COMPANY PROFILE
AND
MATERIAL SPECIFICATION

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www.norock.com

Norock & Co

CONTENT

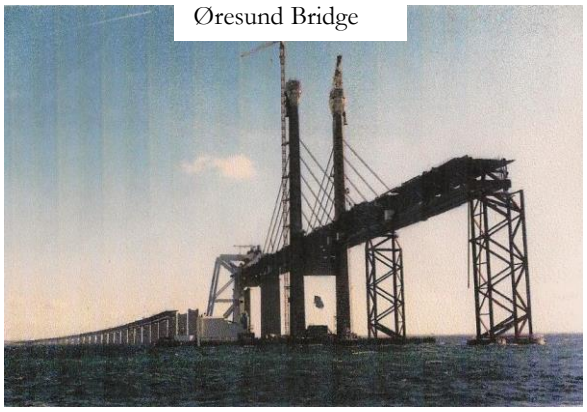
1.0 COMPANY INFORMATION: NOROCK & CO

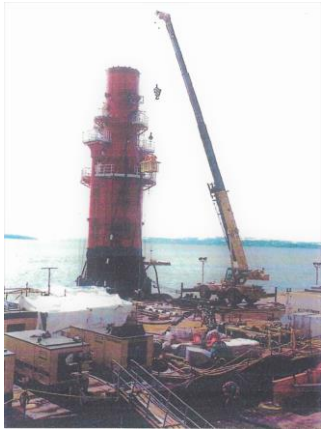
Established in 1976.
The company's main objective is to supply and deliver solid ballast material and to carry out consulting work for Marine Concrete Constructions in the North Sea.

During the 13 years work for Norwegian Contractors the company gained vital experiences on: numerous concrete platforms with focus on solid ballasting inshore/offshore; installation and foundation of gravity platforms; solid (heavy fill) ballasting operations varying from 1.500 tonnes to 340.000 tonnes.

Since the beginning, the company has been working on a number of platforms with respect to solid ballast material operations. There Norock & Co performed a number of tasks: delivering the material, logistics, and fabrication of necessary equipment as well as supervising the actual operation. In addition it undertook procedures, commissioning and final reports/documentation. In addition, the company is also doing a consultancy work for different operations. Norock & Co has been consultants for Hibernia, Mobil Canada with respect to the ballasting operation amounting 500.000 tonnes of iron ore.

In the past, Norock & Co participated in a variety of projects, for example Troll Olje platform, Great Belt Bridge and Øresund Link Bridge where the company delivered ballast material consisting of eclogite and iron ore. Another interesting operation was delivery of approx. 200.000 tonnes of 3-9" eclogite for protection of a gas pipeline for the Malampaya project in the Philippines in 2009 and again
an additional quanty of 80.00 tonnes in 2018.


Øresund Bridge


Ballasting of Fulmar loading bouy

Since 2010 Norock & Co has been delivering heavy rocks to numerous windmill projects in the North Sea and the Irish Sea. The delivery was made to, among another, Belfast Wind Farm Project (2013), Westermost Rough Project, Dolwin 2, Gemini OWF, Merkur Wind, Borkum, Snøhvit CO2, Corrib Project, Veja Mate OWF, Race Bank Wind Farm, Rampion Project, Breagh Project, Cygnus Project, East Anglia, CMC Rock Project, Hohesee and many more.

The company can supply and deliver different types of ballasting materials, i.e. sand, moraines, gravel, heavy rocks and iron ore with specific gravity ranging from 2,2 - 5,0 T/m3.

Norock & Co represents and delivers ballast material from the following companies.

