

Document 7 - Sheringham Coast Protection Scheme

The challenge of protecting the coast at Sheringham

Facing due north, Sheringham has a well documented history of coming under fierce attack by storm surge seas. Northerly winds blowing across the sea all the way from the North Pole can generate severe storm waves, which must be resisted by the natural and man-made defences of the town. If these defences fail then considerable damage will be sustained.

The first line of defence is the natural sand beach and shingle bank to the rear. These are reinforced by the man-made defences comprising groynes, promenades and sea walls, which act as the last line of defence in extreme conditions.

In the late 1980's there was great concern about the integrity of the coastal defences at Sheringham. Waves and tides had gradually removed the once-healthy beach from this exposed stretch of the North Norfolk coast allowing storm waves to attack the man-made defences inflicting considerable damage.

The sea walls, groynes and promenades (first built during the last century) have fixed the alignment of the frontage at Sheringham. Consequently, whilst the cliffs to the east and west of Sheringham have continued to erode naturally, the promenades now jut out by up to 70m seaward of the natural coast line. The exposed position of the beaches and defences means they are subject to an ever-increasing wave attack.

Research has shown that most beaches in North Norfolk including Sheringham are eroding, getting shorter and steeper allowing deeper water inshore to attack the man made defences.

Natural processes gradually carry shingle away from the beaches at Sheringham eastwards towards Cromer. The rate of drift of shingle gradually increases towards the east. Just west of Sheringham the drift of material tends to be in the opposite direction towards Blakeney. So whilst at the western end of the frontage the beach has not suffered quite so badly, the beaches in front of the Central and East Promenades have been stripped of shingle.

Having been stripped of the shingle beach that has historically protected them, the sea walls were in need of urgent repair. Deterioration of the sea walls not only comprised the obvious cracking and decay of the concrete, but actual structural instability meant that the walls were in danger of collapse. The consequences of sea wall collapse and subsequent rapid erosion in the heart of Sheringham would be potentially disastrous (see Figure 1 for an example scenario).

When high waves combine with surge tides the frontage at Sheringham is pounded by waves that break over the sea walls. The storm in February 1993 damaged several seafront properties and reminded residents of the destructive power of North Sea storms. With relative sea levels predicted to rise in the future and with beaches continuing to shorten and steepen, this type of damage would occur more frequently if measures were not taken to alleviate the problem.

An action plan for recovery

Faced with the challenge of protecting the town of Sheringham, North Norfolk District Council embarked upon a prudent and timely project with the aim to provide proper and effective protection for the town for the next 60 years and beyond. In devising a coast protection scheme the following key issues had to be addressed:

- By using proven engineering methods the scheme must reliably resist erosion and reduce flooding damage.
- The scheme must represent good value for money and be affordable within the Council's capital works budget. It must also satisfy the stringent criteria set by the Ministry of Agriculture Fisheries and Food (now DEFRA) to be eligible for Grant Aid from Central Government.
- The scheme must be socially acceptable to the many users of the frontage.
- Disruption to the beaches and town during construction should be minimised.
- The scheme must be environmentally sound having no adverse effect on neighbouring coasts and beaches.

The Scheme - Coast Protection Scheme 902

Stage 1

The first stage was the repair and renovation of 900 metres of the existing sea walls and the placing of large rock armour stone in front of them to act as buttresses and to absorb the energy of breaking waves. A weak bridge across the fishermen's slipway on the west beach was also renewed. The work was designed by Mott Macdonald at their Cambridge and Croydon offices and constructed by May Gurney (Construction) Limited of Norwich. This Stage of the project was completed in 1995 at a cost of some £3.4 Million.

Stage 2

The second stage works involved a lot of work on the groyne system at Sheringham. All five of the old timber groynes at the west end from the Lifeboat Station to the Admiralty Slip were renewed or replaced with new timber groynes and an extra groyne was built. The five remaining timber and steel groynes from the Admiralty Slip to the east end were removed and replaced with four new rock armour groynes (see Figure 2 for a typical design). A new beach access ramp was constructed at the bottom of Beach Road. Additionally, 100 metres of the toe of the seawall on the east fisherman's beach was re-enforced and 90 metres of rock armour placed to the west of the Admiralty slip towards the Upcher groyne (details of all the Stage 2 works are shown in Figure 3).

