Verification following ONR 24810

If you have selected to follow the ONR 24810 [1] design guidelines in the previous step, the recommended values to input for the parameters are listed below.

Consequence Classes

The spirit of ONR 24810 depends on consequence classes as detailed in Eurocode [2]. The consequence classes are summarized in Table 1 below:

Consequence Classes (CC)	Characteristics	Examples
CC 1	**Low** impact on human lives or modest economic consequences	Agricultural buildings, barns, storage
CC 2	**Medium** impact on human lives or considerable economic consequences	Residential or office buildings
CC 3	**High** impact on human lives or significant economic consequences	Public buildings, schools, hospitals

Table 1: Consequence Classes Classification

Partial Safety Factors

The partial safety factors depend on the consequence classes (Table 2). The values will be automatically filled in once you select the consequence class.

Partial safety factors	**CC1**	**CC2**	**CC3**
Impact Energy Factor ($\gamma_{E,kin}$)	1.00	1.05	1.15
Resistance Energy Factor ($\gamma_{T,R}$)	1.00	1.05	1.15
Bounce Height Factor (α_1)	1.05	1.10	1.30
Barrier Height Factor (α_2)	1.00	1.05	1.10
Elongation Factor (α_4)	1.2		

Table 2: Partial Safety Factors

Design Block Selection

The design block size (V_{BB}) depends on the consequence class and the risk potential (frequency class). There are 2 methods: the simplified approach and the standard approach.

The simplified approach is allowed if one of the following conditions is met:

a. Less than 100 rocks in the fall deposit zone
b. Less than 100 rocks in the fall start zone
c. Consequence Class 1 (CC1)
d. Event frequency is less than 1 per year (n < 1)

If you meet one of the above criteria, the user can determine the block size based on his/her experience and site investigation data. Otherwise, use the table below (Table 3) to determine the design block size.

Event Frequency Classes	Event Frequency	Fractile for Design Block
EF 4 (very high)	>= 10 events per year (n>=10)	V_{98}
EF 3 (high)	1 ~ 10 events per year (1 <= n < 10)	V_{97}
EF 2 (low)	1 event per year ~ 1 per 30 year (0.03 <= n < 1)	V_{96}
EF1 (rare)	1 event per 30 years (n < 0.03)	V_{95}

Table 3: Design Block Sizes based on the Event Frequency Classes

In RocFall, the user only needs to enter the design block fractile and a filter will be performed on the rocks generated based on the statistical definition(s) in the "Rock Type Library" dialog.

Design Parameters

The Design Coefficients described above combine to give the Design Parameters for the Barrier Report. The Design Parameters are defined below.

Design Parameters	**Equations**	**Additional Definitions**
Design Impact Energy ($T_{E,d}$)	$T_{E,k} \times \gamma_{E,kin}$	$T_{E,k}$ – 99% impact kinetic energy = 1/2 m x v^2
Resistance Energy ($T_{R,d}$)	$T_{k,MEL} / \gamma_{T,R}$	$T_{k,MEL}$ – rated maximum energy resistance capacity (MEL)
Design Height ($h_{E,d}$)	$h_{E,k} \times \alpha_1$	$h_{E,k}$ – 95% bounce height + 1/2 maximum rock dimension from V_{BB}
Resistance Height ($h_{R,d}$)	$h_{R,k} / \alpha_2$	$h_{R,k}$ = nominal height of the barrier

Verification Equations

Verification Type	Equation	Additional Definitions
Energy	$T_{E,d} <= T_{R,d}$	
Height	$h_{E,d} <= h_{R,d}$	
Elongation	$D_R >= D_E$	D_R -minimum distance between barrier and protected zone D_E – the bigger of the maximum elongation at rated MEL x α_4 or the maximum elongation at rated MEL + 1m

The user is responsible for performing the foundation verifications and designs.

References

[1] Austrian Standards Institute (2013) "ONR 24810: Technical protection against rockfall – Terms and definitions, effects of actions, design, monitoring and maintenance." Austrian Standards Institute, Vienna Austria (in German), www.a-plus.at

[2] CEN. EN 1990:2003, Eurocode – Basis of structural design. Annex B.1, 2005

[3] Stelzer, G., Bichler, A., (2013) "ONR 24810 – A Comprehensive Guideline for Building Better Rockfall Protection Structures" 64th Highway Geology Symposium, 2013