Company:		
Visnes Eclogite, Norway	:	Eclogite
Norwegian Producers, Norway	:	Granite

1.1 Reference list

Project	COMPANY	YEAR	MATERIAL	CASE	SATURATED	QUANTITY	EQUIPMENT
BERYL A	Mobil	74	Gravel	Ballast	2,20	125 000	Conveyorbelt
BRENT B	Shell	74	Gravel	Ballast	2,20	140 000	Conveyorbelt
BERYL A	Mobil	76	Gravel	Scour	2,20	30 000	Grabs, floating
BRENT D	Shell	76	Gravel	Ballast	2,20	100 000	Grabs,
STATFJORD A	Mobil	76	Gravel	Ballast	2,20	80 000	Grabs,
			Olivine		2,50	10 000	conveyorbelts
STATFJORD B	Mobil	79	Iron-Ore	Ballast	3,35	40 000	Pump. and mix. unit
		80	Olivine	Ballast	2,25	130 000	Grabs, splitbarges
FULMAR SALM	Shell	81	Iron-Ore	Ballast	3,60	4 000	Pump. and mix. unit
TECHNOMARE	Phillips	83	Iron-Ore	Ballast	3,85	60 000	Concrete pump.equip.
			Orecrete				(tests only)
STATFJORD C	Mobil	83	Iron-Ore	Ballast	3,70	230 000	Special ship, mix unit
GULLFAKS A	Statoil	85	Iron-Ore	Ballast	3,60	215 000	Special ship, mix unit
GULLFAKS B	Statoil	86	Olivine	Ballast	2,35	200 000	Special ship, mix unit
OSEBERG A	Hydro	86	Olivine	Ballast	2,35	340 000	Special ship, mix unit
SNORRE	Hydro	91	Iron-Ore	Ballast	3,50	11 000	Grab, remote control
			Olivine		2,20	10 000	shute (delivery)
DRAUGEN FLP	Shell	93	Iron-Ore	Ballast	3,50	2 000	Pump. & mix. equip. (delivery)
TROLL OLJE	Hydro	94	Concrete	Ballast	2,40	10 000	Concrete, mix, pump
GREAT BELT BRIDGE	DK	94 -96	Iron-Ore	Ballast	3,40	43 000	Grabs, barges
							conveyorbelts (delivery)
ØRESUND BRIDGE	S	97-99	Iron-Ore	Ballast	3,40	60 000	Grabs, barges
			Eclogite	Ballast	2,50	115 000	conveyorbelts (delivery)
PIPELINES NORTH SEA		02-05	Eclogite	Cover	2,20	600 000	Special Ships fallpipe (delivery)
DE RUITER, HOLLAND	Shell		Eclogite	Ballast/scour	2,50	120 000	
ORMEN LANGE	Statoil		Eclogite	Cover	2,20	600 000	Fall pipe
PIPELINES NORTH SEA		07-09	Eclogite	Cover	2,20	600 000	Fall pipe
PIPELINES, The Phillippines	Shell		Eclogite	Cover	2,30	200 000	Fall pipe
WINDMILLS NORTH SEA		11-17	Eclogite	Scour	2,30	1 800 000	Fall pipe
PIPELINES, The Phillippines	Shell	18	Eclogite	Cover	2,30	80 000	Fall pipe
WINDMILLS NORTH SEA		18	Eclogite	Scour	2,30	200 000	Fall pipe

1.2 Credentials: Founder

TRULS SVERDVIK
9 Oct 1943

EDUCATION: B.E. in Civil Engineering
University of New South Wales Sydney, Australia

PROF. SOC.: S.P.E. (Society of Petroleum Engineers)
P.F. (Petroleumsforeningen)

PAPERS: Europec 78 (London): "Foundation of offshore structures"

EXPERIENCE:

1987 - **NOROCK & CO AS**
Project Manager
Consultancy work for the mining and offshore industry.
Design, co-ordination and execution of the offshore/inshore solid ballasting operation on the following projects.

1991	Snorre CFT, SAGA	delivery of ballast material
1993	Draugen FLP, SHELL	delivery of ballast material
1993/1994	Troll Olje, HYDRO	consultancy
1994	Hibernia, MOBIL Canada	consultancy
1994/1995	Great Belt Bridge, DK	delivery of ballast material
1997/1999	Øresund Bridge S	delivery of ballast material

2002/ -Delivery of rocks for pipeline cover North Sea; Kristin, Åsgaard, Mikkel, Draugen