As access was very poor and because large volumes of rock were required, it was planned to have the rock delivered by sea directly to the beaches (see **Appendix 1**). This work can only be done in the spring, summer and autumn seasons say April to October. This type of work is governed by the tides, making 24 hour working necessary. In recognition of the conflict between tourism and engineering works none of this work was done during the months of July and August.

The work of timber groyne reconstruction at the west end of Sheringham was less affected by weather and tide. The west beach is however more heavily used by tourists and visitors. Work here did not take place in the months of May to September inclusive, thereby avoiding damage to the tourist industry.

The preliminary study and modelling was undertaken by Hydraulics Research, Wallingford, before North Norfolk District Council's technical staff completed the design. The main contractor for the second stage was Edmund Nuttall Ltd with Commercial and Marine Piling Ltd constructing the timber groynes as sub-contractor and John Martin Construction Ltd completing the east beach ramp under a separate contract. The cost of stage 2 was approximately £1.85 million and work was completed in 1999.

Monitoring

An integral part of the second stage was to monitor very carefully, over a number of years and within a predetermined monitoring programme, just how the existing beach and the sediment moving through the system responded to the new groyne design. It is also necessary to record how the rock armour and the refurbished sea-walls withstand storm surge conditions.

Detailed analysis of the monitoring will be undertaken to see how the completed scheme performs over a period of time and in a wide range of sea conditions. It will determine whether the council will need to further bolster the defences in the future by building up the existing beach level to act as the first line of defence in storm conditions.

To date (2009) the work at Sheringham seems to have been successful and beach levels appear to be slowly increasing which suggests the groynes are functioning correctly. However, the North Norfolk coast has not experienced serious storm surge conditions since the work was completed and only after one or two of these events will it be clear if the defences really are performing as planned.

902 Scheme Statistics

Length of frontage 1,800 metres

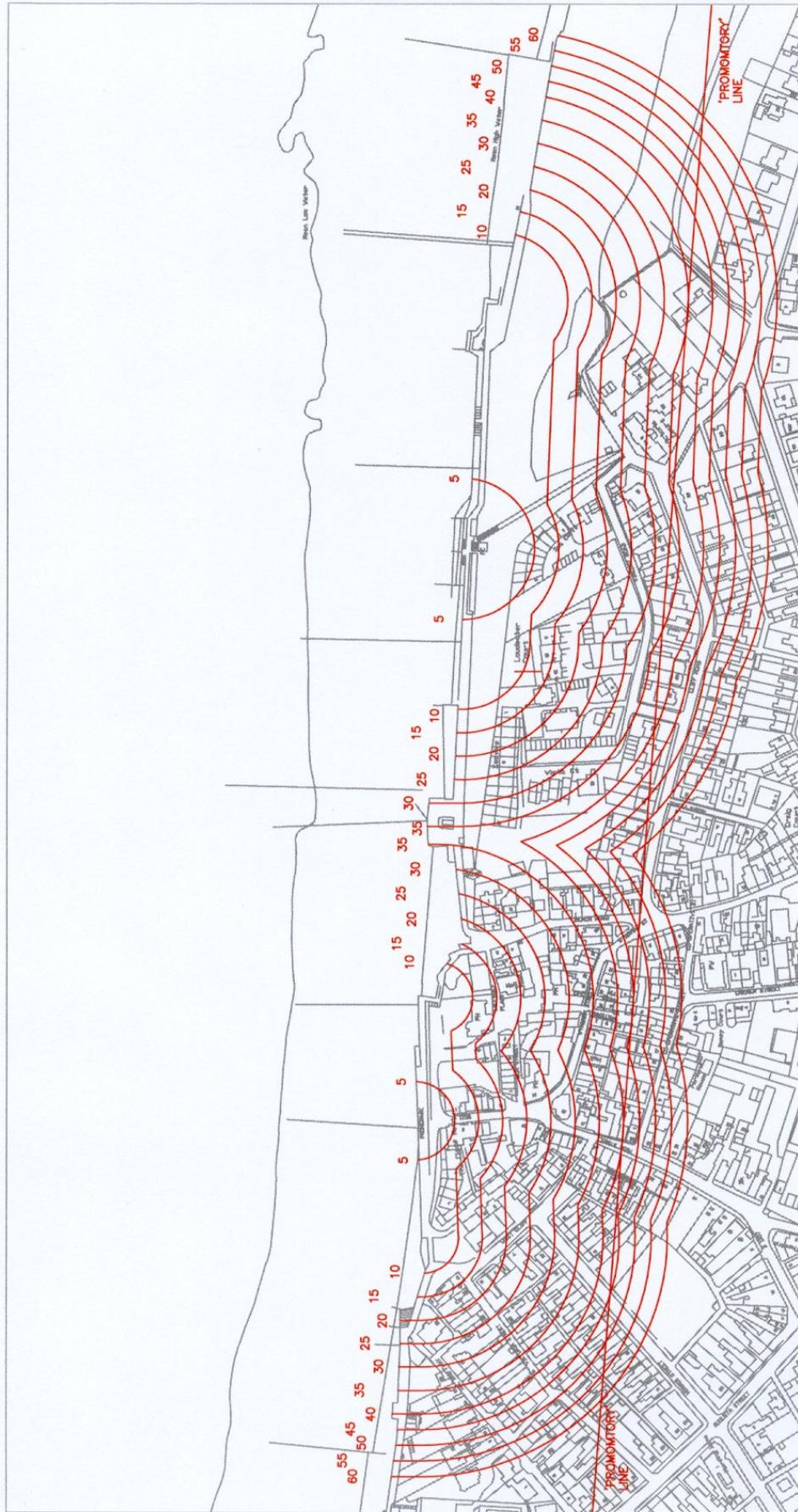
Materials (combined Stages 1 & 2)

