The new Norwegian Breakwater Handbook
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Brief history and background

- Up to ca 1990: Breakwater construction was mainly carried out by the Norwegian Coastal Authority NCA (or its predecessors), using in-house crews and equipment. This organization handled every step of the process, from initial planning and design to construction.

- NCA builds, owns and operates fishery harbors

- Gradually from early 90’ies: External (national) contractors and consultants enter and gradually design and build more breakwaters

- **1994: First version of a National Breakwater Handbook** (written by SINTEF) – a text file with references to calculation tools – primarily for use within NCA, but distributed to any interested party

- From ca 2000: increasing participation from EU contractors – large contracts won by Danish and Icelandic companies

- 2005: All construction activities within NCA is concentrated in a commercial company SECORA

- 2020: NCA will give up all responsibility for port construction; ownership and responsibility to be transferred to the new administrative level «Fylkeskommunen» (= county)
The need for a breakwater handbook

First version 1994:
- To enable NCA staff to plan and design smaller units with standard tools, and give guidelines for requirements to designers in large projects
- To provide external designers and contractors with the requirements and standards demanded by NCA
- To collect and preserve experience and knowledge collected over generations of breakwater construction

2019 version:
- Updating the by now 25 year old version
- Include more items relating to modern planning procedures, environmental issues, legal aspects and new design ideas
- Provide a reference for national and international contractors who compete for contracts in Norway
- Provide a tool for the new owners and operators of the breakwaters (2020). These organisations have no previous experience with breakwaters and will receive no staff from NCA
Breakwater construction in Norway

- Approximately 800 ports for fishery purposes have been built in Norway, and they generally involve the construction of one or more breakwaters.
- Ample access to good rock – concrete units are not used.
- Steep underwater slopes close to shore – large benefits from building on steep slopes.
- Protected sites $H_s = 1.0 – 3.0$ m.
- Exposed sites $H_s = 4.0 – 8.0$ m.
Defining Breakwaters

Breakwaters, new and expansion of existing breakwaters. Port of Gryllefjord
Defining Breakwaters
Defining Breakwaters
Defining Breakwaters

... roads and railways filled into water/ocean
Defining Breakwaters

Upgrading program til increase the safety zones around Norwegian small airports

... expansion of airports – extension into the ocean.
Plenty of litterature available – why do we need this?
Organisation and participants

NCA Steering group:
• Eivind Edvardsen (Kystverket/WSP Norge)
• Rita Svendsbøe
• Per Helge Thom
• Martin Fransson
• Jan Arild Jenssen

External group of contributors:
• Arne Erling Lothe, Norconsult
• Raed Lubbad, NTNU
• Øivind Arntsen, NTNU
• Gonzalo Diz Palomares, Dr techn Olav Olsen
• Flemming Sclütter, DHI, Danmark
• Arne Nestegård, DNV GL
• Elin Kramvik, Multiconsult
• Erlend Berg Kristiansen, Multiconsult
• Dag Andreassen, State Highways Department
• Rune Laberg Olsen, Secora
• Per Midjord, Aarsleff, Danmark
• Camilla Spansvoll, NCA
• Ole Johan Aarnes, Norw. Met Office
Conclusion from debates in the external group

1. The Norwegian practice of building on steep slopes (1 : 1.3) is unfamiliar to international contractors (excepting Iceland)

2. The Norwegian practice of individually placing rocks («plastring») is not common outside the North-Western European region. This is a departure from the generally used term «loosely laid» and «rubble mound» breakwaters

3. The Norwegian design does not specify a number of layers of rocks in the armor layer. In stead, a total thickness of the armor layer and a weight range for the rocks are given. The number of rock layers is then excess information

4. A Norwegian design should never specify a rock diameter \( D_{n50} \) or equivalent. The equivalent diameter of a rock is open to discussion. The weight of a rock is an exact parameter and not open to debate.

5. Weight of armor units are given as \( W_{\text{min}} \), \( W_{50} \) and \( W_{5\%} \)

6. The only climate change parameter concidered is sea level rise
# Classification

<table>
<thead>
<tr>
<th>Classification</th>
<th>Requirements</th>
<th>Area of application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rubble</td>
<td>Dumped rock, remove overhang</td>
<td>( H_s : 0.0 - 0.5 \text{ m} ) ( T_p : 0 - 4.0 \text{ s} )</td>
</tr>
<tr>
<td>Smoothened rubble</td>
<td>Dumped rock and arrangement of surface, remove overhang</td>
<td>( H_s : 0.5 - 1.5 \text{ m} ) ( T_p : 0 - 6.0 \text{ s} )</td>
</tr>
<tr>
<td>Individually placed («plastring») - preferred in Norwegian breakwaters</td>
<td>Individually placed rock in interlocking pattern, to be laid form bottom up on designed filter layer</td>
<td>( H_s : &gt; 1.5 \text{ m} ) ( T_p : 0 - 20 \text{ s} )</td>
</tr>
<tr>
<td>Masonry</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Construction types

- Rubble mound
- Smoothed rubble
Construction types

- Individually placed – standard for exposed locations
Construction types

Principle of mutual support

Masonry
Status

1. The final issue of the Breakwater Handbook in Norwegian was issued on 01 December 2018. It is available in electronic form and can be downloaded from NCA at https://www.kystverket.no/

2. An English version is planned, and a preliminary issue has been made for students at the University of Trondheim. The English version needs more editing and work before it can be published.
Life is a circus, you come in and take a bow, do your tricks, bow again and leave.