2004	Consultant for Adriatic LNG Terminal	Venezia. Italy
2004	Consultant for concrete platforms for PB	Sakhalin CGBS project, Russia
2005	Consultant for Shan Deniz project	Baku, Azerbaijan
2006	Delivery of rocks for the Ruiter Platform	
2007	Delivery of rocks for Offshore Constructions	
2009	Delivery of rocks Malampaya Gas Project	The Philippines
2010/ 2017	Delivery of rocks for offshore constructions as ballast and scour protection for windmills	
2018	Dlivery of rocks Malampaya Gas Project	The Philippines

1975 - 1987 **NORWEGIAN CONTRACTORS, OSLO**
Senior Project Engineer
Responsible for design, co-ordination and execution of inshore and offshore solid ballasting operations as well as all phases of the offshore installation work, including grouting of seabed foundation on the following platforms:

1976	Mobil Beryl A (Mobil Expro UK)	/ Shell Brent B (Shell Expro UK)
1977	Shell Brent D (Shell Expro UK)	
1978	Mobil Statfjord A (Mobil North Sea)	/ Elf Frigg TCP-2 (Elf Aquatine N)
1979	Fulmar SALM (partly) (Exxon UK)	
1981	Mobil Statfjord B (Mobil North Sea)	
1983	Mobil Statfjord C (Mobil North Sea)	
1984	Gullfaks B (Statoil N)	

1985	Gullfaks B (Statoil N)	
1987	Gullfaks C (Statoil N)	/ Oseberg A (Hydro N)

2.0 COMPANY INFORMATION : VISNES EKLOGITT AS

Visnes Eklogitt A/S was founded in 1992 and is a subsidiary of Visnes Kalk og Marmorbrudd A/S.

Visnes Kalk og Marmorbrudd A/S is a privately owned company, founded in 1904. It`s activity is based on mining and processing limestone deposits at Visnes in Eide, Norway. Visnes Kalk og Marmorbrudd A/S has deposits of approximately 30 million tonnes of limestone with 98% CaCO3 to which they have mining and production rights.

The eclogite deposit is approx. 100 million tonnes.

Visnes Eklogitt has all the necessary equipment for crushing and sieving eclogite.

Due to its mechanical properties and high density eclogite can be used as ballast material in bridges and large offshore constructions, as well as armour stones for coastal protection and cover for underwater pipelines. Other applications have been for heavy concrete for underwater tunnels and, in the resent years, as scour protection for offshore constructions.

The private quay can take vessels up to 200m length, water depth of 11,5 m. The quay can load vessels up to 45.000 tonnes. The conveyor belt has an outreach of 14 m and height above mean sea-level of 15 m.
A large storage area adjacent to the port can store approx 200 000 tonnes of material.

The loading takes place 24hr/day, 7 days/week SHINC by conveyor belt with a capacity of approx. 2.500 ton/hr (up to 10" (250mm)). For loading of larger rocks up to 20" (500 mm) another special conveyor belt will be used. Alternative option is a gangway-ramp and front wheel loaders.

2.1 Product Certificate

CE

1111

Visnes Eklogitt AS, 6493 lyngstad
13
1111-CPR-0160

NS-EN 13383-1: 2002
NS-EN 13383-2: 2013
Armourstone, Part 1: Specification
Armourstone, Part 2: Test methods
Aggregates obtained by processing natural, manufactured or recycled materials and mixtures of these materials for use as armourstone

Product information

125-330 mm crushed Eclogite

Type of aggregate	*Crushed mafic rock (eclogite) with cubically angular grain form. Loose surface coating, none weathered particles and none weak particles.*
Length-to-thicknes ratio	LT_A
Particle size	$CP_{125/330}$
Particle density	$3.20\ Mg/m^3$
Water absorption	$WA_{0.5}$
Compressive strength	CS_{80}
Resistance to attrion	$M_{DE}30$
Durability against salt crystallisation	MS_{25}
Dangerous substances *according to Norwegian requirement*	*Approved for Class 2**

Visnes Eklogitt AS declare that the product is produced in accordance with Anneks ZA in NS-EN 13383-1 and tested according to NS-EN 13383-2 "Armourstone".

