include the design of connections to the existing structure to ensure that loads are effectively transferred to adequate points of anchorage. For posts at corners, and where wire rope terminations occur, sufficient bracings will also need to be included.