

A nature-based solution: the Icelandic-type berm breakwater

Majid Eskafi¹, Sigurdur Sigurdarson², Kjartan Eliasson³ and Fannar Gislason³

¹ Faculty of Civil and Environmental Engineering, University of Iceland, Hjarðarhagi 2-6, 107 Reykjavik, Iceland

E-mail: mae47@hi.is

² Coastal Division, The Icelandic Road and Coastal Administration, Sudurhraun 3, 210 Gardabaer, Iceland

E-mail: sigurdur.sigurdarson@vegagerdin.is

³ Harbor Division, The Icelandic Road and Coastal Administration, Sudurhraun 3, 210 Gardabaer, Iceland

E-mail: kjartan.eliasson@vegagerdin.is, fannar.gislason@vegagerdin.is

1. INTRODUCTION

There is growing interest to use environmentally friendly structures to protect coasts and ports. Nature-Based Solutions (NBS) are used as soft solutions in coastal and port protection projects. Furthermore, hard solutions such as breakwater are commonly practiced. The Icelandic-Type Berm Breakwater (IceBB) constitutes nearly half of the constructed berm breakwaters in the world. This structure is designed and developed for a wide range of wave climates, water depths, and tidal conditions. In this research, the International Union for Conservation of Nature (IUCN) standard is used to assess the characteristics of the IceBB to identify whether this structure can be considered as a NBS.

2. ICELANDIC-TYPE BERM BREAKWATER (IceBB)

The IceBB is designed to be statically stable with only limited stone movement and structural reshaping. To increase the performance of the structure throughout its design life, the void volume of the berm has 35-40% porosity. Furthermore, its narrowly graded armor classes have a higher porosity than wider graded armor classes (i.e., conventional breakwater). This leads to a structure with 1- higher permeability and wave energy absorption, 2- more stability, 3- lower wave penetration into the harbors, and the wave overtopping, and 4- lower wave reflection from the trunk and head of structure (Van der Meer and Sigurdarson 2016). These advantages are highly demanded by ports with narrow entrances that cause high breaking waves and refraction, or coasts that should withstand severe wave conditions and high storm frequency. The preliminary design of the IceBB is based on initial size distribution estimates from potential quarries. The final design is tailored to fit the selected quarry, the design wave load, available construction equipment, transport routes, and required functions. Figure 1 shows the location of some of the IceBB in Iceland for coastal and port protection.

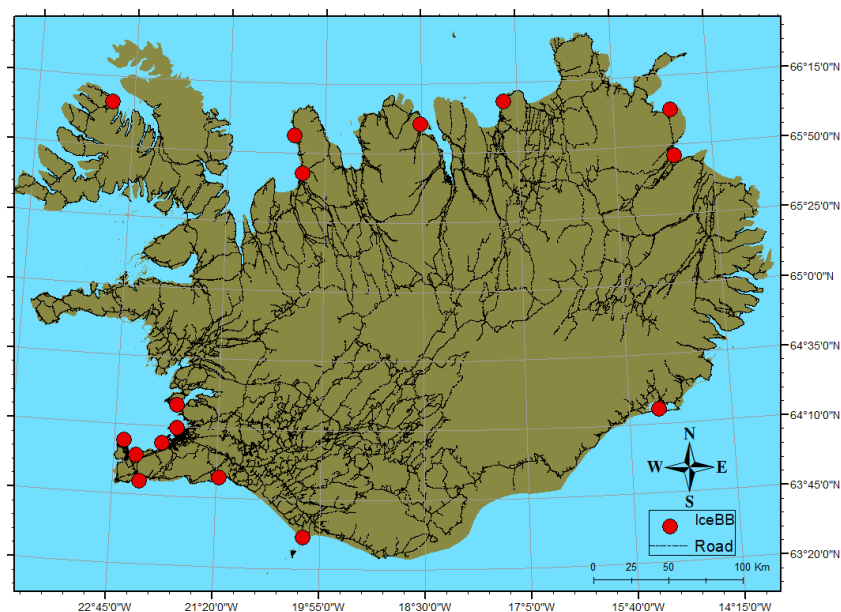


Figure 1: Location of the IceBB for coastal and port protection in Iceland

3. INTERNATIONAL UNION FOR CONSERVATION OF NATURE (IUCN)

NBSs aim to address societal challenges effectively and adaptively (e.g., coastal and port protection) and sustainably add benefits to the ecosystems. IUCN has introduced the global standard (i.e., criteria, indicators) on NBS to ensure the credibility of its implementation. Using this standard, implementation of a NBS can be measured, monitored, and adapted for similar cases (IUCN 2020). The IUCN criteria are 1- NBS effectively address societal challenges, 2- Design of NBS is informed by scale, 3- NBS results in a net gain to biodiversity and ecosystem integrity, 4- NBS are economically viable. 5- NBS is based on inclusive, transparent, and empowering governance processes, 6- NBS equitably balance trade-offs between the achievement of their primary goal(s) and the continued provision of multiple benefits, 7- NBS are managed adaptively, based on evidence, 8- NBS are sustainable and mainstreamed within an appropriate jurisdictional context.

4. DISCUSSION

The IceBB has been constructed by authorities in many countries to protect and develop coasts and ports (criteria #1). The technical quality of the IceBB to protect the ports and coasts has been well documented in the literature which determines its success (criteria #2) (van der Meer and Sigurdarson 2016). The IceBB design and implementation are based on matching the quarry yields which helps to utilize all size grades from the predicted quarry. Thus, its construction limits disturbances in the quarry (criteria #3). The IceBB requires about 25% less volume of rock than the dynamic berm breakwater. Furthermore, its construction cost ranges between 67-86% of the cost for the conventional rubble mound breakwater (criteria #4) (Sigurdarson *et al.* 1998). The design process of the IceBB is through close cooperation with stakeholders including designers, geologists, supervisors, contractors, and local governments (criteria #5). Coastal and port protection provides social and environmental benefits and ensures continued provision of other ecosystem services, such as food supply for sea-dependent coastal communities (criteria #6). The design of the IceBB is relatively easy to be adapted based on the size of rock available from quarry yield (criteria #7). The adaptive development of the IceBB and its durability increases the lifecycle of the structure and its long-term sustainability (criteria #8) (van der Meer and Sigurdarson 2016).

Although IUCN (2020) does not state to what extent the criteria should be fulfilled by a solution (i.e., the IceBB in this research), as discussed, the IceBB can meet the criteria of IUCN for NBS. Therefore, this structure might be considered as a viable NBS for coastal and port protection.

5. ACKNOWLEDGEMENTS

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