



Addendum to the “Adaptation of the Swiss Guidelines for Supporting Structures for Icelandic Conditions” (IMO, Rep. G99013)

Tómas Jóhannesson

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Since the publication of the report “Adaptation of the Swiss Guidelines for Supporting Structures for Icelandic Conditions” (Tómas Jóhannesson and Stefan Margreth, 1999, IMO, Rep. G99013, hereafter referred to as the “Adaptation for Icelandic condition”), the Icelandic Meteorological Office has received some questions regarding the interpretation of several technical issues in this report and in the “Swiss Guidelines”. This memo answers these questions and gives some relevant background to the answers.

Corrosion protection of steel ground plates The “Adaptation for Icelandic conditions” (and the “Swiss Guidelines”) specifies that anchors and other subsurface steel parts (other than wire ropes) shall be produced with an additional steel thickness of 2 mm on each side in order to compensate for corrosion as specified in Section 42.3 on p. 45 of the Swiss Guidelines. *This requirement does not apply to steel ground plates* although they should be dug down by at least 0.5 m in loose material according to the Swiss Guidelines. Steel ground plates should be hot dip galvanised according to the requirements specified for steel parts above ground in section 2.4 of the “Adaptation to Icelandic conditions”. The corrosion protection of steel ground plates that are dug down in loose material will thereby be somewhat poorer than for other subsurface steel parts, such as anchors, where the requirement of 2 mm additional steel thickness applies. The background for this decision is that ground plates can be replaced comparatively easily in case corrosion is found to have weakened them considerably. Bending or failure of the ground plates does also not threaten the stability of the supporting structures to the same degree as failure of other parts of the foundations of the structures. Therefore, it is not judged necessary to apply the same strict requirements to the corrosion resistance of ground plates as for the more critical subsurface parts of the foundations.

Design of steel ground plates Generally, a safety factor of 1.6 is used in the design of supporting structures according to the “Swiss Guidelines”, but a factor of 2 is used for all critical subsurface components, such as anchors, where poorly known ground properties



are important. This might be interpreted to apply to the internal design of ground plates as well as to the load from the ground plate on the ground surface, although this is not clear from the text of the “Swiss Guidelines”. A small displacement of the ground below a ground plate does usually not threaten the stability of the construction to the same extent as a failure of an anchor. Also, a small displacement or a failure of the ground below a ground plate does not lead to accelerating movement in the same way as if an anchor starts to move. Furthermore, the ground may be assumed to be frozen or partly frozen in most cases when the maximum load is applied. Based on these considerations, *no safety factor is required for the load of a ground plate on the ground* when the area of the plate is determined (that is a safety factor of 1 is used). *The internal strength of a ground plate shall be based on a safety factor of 1.6* as for other steel parts above ground in the construction. As a reference value for loose materials, an admissible pressure of 500 kN/m^2 perpendicular to the slope may be used for determination of the plate size, but the bearing capacity of the surface material needs to be checked in each case in order to see whether this value is appropriate. Under unfavorable conditions a lower strength of the loose materials may have to be adopted.

Distance between rows The “Adaptation for Icelandic conditions” (Section 2.1) specifies that a gliding factor $N = 2.5$ should be used in the design of supporting structures for Icelandic conditions in order to take the high density of snow in Iceland into account. The gliding factor also affects the recommended down slope distance between rows of structures according to the “Swiss Guidelines” (see Section 22, in particular Fig. 22). In Iceland, this distance should be determined according to Fig. 22 in the “Swiss Guidelines” using the gliding factor $N = 1.2$ and $\text{tg}\phi = 0.55$.

Special strengthening of line ends Requirements in the “Swiss Guidelines” regarding a special strength of the ends of supporting structures (Section 48) specify different requirements for different distances between neighboring line ends. The maximum strength is only required for lines that terminate on open slopes. No additional strength is required for snow bridges for openings that are smaller than 2 m. Such openings are for example used to adapt the supporting structures to local landscape features. The required strengthening for the ends of snow nets in such openings is much smaller than for ends that terminate on open slopes.

The second case of loading for snow nets In Section 55 on p. 57 in the “Swiss Guidelines” it is stated that the pressure corresponding to second case of loading (“zweiten Belastungsfall”)¹ should be applied on the whole height of the nets. This requirement only applies to the strength of wire ropes in the mesh of the nets and to the perimeter wire ropes, but not to the overall loading of the structures that determines the strength of anchors and posts.

“Maschengitter” in snow nets In Section 55 on p. 57 in the “Swiss Guidelines” there are some

¹This loading corresponds to the higher one of the two adopted values of the snow density which is assumed to be appropriate for late winter or spring conditions.



requirements about the mesh of snow nets. These requirements are somewhat ambiguous and they do not seem to be fully satisfied by currently produced nets by the main producers of snow nets. There are indications from recently installed snow nets in Drangagil in Neskaupstaður that 100% coverage with a 5x5 mm “maschengitter” may lead to problems with accumulation of drift snow. At the same time, eliminating the “maschengitter” altogether, might reduce the capacity of the nets to prevent the release of loose snow avalanches for fresh, cold and dry snow conditions. The following requirements have been adopted for “maschengitter” for snow nets in Iceland.

1. “Maschengitter” is not required when the openings of the main mesh are smaller than 100 cm².
2. Main mesh with openings in the range 100–300 cm² or larger than 625 cm² is not recommended.
3. “Maschengitter” with mesh size 5x5 cm is required when the main mesh has openings in the range 300–625 cm². It should cover 50% of the area of the upper half of the nets, but there should be no “maschengitter” in the lower half of the nets.

Lubrication of wire ropes as a corrosion protection Section 2.6 in the “Adaptation for Icelandic conditions” specifies that wire ropes in snow nets shall be lubricated with a lubricant designed to impede corrosion. It has turned out to be difficult for manufacturers to obtain lubricated wire ropes and there is not agreement between professionals regarding the improvement in the corrosion resistance provided by lubrication. For these reasons it is no longer required that all wire ropes in snow nets in Iceland be lubricated. Manufacturers of snow nets for Iceland are encouraged to use the best available technical measures to increasing the corrosion resistance of their wire ropes as experience has shown that corrosion is one of the most important determining factors for the life time of snow nets under Icelandic conditions. Manufacturers are required to document the corrosion protection of their wire ropes and rope anchors in detail.

Minimum steel thickness in beams of steel bridges Section 36 on p. 42 in the “Swiss Guidelines” specifies a minimum thickness of 5 mm for the steel in the structures. This requirement arises both from considerations that have to do with corrosion of ungalvanised steel and also in order to maintain sufficient strength against impact loading due to rock fall. When the structures are galvanised, as required in Iceland, this minimum beam thickness is not necessary as a corrosion protection. If thinner beams than 5 mm are used, the required strength against *impact loads* must nevertheless be maintained (point impact of 3.5 kNm from any direction from above the structures according to Section 36 of the “Swiss Guidelines”). The beams must in this case also be able to support the *transverse loading* specified by Section 53 on p. 55 in the “Swiss Guidelines” (see Figure 53.3 of this Section). It should, furthermore, be noted that the torsion from the transverse load must be considered in the design of the cross beam (see item 7 on p. 55 in Section 53). This torsion becomes higher for a higher profile of the beam.



Grouting method The “Adaptation for Icelandic conditions” does not specify detailed requirements for grouting materials or grouting methods, although there are some requirements that are related to these issues. As a general rule, grouting of anchors shall be performed from below by pumping the grouting material through a hose or through the anchor itself to the bottom of the drill hole so that the grout fills the hole from the bottom and up.