Lyngstad 13th of June 2017

Karl Johan Eide

Karl Johan Eide *Managing Director*

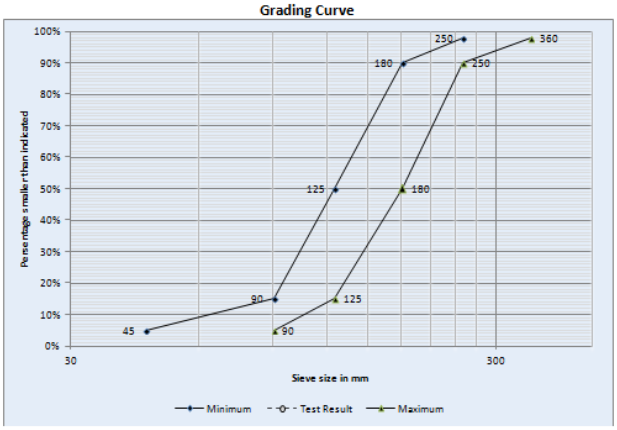
3.0 MATERIAL SPESIFICATION : ECLOGITE

3.1 Physical Properties

Type	Eclogite
Specific density	3,20 – 3,30 T/m³
Moisture	< 0,1%

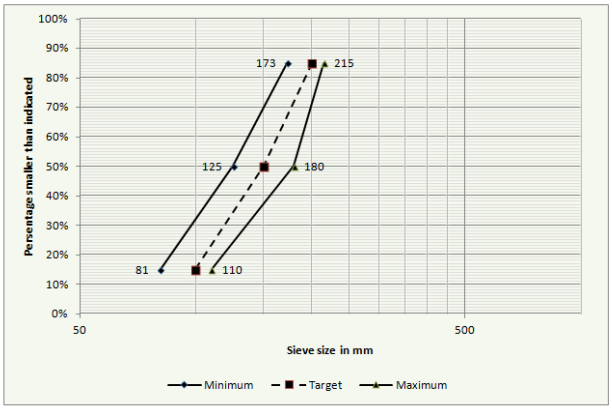
3.2 Grain Size Distribution

Opening				% passing
1"- 3"	**1"- 5"**	**3"- 9"**	**9"- 18"**	
75mm	125 mm	225 mm	450 mm (300 kg)	100%
50mm	75 mm	150 mm	300 mm (90 kg)	50%
25mm	25 mm	75 mm	225 mm (30 kg)	10%

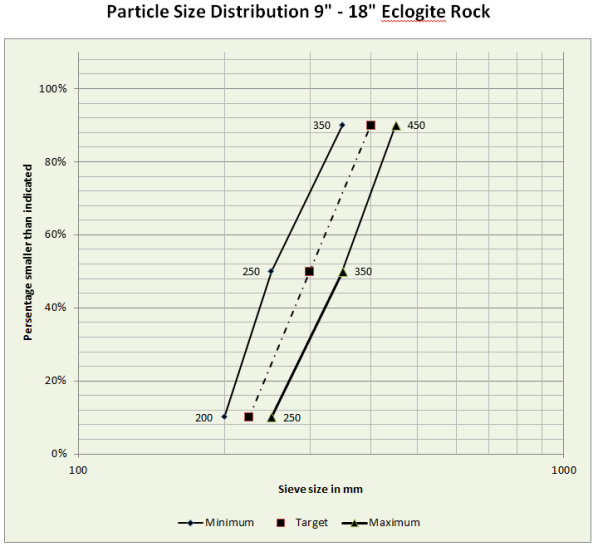


Cumulative Percentage Passing (by mass)

90 – 250mm	D5	D 15	D 50	D90	D 98
Minimum	45 mm	90 mm	125 mm	180 mm	250 mm
Target					
Maximum	90 mm	125 mm	180 mm	250 mm	360 mm



3" - 9"	d 15	d 50	d 85
Minimum	81 mm	125 mm	173 mm
Target	100 mm	150 mm	200 mm
Maximum	110 mm	180 mm	215 mm



9" - 18"	10 %	50 %	90 %
Minimum	200 mm	250 mm	350 mm
Target	225 mm	300 mm	400 mm
Maximum	250 mm	350 mm	450 mm

