



Ramnäs Bruk Product Catalogue

TOP QUALITY MOORING PRODUCTS FOR HARSH OFFSHORE CONDITIONS

Tradition

Ramnäs Bruk has pioneered the development of production, chain grades and quality for years and years. With the tradition of craftsmanship combined with new technology we keep setting new standards for reliability.

Quality

At Ramnäs Bruk, quality is a way of life. Without any mooring line failure due to fabrication defects in over 25 years, we have proven that quality is not only the number one issue on our everyday agenda. It is our only issue.

Technology

With continuous development of our high tech inspection and production tools, we always strive to offer you the best possible mooring chain for any demanding offshore project. That is how we maintain our quality leadership.



Ramnäs – in brief

Ramnäs Bruk strives to be the best and most reliable alternative from all aspects between inquiry and delivered chain. We focus on always improving technology and quality, to make sure that our deliveries can be trusted in any demanding offshore project. Reliability is a must.

For top quality mooring products You can rely on our expertise



Our craftsmanship combined with new technological methods ensures that chains from Ramnäs Bruk keeps setting new standards of reliability in harsh conditions.



We always deliver beyond the requirements of the classification societies.

The sooner you bring Ramnäs quality in to your mooring system the better.

Magnus Westher, General Manager

Innovation for quality

Innovations and increased efficiency are necessities to stay in a leading position. Ramnäs Bruk would not be in successful operation since 1590, and in the offshore mooring market for over 50 years, if we didn't continuously consider our customers future needs and improve our products and services.

Ramnäs unique assymetrical stud design and our Phased Array ultrasonic inspection method are two examples of Ramnäs innovations that gives assurance to safe mooring systems.

Production and delivery

Manufacturing chain of large dimension is a heavy procedure where quality is the main concern in every part of the production. Each link has its own specific history, with full traceability of fabrication and inspection data stored on file. We cannot afford to take anything for granted.

Quality and quantity must go hand in hand. Ramnäs is in the process of soon reaching double delivery capacity by some of the largest

investments in new production equipment since the seventies. Top quality chain at increased quantities, delivered with shorter delivery time to ensure the performance of your mooring system installation.

5 years quality warranty

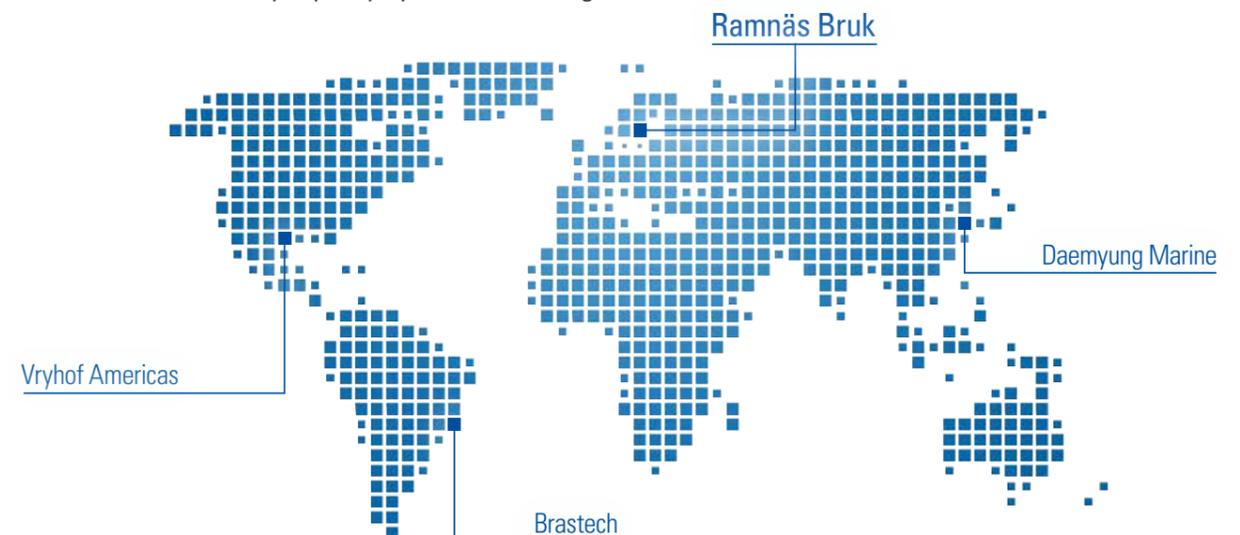
We trust our quality to the degree that we always offer 5 years quality warranty in our General Conditions together with ORGALIME S 2012.

Ramnäs is extremely proud that many of our employees have decades of continuous service, but all of that knowledge can't be fitted in a printed catalogue. The sooner we bring Ramnäs quality in to your mooring system the better. Please contact us as early as possible in your mooring process and let us support you.

Short facts

- Ramnäs is located in the heart of Sweden, 140 km west of Stockholm and 30 km north of Västerås.
- With the railroad outside the window, we transport chain to the port of Gävle and Uddevalla.
- Approved as manufacturer by all major classification societies for all offshore chain grades.
- Preferred production range: 76 – 165 mm dia stud and studless chain.
- Certifications: ISO 9001, ISO 14001, OHSAS 18001.
- Standard terms of delivery are as per Incoterms 2010.
- Ramnäs Bruk Sales is represented in USA, Korea and Brazil.

sales@ramnas.com





At Ramnäs Bruk Quality is a way of life



A chain is never stronger than its weakest link. It is our mission to deliver top quality mooring chains to our customers.

Quality is a lifestyle

Ramnäs Bruk was one of the pioneers in the offshore industry to conform to the international standard of ISO 9001 back in the 90's. To us, quality is a lifestyle where nothing can be assumed or taken for granted. There is no higher objective than quality, all the way from supplier deliveries, through the production process and the logistics to get the mooring in place.

We believe in our excellent product quality to the extent that we have introduced a 5 year quality warranty on all our chains. We understand that the quality we deliver controls the reliability you receive.

Certification is not our only goal

We know the importance of certification. But it is also our firm belief that certificates are only a proof that we have reached certain heights in our quality work. We always strive to go beyond that.

All material is passing through our acceptance control before it is taken into production. Every flash weld on each link is recorded to ensure the weld quality. Our heat treatment process is performed in continuously and automatically controlled furnaces to meet the desired criteria for mechanical properties. All links are verified in a proof load test and we use magnetic particle inspection and our developed ultrasonic inspection method Phased Array, to find any surface or internal indications.

All tests are documented, and every single link can be traced back to its source. Without any mooring line failure due to fabrication defects

in 25 years we have proven that our quality is reliable. This is the kind of certification we are proud of.

Continuous Improvements towards reliability

Ramnäs Bruk occupational health and safety management system conforms to the international standard of OHSAS 18001.