Concrete	5,175 cu metre
Steel Reinforcement	230 tonne
Rock Armourstone	29,000 cu metre (approx 50,000 tonne)

Total Scheme Value £5,250,000 approx

The Future

Since the completion of the major scheme in 1999 the criteria for grant aid have changed and it is now the case that Sheringham will only qualify through a scheme of moderation that permit urgent schemes to be approved without meeting the criteria. The Council is seeking grant aid for works to the west end sea walls, but is not expecting to qualify. It will therefore shortly embark on a programme of works to refurbish the west end walls over a period of years using its own revenue resources.

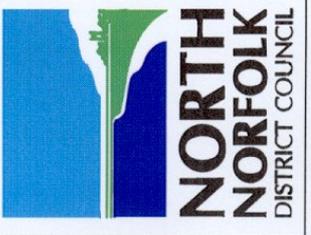


PROJECT	Coastal Management Unit	
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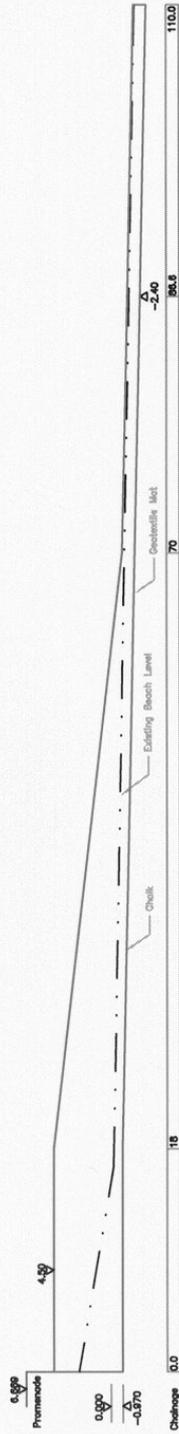
Figure 1
Failure scenario for Sheringham Coast Protection Scheme. Based on NNDC Technical Services' drawing SHERBCA 02, March 1996.