3.3 Laboratory Tests Results

3.3.1 Laboratory test

Particle density	:	3,29 Mg/m³
Water absorption (% of dry mass)	:	0,3
Aggregate Abrasion Value (mean)	:	2,8
Aggregate Impact Value (Dry)	:	10
Aggregate Crushing Value	:	9
Ten per cent fines value – Dry	:	440 kN
Magnesium Sulphate Value	:	19
Polished Stone Value	:	61 – 59 - 61
Compressive Strength	:	168 Mpa

3.3.2 Chemical analysis

SiO2	48,80%	TiO2	1,60%
Al2O3	14,55%	Fe203(tot)	11,00%
MgO	9,05%	CaO	11,75%
MnO	0,16%	K2O	0,09%
Na2O	3,35%	P2O3	0,20%

3.3.3 Pre Qualification tests (for coverage of pipelines offshore)

Mineralogic results:	Quartz	5%
	Plagloklase	5%
	Klinoamph	80%
	Garnet	5%
	Trace min	5%

Grain specific density	:	3,29 t/m³
Dry bulk density	:	1,90 t/m³ uncomp.
Porosity	:	0,42 t/m³ uncomp.
Point load Index	:	12,08 MPa
Salt Resistance	:	Sea salt resistant mineral comp. above
Natural slope angle	:	34 degrees

3.3.4 Shape Classification Test

"Flaky" and /or "Elongated" rocks not observed

3.4 Sampling

The following tests will be carried out for each shipment

1. Specific gravity
2. Dry bulk weight

3. Grain Size Distribution
4. Other tests required by client

3.5 Comparison Eclogite vs Granite

Scour, High Density Protection.
If high density rock material is used, the stone weight can be reduced considerably.

The stone weight needed for a given rock density may be corrected according to the formula:

$$W = Wo \quad \frac{(Pso/Pw - 1)\ 3 \times Ps}{(Ps/Pw - 1)\ 3 \times Pso}$$

W	=	Weight of actual rock
Wo	=	Weight of reference rock
Pw	=	Sea water density ~ 1.025 kg/dm³
Ps	=	Actual rock density
Pso	=	Reference rock density = 2.680 kg/dm³ and the stone weight is given by

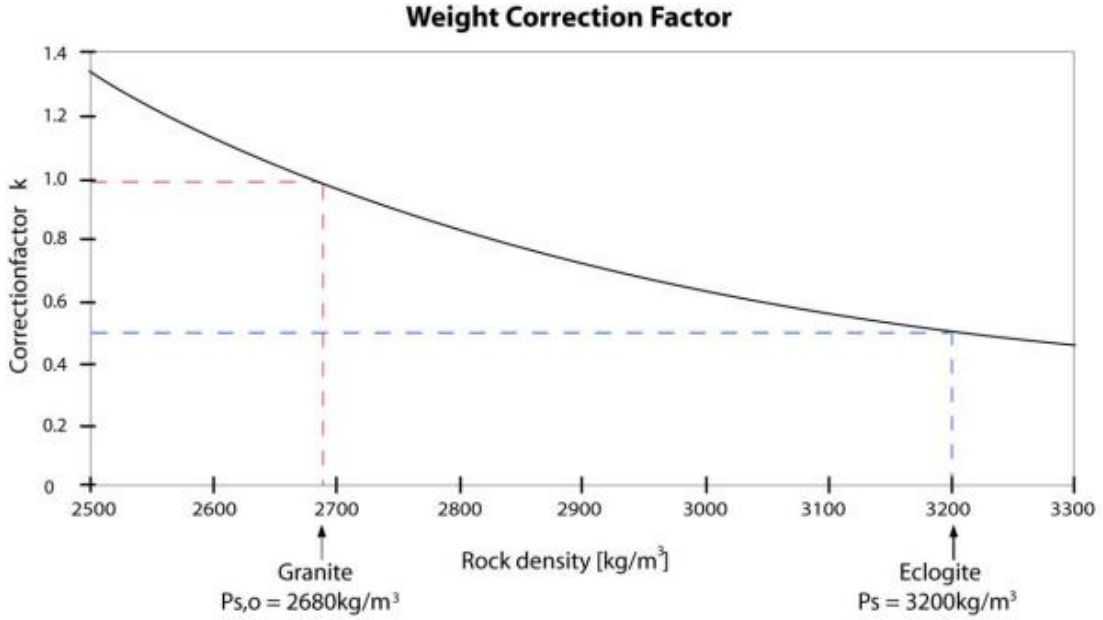
$$W = Wo \times k$$

The factor k below is shown as a function of the rock density.