Constantly encouraging our experienced and qualified staff to develop and further educate themselves in their professions. To improve in all processes, we apply thoughts of LEAN and 5S through our corporate development programme. The expertise of our staff are shared internally by using the methods and tools of continuous improvements, this is one of the main factors that have made Ramnäs the company that it is today.

Taking care of our planet

Located in the heart of Sweden, surrounded by the beautiful Swedish nature, we are aware of our responsibility for the environment. Our environmental work goes through the entire business. Each department has their own activity plans to minimize waste and enhance recycling in compliance with the regulations of ISO 14001.

To further decrease our footprint on the environment we have made various investments over the years, for example a new cooling water system where excessive heat from cooling water are used to heat up our premises and decrease the CO₂ emissions by converting furnaces to be powered by natural gas (LNG). To stay in the forefront even in the next generation chain production we are continuously improving to make our future environment sustainable.

Quality. Nothing else.



Ramnäs Bruk has been successful since 1590, and in offshore mooring for over 50 years. Our long tradition has always been to continuously consider our customers future needs and to improve our products and services. During all these years we have proven that quality is our guiding principle.





Innovating reliability

With continuous development of our high tech inspection tools, we always strive to increase the reliability of the mooring chain. Our craftsmanship combined with new technological methods ensures that chains from Ramnäs Bruk keeps setting new standards for reliability in harsh conditions.

Continuously improving world class reliability Requires innovative minds



At Ramnäs Bruk we focus on developing new methods and processes to improve every step from raw material to installed mooring. The perfection is in the details.

Material

We continuously work to improve steel grades, and with more than 50 years of cooperation with steel suppliers and all major classification societies we ensure that our material grades meet or exceed the rigorous standards.

With specific steel recipes, pre-dispatch certification, detailed arrival control and continuous quality assurance routines, we make sure all material we use meet the high Ramnäs Bruk standards.

Welding procedure

Our verification procedures for weld quality are the result of decades of experience and have been incorporated into our processes to ensure 100% accuracy at all times.

But also with pre-set welding machines and full inspection of each weld by microprocessors, we will always rely on our operators craftsmanship to make sure all products are of supreme quality.

Heat treatment

The settings and procedures for each individual grade or size of chain has been carefully developed through decades of experience.

Our heat treatment is performed in continuously and automatically controlled furnaces, operated by our experienced personnel. This gives every chain the best possible heat treatment, resulting in best-in-class mechanical properties.

Inspection

We put great pride in continuously developing the world's most advanced inspection, and are always researching new ways of improving the process.

Thanks to the strict quality procedures at both our suppliers and in our manufacturing, we are proud to put the Ramnäs Bruk seal of approval on our chains.



Ramnäs Bruk Technology Highlights

Phased Array Inspection

The Phased Array method, developed by Ramnäs Bruk, uses ultrasonic waves to check the interior of the welded area of the link. The versatility and high speed of the method enables 100% check of all welds, with faster and more accurate result than with traditional UT methods. And – the Phased Array method is of course approved by all major classification societies.

Supersonic Corrosion Protection

Offshore chains are particularly sensitive to corrosion in the splash zone, where salts of the sea and the oxygen on the surface create a highly corrosive environment. With Supersonic Corrosion Protection even partial coverage can reduce the corrosion rate up to four times, providing lifecycle cost savings.

RFID Instant Traceability

Ramnäs has, as first supplier, chains with RFID chip for instant traceability installed in stud link chains offshore. This solution for identification and tracking gives the possibility to track each link and obtain necessary information for evaluation.

Automatic Magnetic Particle Inspection

The final magnetic particle inspection eliminates the risk for surface defects on the finished chain. We use an Automatic Magnetizer to make the inspection more exact by ensuring full strength of the magnetic field in both directions simultaneously. By using both the Phased Array and Automatic Magnetic Particle inspection, we increase our efficiency by 50%, while further enhancing the Ramnäs Bruk quality.

Premium products

Combining tradition, quality and technology, we are constantly making sure that products from Ramnäs Bruk always are at the forefront of the mooring business. We take great pride in our products unsurpassed track record, and we continuously make improvements to our already top quality chains.

Ramnäs Stud Chain



With our unique manufacturing method, we make the best stud link mooring chain, with proven use even for LTM.

Asymmetrical design

Ramnäs Bruk has developed an asymmetric stud that is carefully installed and expanded to exact tolerance that was established through years of research and development. The asymmetrical design of the stud gives equal stud footprints and contributes to a symmetric stress-distribution in the link.

No more loose studs

Our stud link chain is superior compared to all other available stud link mooring chain today. The design combined with Ramnäs Bruk's controlled stud expansion, is the standard method in our production process since 1991.

The built-in "spring" effect makes a tremendous difference in avoiding loose studs. The percentage of loose studs has been reduced to zero. In fact, many of our customers have experienced Ramnäs Bruk stud chains with intact studs for over 20 years. It is safe to say that our studs stay in place.



The key benefits in short

- Higher proof load
- At least three times increased fatigue life
- Reduced risk of stress corrosion in the weld
- Improved utilisation of the base material ductility
- Increased peak loads without any deformation
- Facilitate installation, no kink and knots
- Low life cycle cost

Ramnäs Studless Chain



Our studless link can deliver the same performance as a stud link in terms of static strength – while offering a saving of 9% in weight.

Ramnäs Studless Chain for deepwater applications offers a potential reduction in weight, and consequently cost savings. Alternatively, the weight can be kept constant and fatigue strength correspondingly increased by opting larger diameter chain. This option also gives a higher margin of safety against the incidence of corrosion.

Design

Compared to a stud link that has a width of $3.6 \times d$, Ramnäs Bruk standard studless link has a width of $3.35 \times d$. The length of the studless link is $6 \times d$ which is the same as for stud link.

Static Strength

Ramnäs studless chain withstands the same break load as a stud link chain with the same nominal diameter.



The key benefits in short

- Lower weight with the same safety factor
- Easy to connect without end link
- Studless chain is easier to inspect and being a simpler structure, requires less inspection

In stock

To assist you in reducing downtime and to increase productivity, we stock some of the most commonly used accessories.

Please contact us directly if you want further information about the products that we keep in stock.

sales@ramnas.com

Tailor made accessories



We know the mooring business often requires specific solutions. That is why we offer our immense expertise in helping you with design and supply of customized products.

RF Connector

When joining two mooring chains, a solid connector can be used. The RF Connector has the same outside shape as a traditional Kenter joining connector, but with an outside thickness (D) of 1.30 x d. The slim shape will enable the RF connector to be used on every mooring system on semisubmersibles, offshore loading system, and will fit any wildcat.

Through the unique robotized heat treatment process that is used in producing the connector, the results are identical for quenching and tempering. The unique heat treatment also ensures visible deformation in good time before the components fails – all in favour to provide the highest quality product for any and all offshore project.