Notes:
 Predicted erosion contours following two beaches a weak points in the defences. An erosion rate of 3 metres per year is used for years 5 to 40 and a rate of 2 metres per year for years 40 to 60.
 Drawing shows Groyne positions before the Sheringham Scheme

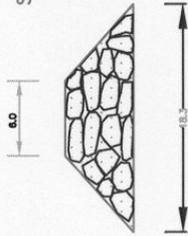
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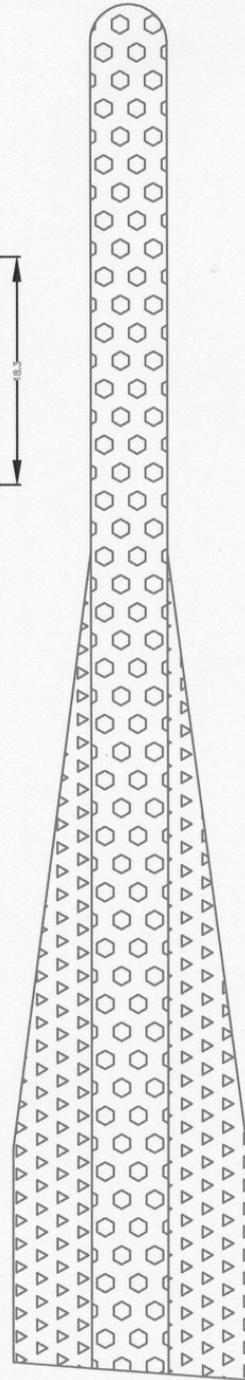
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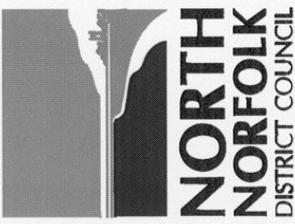
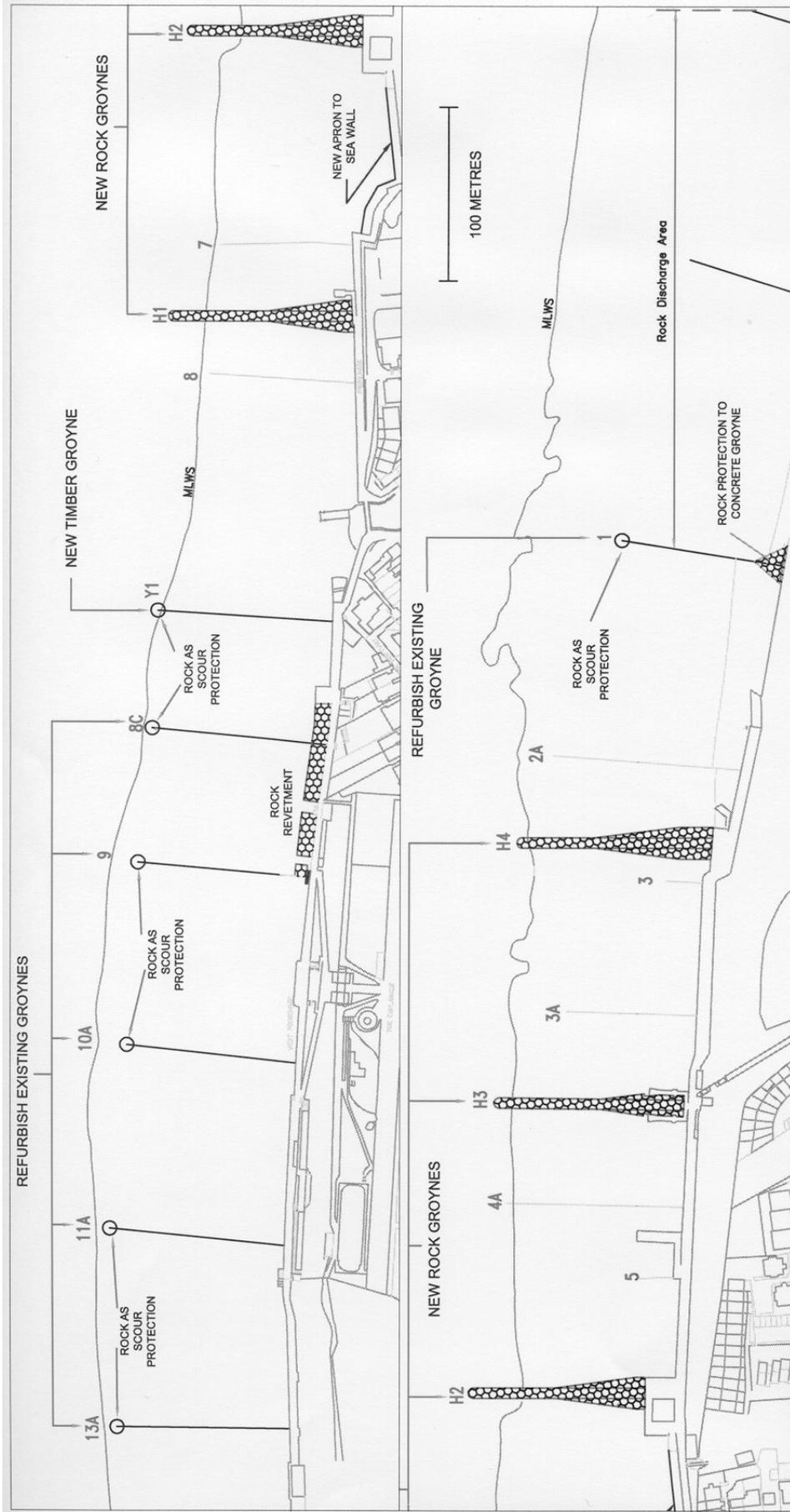
 <p>NORTH NORFOLK DISTRICT COUNCIL</p>	<p>Based upon the Ordnance Survey Map with Permission of the Controller of H.M. Stationery Office.</p> <p>(C) Crown Copyright.</p> <p>Unauthorised reproduction infringes Crown Copyright and may lead to prosecution or civil proceedings.</p> <p>O.S. LICENCE No. L.A. 078816</p>	<p>PROJECT</p> <p>Sheringham Stage 2 design for rock groyne H4. Based on NNDC Technical services' drawing EB 1070 511 A, July 1996.</p> <p>DRAWING TITLE</p>	<p>Coastal Management Unit</p>
	<p>DATE</p> <p>SCALE</p> <p>DRAWING No.</p> <p>DRAWN BY</p> <p>CHECKED BY</p>		