Example:

W	=	Weight of eclogite	density 3,20 kg/dm³
Wo	=	Weight of granite	density 2,68 kg/dm³
k	=	Factor 0,50	

Ie. W = 100 x 0,50 = 50 kg.



A 100 kg granite rock has the same submerged weight/dm2 as a 50 kg eclogite rock.
A 100 kg granite rock can be replaced with an eclogite rock of 50 kg.

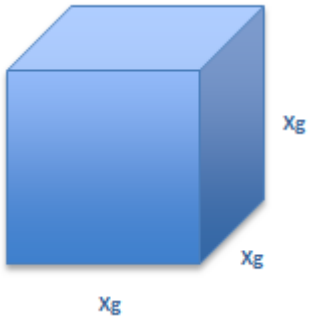
3.5.1 Eclogite vs Granite calculation

High density rock protection material

Comparison between Eclogite and Granite (Gneiss) under water :
Use of high density rock reduces the stone weight by 50% and volume by 60%.

Assumption: Sg. Eclogite : Sge = 3,20 kg/dm³
Sg. Granite : Sgg = 2,65 kg/dm³
Sg. Seawater: Sgw = 1,026kg/dm³

50 kg rock of Eclogite = 100 kg rock of Granite



We = Ve * Sge
50 kg = Ve * 3,20 kg/dm³
): Ve = 50/3,20 = 15,63 dm³ = 15,63 L
Submerged weight
50kg - 15,63 * (1,026) = 34,0 kg
Volume = x3e = 15,63 dm³
xe = 2,50 dm
Area = x2e = 6,25 dm2
Pressure of rock at seafloor:
Pe = 34,0 kg / 6,25 dm2 = **5,44 kg/dm2**

Wg = Vg * Sgg
100 kg = Vg * 2,65 kg/dm³
): Vg = 100/2,65 = 37,74dm³ = 37,74L
Submerged weight
100kg – 37,74 * (1,026) = 61,3kg
Volume = x3e = 37,74 dm³
xg = 3,36 dm
Area = x2e = 11,29 dm2
Pressure of rock at seafloor:
Pe = 61,3kg /11,29 dm2 = **5,43kg/dm2**

3.5.2 Rocksize in inch Eclogite vs Granite

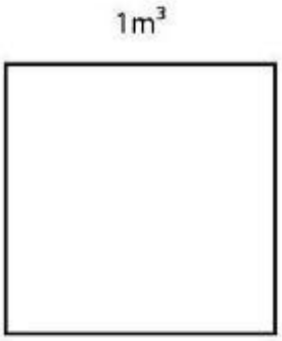
Table comparing Eclogite and Granite submerged Kg/dm³
(active force against sea water).

Note: Weight calculations based on a cube shape. However a more realistic values would be 80% of the table values.

Rock size Inch	**Rock size mm**	**Volume dm³**	Eclogite **Sp. gravity** 3,20 kg/dm³ **kg**	Granite **Sp. gravity** 2,65 kg/dm³ **kg**	**Eclogite weight Reduced by 50% kg**	
1”	25,40	0,02	0,06	0,04	0,022	kg
2”	50,80	0,13	0,42	0,35	0,174	kg
3”	76,20	0,44	1,41	1,17	0,586	kg
4”	101,60	1,05	3,36	2,78	1,390	kg
5”	127,10	2,05	6,56	5,44	2,721	kg
6”	152,40	3,54	11,33	9,38	4,690	kg
7”	177,80	5,62	17,98	14,90	7,448	kg
8”	203,20	8,39	26,85	22,23	11,117	kg
9”	228,60	11,95	38,24	31,66	15,829	kg
10”	254,00	16,39	**52,45**	43,43	21,713	kg
11”	279,40	21,81	69,79	57,80	28,900	kg
12”	304,80	28,32	90,62	75,04	37,520	kg
13”	330,20	36,00	115,20	95,41	47,703	kg
14”	355,60	44,97	143,90	**119,16**	59,580	kg
15”	381,00	55,31	**176,99**	146,56	73,281	kg
16”	406,40	67,12	214,78	177,87	88,936	kg
17”	431,80	80,51	257,63	213,35	106,675	kg
18”	457,20	95,57	305,82	253,26	126,629	kg
19”	482,60	112,40	359,68	297,86	148,929	kg
20”	508,00	131,10	**419,52**	**347,41**	**173,703**	kg
27”	685,80	322,55	-	**854,75**	**427,374**	kg