Its six teeth locking head provides a larger bearing area and a better stress distribution. Compared with standard or slim type connectors the side load resistance is larger and it has a better shock load resistance as well.

Key benefits of RF Connector in short:

- +5% proof and break load compared to standard grade RF
- Locking mechanism with a larger bearing area
- Robotized heat treatment process
- RF design improves fatigue life
- A designed spot for RFID chip as standard
- All parts are CNC/DNC machined
- Available in all grades
- Also available with pinless locking system

RF Anchor Connector

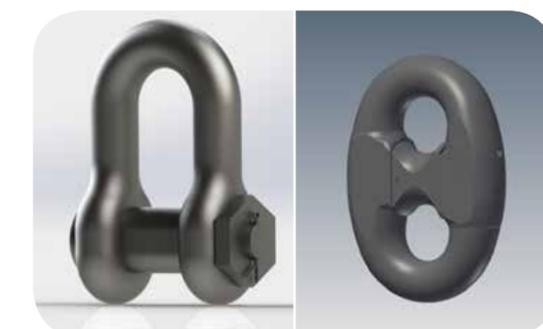
The RF Anchor Connectors are very similar to the RF Connectors. The one thing that differs is the small end of the shackle, designed to accept a common link. This eliminates costly enlarged links and end links, saving you money.

The RF Anchor Connector is dismantled and assembled in a similar way as the RF Connector.

Shackles

Ramnäs Bruk supply Joining and Anchor Shackles for your every need, both in standard D-type and D-type LTM.

Our conventional D-type Joining and Anchor Shackles are available in all offshore grades and in dimensions from 76 mm diameter and above.



Anchor Shackle

RF Connector

Accessories

Ramnäs Bruk is not just a renowned Swedish chain manufacturer. With our experience and cutting edge research, we can support you during the design and engineering phase. So – in addition to our standard products, we can supply specific connecting parts to suit your every need.



Customer specific connectors

In addition to our standard products, we can help you produce specific connecting parts for your every need. Below are some examples of customer specific connectors.

sales@ramnas.com



H-Shackle



Ramplate



ROV-Shackle



Triplate

The Ramnäs Bruk production system

Securing premium quality all the way

1 Inquiry and Quotation



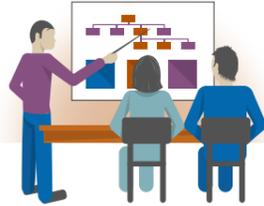
Inquiry from customer is sent to Ramnäs Bruk Sales Department and a quotation to meet customer specifications is prepared.

2 Order



A delivery from Ramnäs often starts with engineering and detailed design. Every project gets a dedicated Project Manager that will be the customer's link to Ramnäs. During the project, the Project Manager will supply progress reports on a regular basis.

3 Planning the project



For larger scale projects, a Kick Off Meeting is held together with the customer to define project specific requirements. Project documentation and procedures are initiated.

4 Arrival control of material



When the steel arrives to Ramnäs a thorough arrival control is made. The arrival control consists of checking the melt identification, checking the surface condition, dimension and tolerances etc.

5 Cutting bars



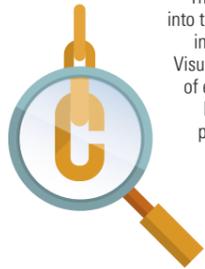
Bars are cut by a cold circular saw and the blank length is checked.

6 Heating of blanks



The blanks are heated by electrical resistance heaters to the optimal temperature to bending the bars into links.

7 Forming of links



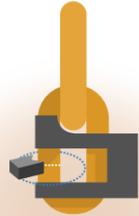
The heated blank is bent into the forged chain length in the bending machine. Visual control of the shape of each link is performed. Forging of test links as per sampling frequency specified in the classification society rules and per each melt of steel.

8 Welding of links



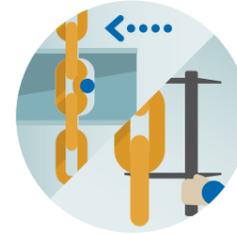
Links are flash butt welded according to a specific welding recipe that depends on chain grade and size. Every flash weld is recorded.

9 Trimming of links



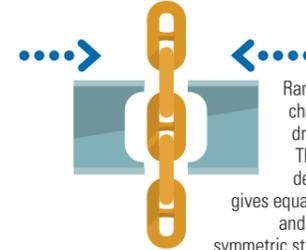
The flash-weld burr is trimmed by a flash removal tool working along the periphery of the weld.

10 Inspection and control at forging



Hot bend test for each melt. Manual gauging of link length and width.

11 Insertion of asymmetric studs or shaping of studless links



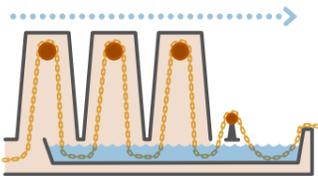
Ramnäs Bruk's stud chain is fitted with drop forged studs. The asymmetrical design of the stud gives equal stud footprints and contributes to a symmetric stress-distribution in the link.

12 Pre Heat treatment inspection



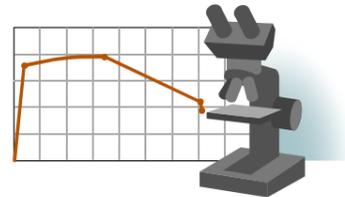
Magnetic Particle Inspection of each link. Visual control of shape, studs and surface of each link.

13 Heat Treatment



The heat treatment is performed in continuous automatically controlled furnaces and consists of quenching and tempering, both operations followed by water cooling.

14 Mechanical testing



The sample sets for the tensile, impact test and break test are retrieved as per sampling frequency specified in the classification society rules and per each melt of steel.

15 Proof loading and gauging



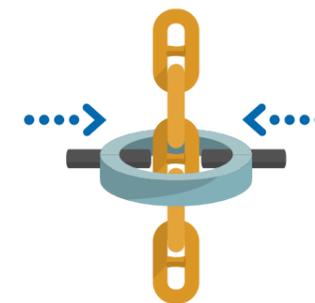
The proof loading is performed by continuous testing machine, 5-11 links are proof loaded with 1 link overlap. Every link is load tested to the proof load specified by the pertinent classification society. Continuous recording of loads and plastic elongation.

16 Visual inspection and gauging



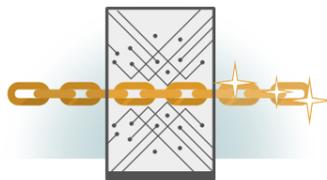
Visual Control of each link. Measuring of five link length, single link length and width.

17 Controlled Stud Expansion (not applicable for studless link)



Ramnäs controlled stud expansion, performed after proof loading is the standard method in Ramnäs Bruk production process since 1991 and it replaces all forms of stud welding. The stud expansion fixes the stud and creates a spring effect that improves the fatigue life of the chain.

