



# Change log for the handbook “Using the Q-system”, revision 2025

Topic	Chapter	Comment
<b>Chapter 1</b>		
Prerequisites for using the Q-system	1.3	New subchapter on prerequisites for using the Q-system
Limitations	1.4	Updated, more detailed information on the limitations of the Q-system
<b>Chapter 2</b>		
(Chapters 2 and 3 in the old version have been merged into one chapter – The Q-system and classification of rock masses)		
Q' (Q <sub>base</sub> )	2.4	New subchapter
<b>Chapter 3</b>		
Calculation of the Q-value	3.1	Added: <ul style="list-style-type: none"> <li>- Recommendation to use table values for each parameter in the calculation of the Q-value.</li> <li>- Recommendation on the use of Q<sub>min</sub> and Q<sub>max</sub>.</li> </ul> With reference to Chapter 5.2 for the mapping of sections and weakness zones.
Rock Quality Designation (RQD)	3.2	New subchapter: 3.2.3 RQD in soft rocks and weakness zones – with reference to chapter 5.2.3.
Joint set number (J <sub>n</sub> )	3.3	New subchapter: 3.3.2 J <sub>n</sub> in weakness zones – with reference to chapter 5.2.3.
Joint roughness number (J <sub>r</sub> )	3.4	Stated terminology for description of J <sub>r</sub> with the terms surface waviness and surface roughness. Added: <ul style="list-style-type: none"> <li>- Parameter values for J<sub>r</sub> in Figure 3-2 with fracture surface profiles</li> <li>- Added parameter values for stepped surface roughness (J<sub>r</sub> = 4)</li> </ul> New subchapter: 3.4.4 J <sub>r</sub> in weakness zones – with reference to chapter 5.2.3.
Joint alteration number (J <sub>a</sub> )	3.5	Added: <ul style="list-style-type: none"> <li>- Stated in text for Table 3-4 that the correlation to the residual friction angle <math>\phi_r</math> is empirical.</li> <li>- Highlighted that the equation <math>\tan^{-1}(J_r/J_a)</math> provides a <u>rough</u> estimate of the effective friction angle.</li> <li>- Highlighted that the maximum friction angle (equation) and the residual friction angle (given in Table 3-4) are not necessarily comparable.</li> <li>- Recommendation to perform laboratory tests for accurate determination of the friction angle.</li> </ul> New subchapter: 3.5.3 J <sub>a</sub> in weakness zones – with reference to chapter 5.2.3.
Stress Reduction Factor (SRF)	3.7	Changed or removed: <ul style="list-style-type: none"> <li>- Changed from four SRF categories (a-d) to five (a-e) → the previous category b) has been split into two: “b) Competent rock with low or favourable stress conditions, mainly massive rock”, and “c) Competent, mainly massive rock, stress-related problems.”</li> </ul>