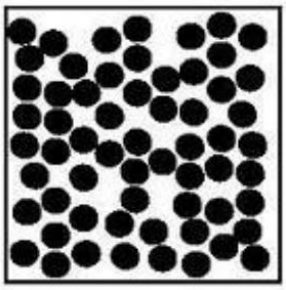
Ex.1.: a 20 inch Eclogite rock of 400 kg can replace a 27 inch Granite rock of 850 kg
Ex.2.: a 15 inch Eclogite rock of 174 kg can replace a 20 inch Granite rock of 350 kg
Ex.3.: a 10 inch Eclogite rock of 52 kg can replace a 14 inch Granite rock of 119 kg

3.5.3 Definition of density



Specific volume weight:

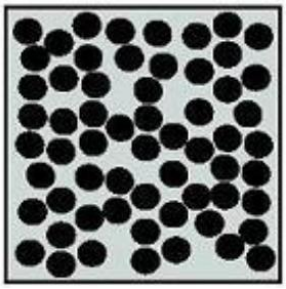
Eclogite	Granite	Iron ore
T / m³	T / m³	T / m³
3,20	2,65	4,80



Dry volume weight:

Ec: 1,85 / 3,20 = 0,57 solid, 0,43 void
Gr: 1,50 / 2,65 = 0,57 solid, 0,43 void
Ir: 3,00 / 4,80 = 0,63 solid, 0,37 void

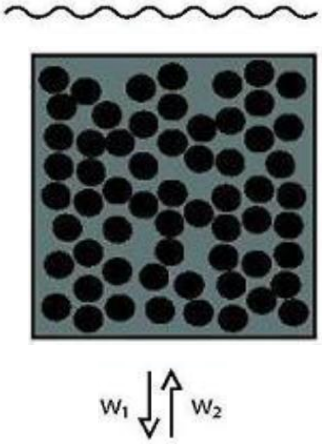
Eclogite	Granite	Iron ore
T / m³	T / m³	T / m³
1,85		
	1,50	
		3,00



Saturated volume weight:

Ec: 1,85 / 3,20 • 3,20 + (0,43 • 1,025)
Gr: 1,50 / 2,65 • 2,65 + (0,43 • 1,025)
Ir: 3,00 / 4,80 • 4,80 + (0,37 • 1,025)

Eclogite	Granite	Iron ore
T / m³	T / m³	T / m³
2,29		
	1,94	
		3,38



Submerged volume weight:

Ec: 1,85 / 3,20 • (3,20 - 1,025)
Gr: 1,50 / 2,65 • (2,65 - 1,025)
Ir: 3,00 / 4,80 • (4,80 - 1,025)

Eclogite	Granite	Iron ore
T / m³	T / m³	T / m³
1,24		
	0,92	
		2,38

3.6 Reports (on request)

3.6.1 Eclogite Summary Test Result, CELTEST

3.6.2 Fibre Analysis of Eclogite, SINTEF

3.6.3 Eclogite Qualification Test, SINTEF

3.6.4 Eclogite as Concrete Aggregate NOTEBY

3.6.5 Sea Water Stability of Eclogite, FOSROC

3.6.6 Abrasion and Impact Norsk Index, ALLIS

3.6.8 Eclogite as Ballast in Marine Concrete Structures, SINTEF.

3.6.7 Reduction of Weight using Eclogite Material. Weight correction factor.

3.6.8 Advantages using eclogite in offshore pipeline cover protection.