18 Shotblasting



The surface of the chain is cleaned by shotblasting. Clean surfaces make the final non-destructive testing efficient and reliable.

19 Magnetic Particle Inspection



All links are checked with Magnetic Particle Inspection on the surfaces which have been in contact with the electrode clamps of the welding machine, the weld itself and its vicinity. 10% of the links are subject to surface control of all accessible surfaces.

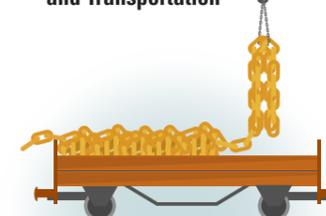
The inspection is performed by qualified and certified personnel.

20 Ultrasonic inspection with Phased Array method



Phased Array method uses ultrasonic waves with a large number of scanning beams to check the interior of the welded area on the link. The versatility and high speed of the PA method enables 100% check of all welds.

21 Dispatch, Logistics and Transportation



The chain is bundled with certified wire slings. The chain is loaded by overhead cranes onto railway wagon or truck for transport to the final destination or to the loading port of carrying vessel.

22 Documentation



After delivery the customer will receive the final documentation as specified by the classification society and customer requirements.

Proof and break loads (kN)

LOAD (in kN) = c x d² x (44 – 0.08 x d) (d in mm)

Test Load	Break Load						Proof Load										Weight			
	Grade	ORQ	R3	R3S	R4	R4S	R5	ORQ	R3	R3S Stud	R3S Stud-less	R4 Stud	R4 Stud-less	R4S Stud	R4S Stud-less	R5 Stud	R5 Stud-less	Stud	Stud-less	
C-factor	0,0211	0,0223	0,0249	0,0274	0,0304	0,032	0,014	0,0156	0,018	0,0174	0,0216	0,0192	0,024	0,0213	0,0251	0,0223				
mm																			kg/m	
76	4621	4884	5454	6001	6658	7009	3066	3417	3942	3811	4731	4205	5257	4665	5498	4884	126	116		
78	4847	5123	5720	6295	6984	7351	3216	3584	4135	3997	4962	4411	5514	4893	5766	5123	133	122		
81	5194	5490	6130	6745	7484	7877	3446	3840	4431	4283	5317	4726	5908	5243	6179	5490	144	131		
84	5550	5866	6550	7208	7997	8418	3683	4104	4735	4577	5682	5051	6313	5603	6602	5866	155	141		
87	5916	6252	6981	7682	8523	8971	3925	4374	5046	4878	6056	5383	6729	5972	7037	6252	166	151		
90	6289	6647	7422	8167	9062	9539	4173	4650	5365	5187	6439	5723	7154	6349	7482	6647	177	162		
92	6544	6916	7722	8497	9428	9924	4342	4838	5582	5396	6699	5954	7443	6606	7784	6916	185	169		
95	6932	7326	8180	9001	9987	10512	4599	5125	5913	5716	7096	6307	7884	6997	8246	7326	198	181		
97	7195	7604	8490	9343	10366	10911	4774	5319	6138	5933	7365	6547	8184	7263	8559	7604	206	188		
100	7596	8028	8964	9864	10944	11520	5040	5616	6480	6264	7776	6912	8640	7668	9036	8028	219	200		
102	7868	8315	9285	10217	11336	11932	5220	5817	6712	6488	8054	7159	8949	7942	9359	8315	228	208		
105	8282	8753	9773	10754	11932	12560	5495	6123	7065	6829	8478	7536	9420	8360	9851	8753	241	221		
107	8561	9048	10103	11118	12335	12984	5681	6330	7304	7060	8764	7790	9738	8643	10184	9048	251	229		
111	9130	9650	10775	11856	13154	13847	6058	6750	7789	7529	9347	8308	10385	9217	10861	9650	270	246		
114	9565	10109	11287	12420	13780	14506	6346	7071	8159	7887	9791	8703	10879	9655	11378	10109	285	260		
117	10005	10574	11807	12993	14415	15174	6639	7397	8535	8251	10242	9104	11380	10100	11902	10574	300	274		
120	10452	11047	12334	13573	15059	15852	6935	7728	8916	8619	10700	9511	11889	10551	12434	11047	315	288		
122	10753	11365	12690	13964	15493	16308	7135	7950	9173	8868	11008	9785	12231	10855	12792	11365	326	298		
124	11057	11686	13048	14358	15930	16768	7336	8175	9432	9118	11319	10061	12576	11161	13153	11686	337	308		
127	11516	12171	13591	14955	16592	17466	7641	8515	9824	9497	11789	10479	13099	11626	13700	12171	353	323		
130	11981	12663	14139	15559	17262	18171	7950	8858	10221	9880	12265	10903	13628	12095	14253	12663	370	338		
132	12294	12993	14508	15965	17713	18645	8157	9089	10488	10138	12585	11187	13984	12411	14625	12993	382	348		
137	13085	13829	15441	16992	18852	19844	8682	9674	11162	10790	13395	11906	14883	13209	15565	13829	411	375		
142	13887	14677	16388	18033	20008	21061	9214	10267	11847	11452	14216	12637	15796	14019	16520	14677	442	403		
147	14700	15536	17347	19089	21179	22294	9753	10868	12540	12122	15048	13376	16720	14839	17487	15536	473	432		
152	15522	16405	18317	20156	22363	23540	10299	11476	13241	12800	15890	14124	17655	15669	18464	16405	506	462		
157	16352	17282	19297	21234	23559	24799	10850	12089	13949	13484	16739	14879	18599	16507	19452	17282	540	493		
162	17188	18166	20284	22320	24764	26068	11405	12708	14663	14174	17596	15641	19551	17351	20447	18166	575	525		
167	18030	19056	21278	23414	25977	27345	11963	13330	15381	14869	18458	16407	20508	18201	21448	19056	611	558		
172	18876	19950	22276	24513	27196	28628	12525	13956	16103	15566	19324	17177	21471	19055	22455	19950	648	592		
177	19725	20847	23278	25615	28420	29915	13088	14584	16827	16267	20193	17949	22437	19912	23465	20847	686	627		

Due to the application of different rounding-off-principles for calculation of loads, individual classification societies show slightly different load values in their tables.

Weights in table are calculated and can therefore differentiate from as-built weights.