Figure 2

Sheringham Stage 2 design for rock groyne H4. Based on NNDC Technical services' drawing EB 1070 511 A, July 1996.

Notes:

- Groyne to be made up of 6 - 10 tonne pieces of rock.
- All chalk and beach levels are approximate
- All levels relate to Ordnance Datum (Newlyn) in metres
- All dimensions are in metres



<p>Based upon the Ordnance Survey Map with Permission of the Controller of H.M. Stationery Office.</p> <p>(C) Crown Copyright.</p> <p>Unauthorised reproduction infringes Crown Copyright and may lead to prosecution or civil proceedings.</p> <p>O.S. LICENCE No. L.A. 078816</p>	<p>Figure 3</p> <p>Details of work undertaken as part of Sheringham Stage 2 Scheme. Based on NNDC Technical Services drawing EB 1070 501C, July 1996.</p> <p>Notes:</p> <p>Groynes 2A, 3, 3A, 4A, 5, 6, 7 & 8 to be removed.</p> <p>Groyne 6 is in the same location a groyne H2</p>	<p>Coastal Management Unit</p>	
		<p>DATE</p>	<p>SCALE</p>
<p>PROJECT</p>		<p>DRAWING TITLE</p>	
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Appendix 1 Sheringham Stage 2 Rock Supply

General

Part of the second stage of this major coast protection scheme requires that 4 new rock groynes are constructed at the east end of the frontage and that about 100 linear metres of additional rock armour revetment is placed in front of the existing unprotected seawall to the west of the Admiralty slope. Additionally, a small rock bund will be placed around the seaward end of all of the timber groynes in order to reduce end scour. These works will require about 20,000 tonnes of rock armour. The average weight of the individual rocks will be about 8.5 tonnes.