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		<ul style="list-style-type: none"> <li>- The relationship between <math>\sigma_c/\sigma_1</math> or <math>\sigma_\theta/\sigma_c</math> has been removed from the main table for SRF (Table 3-6). The relationship between <math>\sigma_c/\sigma_1</math> or <math>\sigma_\theta/\sigma_c</math> for SRF category c) is kept in a separate table in subsection 3.7.3, where it is specified that the relationship should not be applied uncritically. A reference to the article presenting the relationship (Grimstad &amp; Barton, 1993) is provided.</li> </ul> <p>The relationship between <math>\sigma_c/\sigma_1</math> or <math>\sigma_\theta/\sigma_c</math> has been removed for squeezing rock due to insufficient data.</p>
Other		Removed chapter “Q-parameters related to pre-grouting”
<b>Chapter 4</b>		
Span width and Excavation Support Ratio (ESR)	4.1	New subchapter: 4.1.1 Life span considerations in the Q-system
Rock support chart	4.2	<p>Changed/added:</p> <ul style="list-style-type: none"> <li>- Qualitative terms for rock mass class A have been merged into "very good."</li> <li>- Names for RRS-categories have been changed from RRS I, II, and III to A, B, and C (to avoid misunderstandings regarding the number of reinforcement layers).</li> <li>- E500 has been removed and replaced with E700 in support class 4.</li> <li>- E1000 is recommended starting from support class 6.</li> <li>- Recommendation to conduct supplementary engineering geological and rock mechanical assessments for support categories 7-9.</li> </ul> <p>4.2.2 – Wall support: The lower limit for the elevated Q-value for wall support has been adjusted from <math>Q=0.1</math> to <math>Q=1</math>, and a row has been added in Table 4-2 stating that if wall height &gt; span width, the actual Q-value should be used.</p>
Reinforced ribs of sprayed concrete	4.3	<p>Added:</p> <ul style="list-style-type: none"> <li>- Recommendation to consider additional anchoring of RRS and possible need of invert cast concrete in cases of poor rock mass quality.</li> <li>- New subchapter: 4.3.1 Comparison of RRS and lattice girders</li> </ul> <p>New subchapter: 4.3.2 Quality control and improvement of RRS and lattice girders</p>
Forepoling/spiling	4.4	Removed the recommendation on the Q-interval for when forepoling/spiling should be considered. Specified under which rock mass conditions forepoling/spiling should be evaluated.
Energy absorption of sprayed concrete	4.5	Removed the recommendation on use of E500.
Additional comments on stability and rock support	4.6	Added new figures (Figure 4-4 e) and f)) with accompanying text recommending tailored placement of rock bolts and systematic bolting for specified rock mass conditions.

Topic	Chapter	Comment
Recommendations for challenging rock mass conditions	4.7	New subchapter. Describe assessments and the considerations that should be made when using the Q-system in challenging rock mass conditions.
<b>Chapter 5</b>		
Engineering geological mapping	5.2	<p>Added:</p> <ul style="list-style-type: none"> <li>- New figures with examples of 2D and 3D geological mapping (from the software Bever Mapping).</li> <li>- New subchapter: 5.2.1 Use of digital mapping tools for engineering geological mapping.</li> <li>- New subchapter: 5.2.2 Mapping of sections. This subsection provides guidance on how to apply the Q-system in cases with significant variations in Q-parameters and Q-values.</li> <li>- New subchapter: 5.2.3 Mapping of weakness zones. This subsection provides guidance on how to apply the Q-system in both narrow and wide weakness zones.</li> </ul> <p>New subchapter: 5.2.4 HSE during mapping. This subsection briefly addresses health, safety, and environment (HSE) considerations during mapping with the use of the Q-system.</p>
<b>References</b>		
<p>Added the following references:</p> <ul style="list-style-type: none"> <li>- Alejano, L.R., Muralha, J., Ulusay, R. et al. (2018): ISRM Suggested Method for Determining the Basic Friction Angle of Planar Rock Surfaces by Means of Tilt Tests. <ul style="list-style-type: none"> <li>o ISRM standard for conducting tilt tests to determine the basic friction angle.</li> </ul> </li> <li>- Muralha, J., Grasselli, G., Tatone, B., Blumel, M., Chryssanthakis, P., Jiang, Y. (2014). ISRM Suggested Method for Laboratory Determination of the Shear Strength of Rock Joints: Revised Version. Rock Mechanics and Rock Engineering. 47. 291-302. <ul style="list-style-type: none"> <li>o ISRM-standard for conducting shear box tests to determine the shear strength of joints.</li> </ul> </li> <li>- Holmøy, K.H., Aagaard, B. (2002): Spiling bolts and reinforced ribs of sprayed concrete replace concrete lining. Tunnelling and Underground Space Technology 17(4): 403-413. <ul style="list-style-type: none"> <li>o Reference in Figure 4-3.</li> </ul> </li> <li>- Terron-Almenara, J., Skretting, E., Holter, K., Høien, A. (2024). Design of Rock Support in Hard and Layered Rock Masses Using a Hybrid Method: A Study Based on the Construction of the New Skarvberg Tunnel, Rock Mech Rock Eng 57:10491–10532. <ul style="list-style-type: none"> <li>o Reference to the hybrid method for rock mass characterization in Chapter 4.7.</li> </ul> </li> </ul>		