Proof and break loads (KIP)

LOAD (in KIP) = c x d² x (44 – 2.032 x d)/1000 (d in inch)

Test Load	Break Load						Proof Load										Weight			
	Grade	ORQ	R3	R3S	R4	R4S	R5	ORQ	R3	R3S Stud	R3S Stud-less	R4 Stud	R4 Stud-less	R4S Stud	R4S Stud-less	R5 Stud	R5 Stud-less	Stud	Stud-less	
C-factor	3060,3	3234,3	3611,4	3974,0	4409,1	4641,2	2030,5	2262,6	2610,7	2523,7	3132,8	2784,7	3480,9	3089,3	3640,4	3234,3				
Inch																			lb/ft	
3	1044	1103	1232	1356	1504	1583	693	772	891	861	1069	950	1187	1054	1242	1103	85	78		
3 1/16	1084	1146	1280	1408	1562	1644	719	802	925	894	1110	987	1233	1095	1290	1146	89	81		
3 1/8	1125	1189	1328	1461	1621	1706	747	832	960	928	1152	1024	1280	1136	1338	1189	93	85		
3 3/16	1167	1233	1377	1515	1681	1769	774	863	995	962	1194	1062	1327	1178	1388	1233	96	88		
3 1/4	1209	1278	1426	1570	1742	1833	802	894	1031	997	1237	1100	1375	1220	1438	1278	100	92		
3 5/16	1251	1323	1477	1625	1803	1898	830	925	1068	1032	1281	1139	1423	1263	1489	1323	104	95		
3 3/8	1295	1368	1528	1681	1865	1964	859	957	1105	1068	1325	1178	1473	1307	1540	1368	108	99		
3 7/16	1339	1415	1580	1738	1928	2030	888	990	1142	1104	1370	1218	1522	1351	1592	1415	112	102		
3 1/2	1383	1462	1632	1796	1992	2097	918	1022	1180	1140	1416	1258	1573	1396	1645	1462	116	106		
3 9/16	1428	1509	1685	1854	2057	2165	947	1056	1218	1177	1462	1299	1624	1441	1698	1509	120	110		
3 5/8	1473	1557	1739	1913	2123	2234	977	1089	1257	1215	1508	1341	1676	1487	1752	1557	125	114		
3 3/4	1566	1655	1848	2033	2256	2374	1039	1158	1336	1291	1603	1425	1781	1580	1862	1655	134	122		
3 7/8	1660	1754	1959	2156	2392	2518	1101	1227	1416	1369	1699	1511	1888	1676	1975	1754	143	130		
3 15/16	1708	1805	2016	2218	2461	2590	1133	1263	1457	1409	1748	1554	1943	1724	2032	1805	147	134		
4	1756	1856	2073	2281	2531	2664	1165	1299	1498	1448	1798	1598	1998	1773	2089	1856	152	139		
4 1/8	1855	1960	2189	2408	2672	2813	1231	1371	1582	1530	1899	1688	2110	1872	2206	1960	162	148		
4 1/4	1955	2066	2307	2538	2816	2965	1297	1445	1668	1612	2001	1779	2223	1973	2325	2066	171	157		
4 3/8	2057	2174	2427	2671	2963	3119	1365	1521	1754	1696	2105	1871	2339	2076	2446	2174	182	166		
4 1/2	2160	2283	2549	2805	3112	3276	1433	1597	1843	1781	2211	1966	2457	2181	2570	2283	192	176		
4 5/8	2265	2394	2673	2941	3263	3435	1503	1675	1932	1868	2319	2061	2576	2287	2694	2394	203	185		
4 3/4	2372	2507	2799	3080	3417	3597	1574	1753	2023	1956	2428	2158	2698	2394	2821	2507	214	196		
4 7/8	2480	2621	2926	3220	3573	3761	1645	1833	2115	2045	2538	2256	2820	2503	2950	2621	226	206		
5	2589	2736	3055	3362	3730	3926	1718	1914	2209	2135	2650	2356	2945	2614	3080	2736	237	217		
5 1/8	2700	2853	3186	3506	3890	4094	1791	1996	2303	2226	2764	2457	3071	2725	3211	2853	249	228		
5 1/4	2812	2971	3318	3651	4051	4264	1865	2079	2398	2319	2878	2558	3198	2838	3344	2971	262	239		
5 3/8	2925	3091	3451	3798	4214	4435	1940	2162	2495	2412	2994	2661	3327	2952	3479	3091	274	250		
5 1/2	3039	3211	3586	3946	4378	4608	2016	2247	2592	2506	3111	2765	3456	3067	3615	3211	287	262		
5 5/8	3154	3333	3722	4095	4544	4783	2093	2332	2690	2601	3228	2870	3587	3184</						

Mechanical Properties

Classification Society	API Spec 2F	Ramnärs Inhouse	Offshore Mooring Chain (IACS W22)			DNV-OS-E302 October 2013	
Quality	ORQ	ORQ+20%	R3	R3S	R4	R4S	R5
Tensile test							
Yield strength Re (N/mm ²)	-	-	410	490	580	700	760
Ultimate tensile strength Rm (N/mm ²)	641	750	690	770	860	960	1000
Elongation A5 (%)	17	15	17	15	12	12	12
Reduction of area Z (%)	40	40	²⁾ 50	²⁾ 50	³⁾ 50	³⁾ 50	³⁾ 50
Impact strength							
Min average energy, parent material (J)	58 40	58	60 40	65 45	50	56	58
Min average energy, weld (J)	49 36	34	50 30	53 33	36	40	42
Test temperature 1) °C	0 -15	0	0 -20	0 -20	-20	-20	-20

¹⁾ At the option of the Society the impact test of grade R3 and R3S may be carried out at 0°C or -20°C.

²⁾ For cast accessories, the minimum value shall be 40%.

³⁾ For cast accessories, the minimum value shall be 35%.

Twist of stud link mooring chain

A twist of 45 degrees over 5 links is acceptable without noticeable decrease of chain strength. More twist under load will deform the chain. Thus a 90-foot length of chain may be twisted under load according to the formula:

$$\vartheta_{\max} = \frac{27500 \times 45}{4 \times d \times 5} = \frac{61875}{d}$$

Where d is chain nominal diameter in mm.

Chain dimension mm	Allowable maximum twist of 90-foot length	
	ϑ degrees	No. of turns of 360°
76	814	2,3
84	737	2,0
114	543	1,5
140	436	1,2
172	360	1

Coefficient of friction for mooring chain

The coefficient of friction depends upon the actual ocean bottom at the anchor location. General friction factors for chains are given in the table. The starting friction factors may be used to compute the holding power of the chain. The sliding friction factor may be used to compute forces on the chain during deployment.

Ocean bottom	Friction factors	
	Starting	Sliding
Sand	0.98	0.74
Mud with sand	0.92	0.69
Firm mud	1.01	0.62
Soft mud	0.90	0.56
Clay	1.25	0.81

Chain holding power generalized friction factors for mooring chain.