Geological Description of the Armourstone

In order to meet the tight specification stipulated in the contract documents, for size, shape, density, durability and hardness, the contractor elected to purchase rock armourstone quarried from Larvik in Norway. The rock, similar to Granite, is called SYENITE and is *a coarse grained intermediate intrusive igneous rock with high levels of alkali feldspar*. Formed some 250 million years ago the outcrop at Larvik is notable not only for its size but also for its consistency (Appendix 2 provides more information on the rock).

Methodology

Each stone, once cut from the quarry is carefully checked for imperfections, and then stored by weight and shape on the nearby quay from where the armourstone can be selectively loaded directly onto the barge depending upon the client's specification.

Transshipment

In order to tranship the rock safely, a 'Development Zone' is agreed with Sheringham's local fishing fraternity in which all barge operations must be contained. The 20,000 tonnes of rock is towed by tug across the North Sea in the 'STEMA BARGE' which then anchors in the centre of the 'Zone'. A smaller barge, the 'CHARLIE ROCK', collects about 1000 tonnes of rock per trip which it delivers and discharges to the agreed beach area during the period over high tide. Having discharged the rock, the 'CHARLIE ROCK' then returns to the 'STEMA BARGE' for the next load. Meanwhile, when the tide goes out, the main contractor will collect the discharged rocks and store them at the inshore beach. This process is repeated over every high tide until all the rock has been discharged. Because of the complexity of the transshipment and the risks associated with bad weather the works will continue twenty four hours a day until they have been completed.

Appendix 2

WOODSTOCK DEERING LIMITED

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LARVIK ARMOURSTONE

DESCRIPTION

LARVIK ARMOURSTONE describes a complete range of rock armour products varying from corestone to individual rocks weighing in excess of 20 Tonnes.

Over 1.7 million tonnes of LARVIK ARMOURSTONE have now been supplied for use in both marine and coastal protection. These include:

- Breakwaters
- Groynes
- Offshore Reefs
- Scour Protection
- Revetments
- Jetties

STOCKHOLDINGS

Stocks:

The rock has been quarried since the 1920's and large stocks of LARVIK ARMOURSTONE in excess of 10 million tonnes have now been built up. Stocks of armourstone are held within the quarries themselves and at a dedicated storage area at Larvik Port.

Stockpiles:

Every rock is individually checked for weight and stored in designated stockpiles within one tonne bands. This unique sorting and storage operation allows armourstone to be supplied to the specified grading with speed, accuracy and consistency.

Grading:

The loading method is designed to ensure compliance with the standard grading tolerances described in the CIRA/CUR manual, i.e. max. 30% greater than UCL and 10% less than LCL.

Shape:

Visual checks at every stage of the operation are used to control shape. The target specification for shape is based on the recommended clause given in the CIRA/CUR Manual i.e. not more than 5% of stones have an l/d ration greater than 3.

EXTRACTION

LARVIK ARMOURSTONE is sourced from several quarries working the outcrop of Syenite in the Larvik area of Southern Norway. Since the rock is extracted principally by means of drilling and diamond cutting, only a very small amount of explosive blasting is used. This ensures that the stone is uniquely free from partially fractured segments.

GEOLOGICAL DESCRIPTION

Syenite is a coarse grained igneous rock with relatively high levels of feldspar. Formed some 250 million years ago the outcrop at Larvik is notable not only for its size but also for its consistency.

CIRA/CUR TEST RESULTS

Test Method	Typical Results	
Density	2.70	Good
Water Absorption	0.2%	Excellent
Point Load Index	11.8 MPa	Excellent
Mill Abrasion	0.0012	Excellent
Methylene blue	0.1g/100g	Excellent
Drop Test	3.8%	Good

OTHER TEST RESULTS

BS 812 Oven Dry Density	2.73
BS 812 SS Density	2.71
BS 812 10% Fines	170 KN
Aggregate Impact Value	25%
MgSO ₄ Soundness	1%
Aggregate Abrasion Value	4.1
Micro Deval EN1097-1 (wet)	8.5%
Wet Dynamic Crushing Value	22%
Franklin Point Load	10 KN