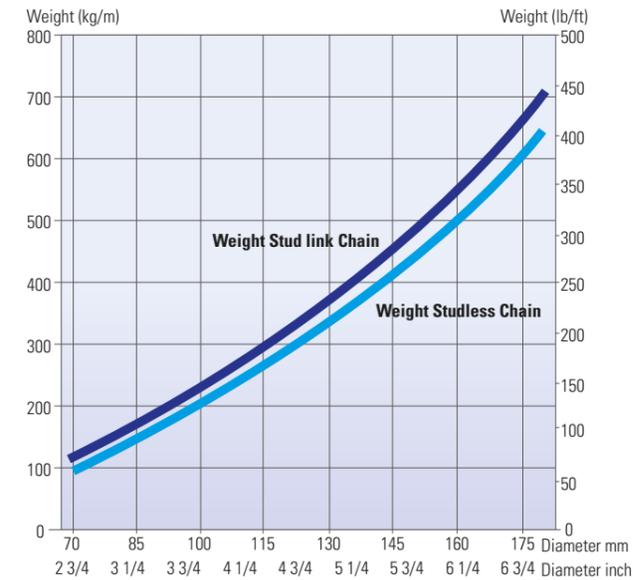
Submerged weight of chain

The submerged weight of chain varies with the density of the seawater, but can be roughly estimated using this formula.

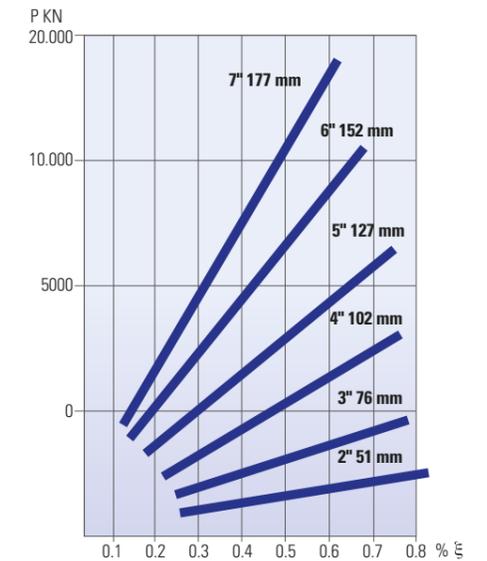
$$\text{Submerged weight} = \left[\frac{v_1 - v_2}{v_1} \right] \times \text{weight of chain in air} = 0,87 \times \text{weight of chain in air}$$

$$v_1 = \text{Density of steel} = 7,85 \text{ kg/dm}^3 \quad v_2 = \text{Density of seawater} \approx 1,02 \text{ kg/dm}^3$$

Weight data



Elasticity data of stud link chain



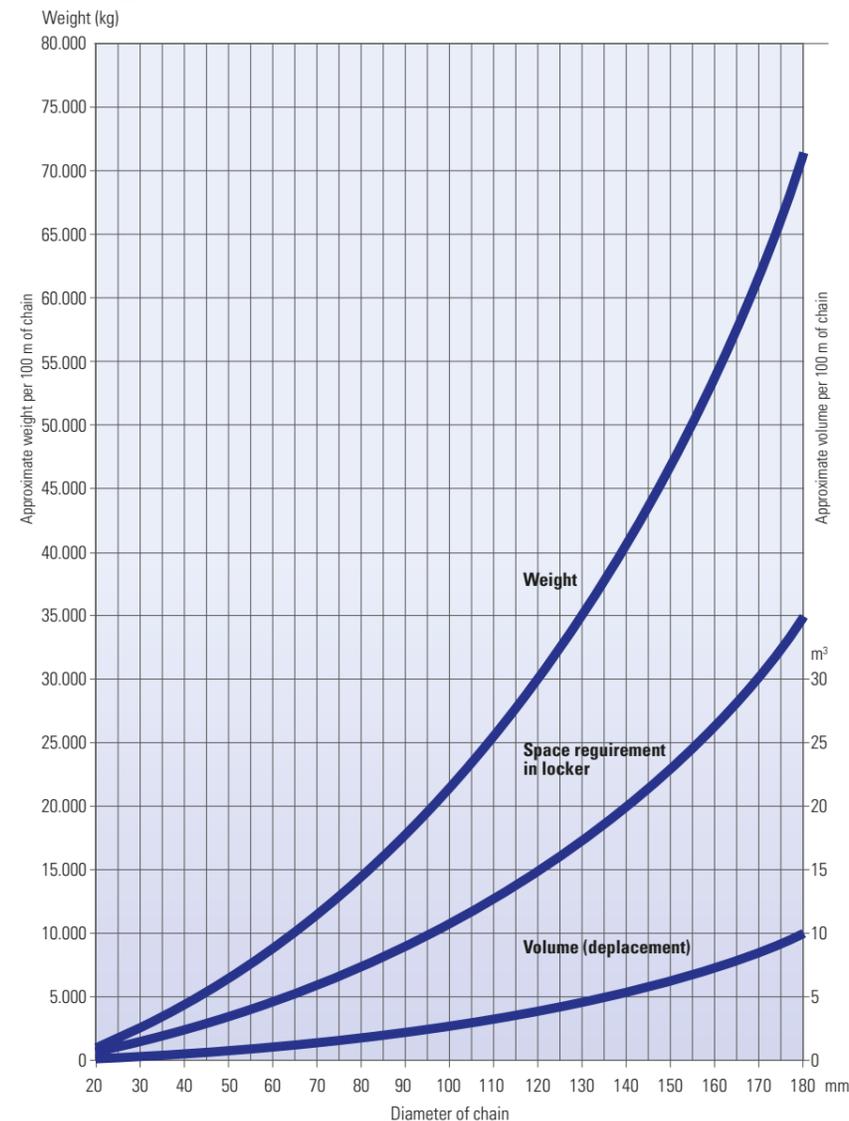
The modulus of elasticity for mooring chain (E) is expressed by the equation:

$$E = \frac{2 \times P \times 100}{d^2 \times \xi \times \pi} = 64000$$

Where:

E is Youngs modulus expressed in MPA
P is the load that causes a ductile elongation (strain) of ξ, P is expressed in Newton.
d is the chain diameter (wire dia) expressed in mm.
ξ is the strain expressed in %.
π is 3,14.

Weight and volume data stud link chain



$$\text{Weight} = 0,0219 \times d^2 \text{ kg/m}$$

$$\text{Volume} = 1,095 \times 10^{-5} \times d^2 \text{ m}^3/\text{m}$$

d = nominal chain diameter in mm.

Weights in table are calculated and can therefore differentiate from as-built weights.

Approximate weight of details (kg)

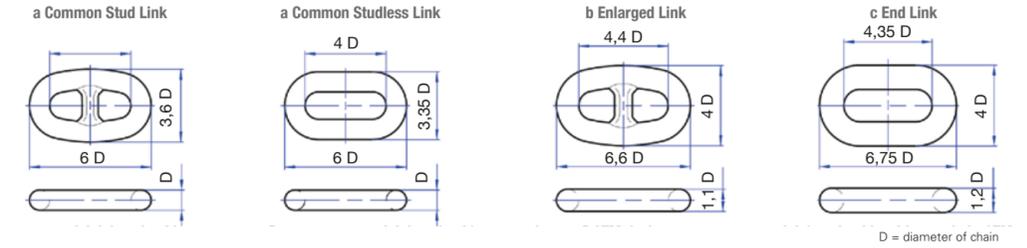
Diameter	Common Stud Link	Common Studless Link	Enlarged Link	End Link	RF Connector	Joining Shackles Type D	Joining Shackles Type D LTM	Anchor Shackles Type D	Anchor Shackles Type D LTM
mm	kg	kg	kg	kg	kg	kg	kg	kg	kg
76	39	36	50	60	65	100	110	140	155
78	43	39	55	65	70	105	115	150	165
81	48	44	60	70	79	120	130	170	185
84	53	49	70	80	88	135	145	195	210
87	59	54	75	85	95	150	165	220	240
90	65	60	80	95	104	165	185	245	265
92	70	64	90	100	106	175	191	255	280
95	77	70	100	110	123	200	220	290	315
97	82	75	100	120	131	210	230	305	330
100	90	82	110	130	144	230	250	335	365
102	95	87	120	140	151	245	265	350	380
107	110	100	140	160	163	285	310	410	445
111	123	112	160	175	175	305	335	445	485
114	133	121	175	195	180	325	360	475	520
117	144	131	185	210	200	345	385	505	555
122	163	149	210	235	245	380	420	550	600
127	184	168	235	260	280	420	465	600	660
132	207	189	260	305	320	480	530	675	740
137	231	211	285	330	350	550	605	750	825
142	257	235	325	375	390	650	710	900	985
147	285	260	395	410	450	720	790	1055	1145
152	315	288	410	460	515	845	885	1200	1300
157	347	317	455	510	585	932	975	1550	1655
162	382	349	500	560	660	1025	1070	1700	1820
167	418	382	540	630	725	1125	1175	1970	2100
172	457	417	590	680		1225	1285	2300	2440
177	498	455	640	730		1340	1400	2700	2855

Weights in table are calculated and can therefore differentiate from as-built weights.

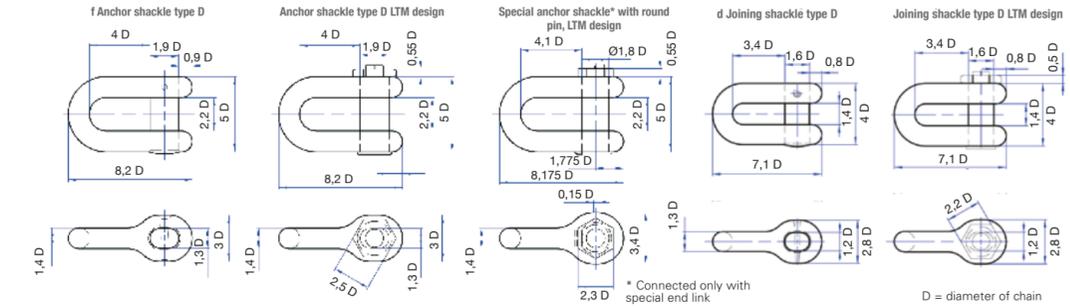
Approximate weight of details (lbs)

Diameter	Common Stud Link	Common Studless Link	Enlarged Link	End Link	RF Connector	Joining Shackles Type D	Joining Shackles Type D LTM	Anchor Shackles Type D	Anchor Shackles Type D LTM
inch	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs	lbs
3	88	80	110	130	143	220	245	310	340
3 1/16	93	85	120	140	154	235	260	330	365
3 3/16	105	96	135	155	174	260	290	375	410
3 5/16	118	108	150	170	194	295	325	425	465
3 7/16	132	120	165	190	209	330	365	480	525
3 9/16	147	134	180	210	229	370	405	535	580
3 5/8	155	141	195	220	234	385	420	565	615
3 3/4	171	156	215	245	271	440	485	640	695
3 7/8	189	172	225	265	289	465	510	670	730
3 15/16	198	181	245	285	317	505	555	740	800
4	208	190	365	305	333	535	585	770	840
4 1/4	249	227	310	350	359	630	685	905	985
4 3/8	272	248	350	385	386	670	745	980	1070
4 1/2	296	270	380	425	397	715	790	1045	1150
4 5/8	321	293	405	465	441	760	745	1115	1220
4 3/4	348	317	465	520	540	840	930	1210	1325
5	405	370	520	575	617	925	1025	1325	1455
5 1/8	437	399	575	670	705	1060	1170	1490	1630
5 3/8	504	460	630	725	772	1215	1340	1655	1815
5 5/8	577	527	715	825	860	1435	1565	1985	2165
5 3/4	617	563	870	905	992	1590	1740	2325	2525
6	701	640	905	1015	1135	1785	1950	2645	2870
6 3/16	768	702	1005	1125	1290	2140	2320	3420	3650
6 3/8	840	768	1100	1235	1455	2350	2540	3750	4010
6 9/16	917	837	1190	1390	1598	2620	2845	4340	4630
6 3/4	998	911	1300	1500		2930	3165	5070	5385
7	1113	1016	1415	1610		3220	3475	5950	6295

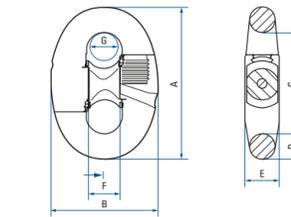
Links



Anchor and Joining shackles



RF Connector



Dimensions for RF connector

Chain Size mm	Chain Size inch	Dimensions (mm)							Weight (kg)
		A	B	C	D	E	F	G	
76	3	456	318	304	76	99	87	84	65
84	3 5/16	504	351	336	84	109	96	92	88
89	3 1/2	534	372	356	89	116	101	98	101
95	3 3/4	570	379	380	95	124	108	104	150
102	4	612	426	408	102	133	116	112	172
114	4 1/2	684	476	456	114	148	130	125	190

Larger sizes upon request.

Conversion Factors for SI-units

Quantity	U.S. or MKK Unit	Multiply by	To obtain SI Units
Length	fathom	1.828 800*	m
	ft	3.048 (10 ⁻¹)*	m
	in.	2.540 (10 ⁻¹)*	mm
Mass	lb	4.535 924 (10 ⁻¹)	kg
	ton (long)	1.016 047 (10 ³)	kg
	ton (metric)	1.000 (10 ³)	kg
	ksi	6.894 757 (10 ⁶)	N/m ² (or Pa)
Pressure, Stress	psi	6.894 757 (10 ³)	N/m ² (or Pa)
		6.894 757 (10 ⁻³)	N/m ² = MPa
		6.894 757 (10 ⁻²)	bar (or 105 N/m ²)
	ton (long) / in. ²	1,544 426 (10 ⁷)	N/m ² (or Pa)
		1,544 426 (10 ⁷)	N/mm ²
	kg/cm ²	9.806 650 (10 ⁴)*	N/m ² (or Pa)
	bar (or 10 ⁵ N/m ²)	9.806 650 (10 ⁻¹)	N/m ² (or Pa)
	kg/mm ²	9.806 650 (10 ⁹)*	N/m ² (or Pa)

Quantity	U.S. or MKK Unit	Multiply by	To obtain SI Units
Area	ft ²	9.290 304 (10 ⁻²)*	m ²
	in. ²	6.451 600 (10 ⁻²)*	mm ²
Energy, Work	BTU	1.055 056 (10 ³)	J
	ft-lb	1.355 818	J
	in.-lb	1.129 848 (10 ⁻¹)	J
	kcal	4.186 800 (10 ³)*	J
	kg-m	9.806 650*	J
Force	lbf	4.448 222	N
	ton (long)	9.964 017 (10 ³)	N
	kgf	9.806 650*	N
	ton (metric)	9.806 650 (10 ³)	N
	KIP = 1,000 lbf	4.448 222	kN
Temperature	°F	(°F-32) / 1.8	°C

This table only provides conversion factors for US units and MKS units that differ from SI units. Proper use of significant figures and rounding-off techniques should be given due consideration when using conversion factors.

* exact value



1590 Ramnäs started as a **Crown enterprise** making wrought iron from pig iron. The first forging-hammer was built by the Queen dowager Catarina Stenbock.

1876 Swedish wrought iron played an important role in Swedish export for 300 years. During the second half of the nineteenth century the wrought iron manufacture in Ramnäs was completed with a rolling mill, thus creating a fully integrated manufacture of steel bars from pig iron. With good access to bar-material, **chain production started**.

1943 Modern fabrication with **flash butt welding** of anchor chains was first developed and introduced by Ramnäs.

1960 By developing the first offshore grade, **ORO**, Ramnäs Bruk was the **first supplier of offshore chain** in the world.

1967 The traditional chain for ships was delivered in 15 fathoms lengths. The offshore industry requested continuous lengths without shackles, and Ramnäs Bruk responded to the customers' wishes by building a factory for manufacture of **continuous lengths of chain**.

1975 Production line for manufacturing of chain up to **165 mm** diameter was built.

1982 First **Grade 4 (K4)** was developed by Ramnäs Bruk.

1990 **New connector design** for Ramfor was introduced. Today known as RF-connector.

1991 A new stud chain design was introduced. Stud welding for stud fastening was replaced by **stud expansion**. This expansion pre-loads the link thus maintaining long-time stud contact in spite of the loss of material by corrosion in the contact surfaces of the stud. The uneven heat distribution in the link during stud insertion is compensated by the creation of the **asymmetric stud**.

1992 Microprocessor **control and recording of every flash weld** was introduced.

1994 New world record for the largest **stud link chain** ever delivered. Troll B, Grade 4, **152 mm 6"**.

1996 The first delivery of **studless chain**. Over the years more than 30 000 tonnes studless chain has been delivered from Ramnäs since then.

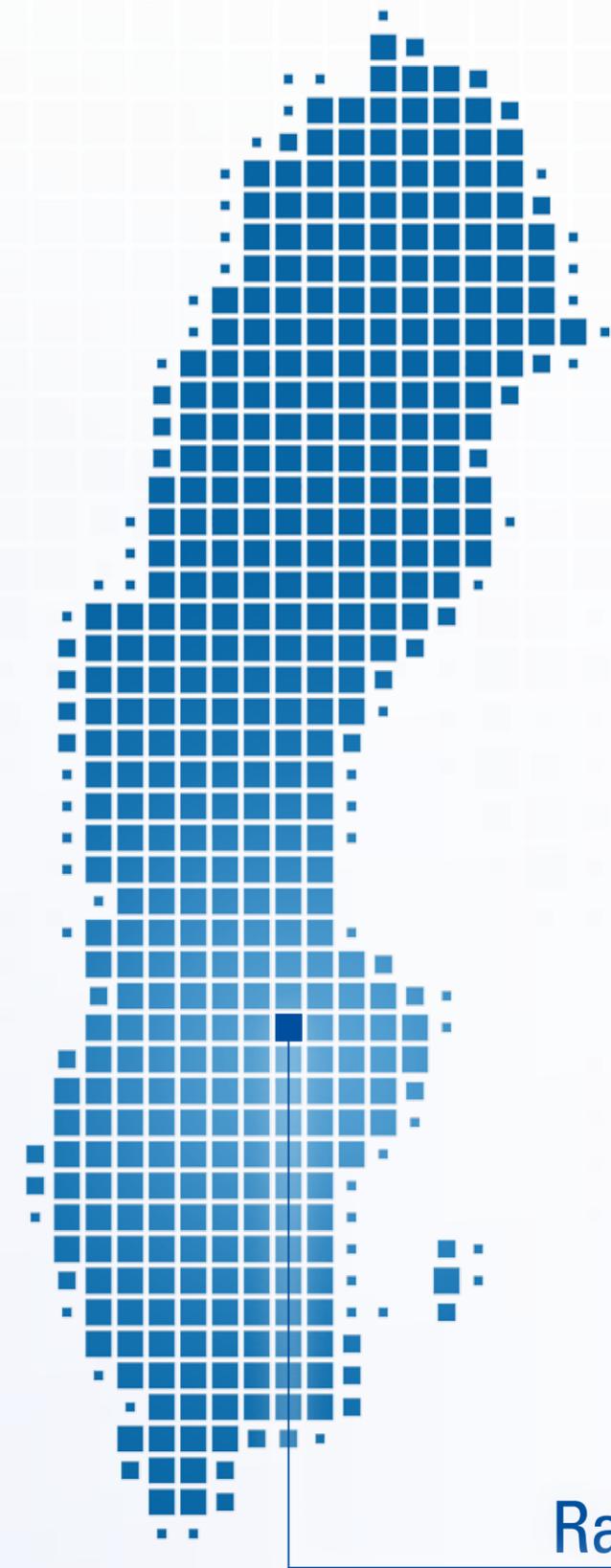
1999 In order to be able to utilise existing winches with stronger chains **Grade 4+** was developed. A stronger steel was utilised in combination with 82 mm bar diameter for chain with the five-link length of 76 mm diameter.

2006 Chain **Grade 5** was introduced.

2010 Ramnäs Bruk introduces the new State of the Art technique, **Phased Array** for Ultrasonic Testing.

2013 New **furnace** was installed with an increased chain speed with 30% compared to our prior furnace.

2015 Ramnäs Bruk continues to invest for the future by building a new **furnace system** consisting of both quenching and tempering furnaces. The new furnaces will increase the production **capacity by double** and also give Ramnäs Bruk the potential to develop future chain grades, as **R6**.



Ramnäs Bruk

N 59° 46' 34" E 16° 11' 7"