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RR Piling Manual

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TUOTE

HAKIJA JA VALMISTAJA

Rautaruukki Oyj Metform, Hämeenlinna

LAADUNVALVONTA


MERKITSEMINEN

VOIMASSAOLOAIKA

Heikki Aho

Jaakko Huuhtanen

LIITTEET

TIEDOKSI

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1. General

This manual deals with impact-driven RR piles. It is an abridgement of the RR Piling Handbook which contains more detailed instructions on the design, installation and supervision related to RR piling.

2. Requirements of RR piling site

Piling class III (Easy projects)

- Lightweight and basic buildings and constructions not intended for permanent habitation.
- Sites with easy soil conditions.

Piling class II (Demanding projects)

- Lightweight and basic residential buildings and constructions.
- Sites with easy soil conditions.

Piling class IB (Very demanding projects)

- Bridges, hydraulic structures, industrial structures and other corresponding engineering structures.
- Large or complicated structures and buildings located in areas of organic or fine-grained soils.
- Sites where rock is overlaid only by organic or fine-grained soils.
- Structures subject to dynamic or otherwise exceptional loads such as significant horizontal loads, bending or heavy vertical loads, or special requirements.
- Structures incorporating piles driven through thick fill.

3. Soil investigations

The following case-specific site investigations are recommended.

Piling class III (Easy sites)

Piles bearing on ground

- Weight sounding at least at each corner of building or structure to be founded.
- In exceptional cases RR piling may be considered to substitute for sounding. Then, pile-driving resistance must be documented as dynamic-probing resistance. Pile bearing capacity must be determined based on end-of-driving criteria.

Horizontally loaded piles

- Weight sounding at least at each individual foundation or at every fourth noise-barrier or fence pier or no more than 20 metres apart.

Piling class II (Demanding sites)

Piles bearing on ground or rock

- Dynamic probing may be substituted by weight sounding if it can be assured that the piles reach a compact coarse-grained soil or moraine layer.
- Dynamic probing must be performed at least at each corner of the building to be founded and at 5-15 metre intervals depending on the degree of variation in soil conditions. Probing must go as deep as possible since RR piles often penetrate deeper than dynamic probing.
- The definition of the parameters needed in calculating the buckling load of a pile requires performing vane tests.
- Disturbed samples should be taken from every fourth test hole in order to determine soil-layer boundaries.

Horizontally loaded piles

- Weight sounding or cone penetration tests at each individual foundation or at every fourth noise barrier or fence pier or no more than 20 metres apart.
- Disturbed samples should be taken from every fourth test hole in order to determine soil-layer boundaries.
- Vane tests at each fourth individual foundation or at every fourth noise barrier or fence pier or no more than 20 metres apart.

Piling class IB (Very demanding sites)

General

At very demanding sites an investigation is required at each foundation and at each corner of large foundations such as pile-group foundations of bridges.

Piles bearing on ground

- Dynamic probing must penetrate as deep as possible.

- Disturbed samples should be taken from every fourth test hole in order to determine soil-layer boundaries.
- The definition of the parameters needed in calculating the buckling load of a pile requires performing vane tests.
- In the case of fine-grained and organic soil layers, soil samples should be taken in order to determine compressibility and/or strength by an oedometer and/or triaxial tests.

Piles bearing on rock

- Similar site investigations as with piles bearing on ground.
- Determination of the position of bedrock face by percussion drilling.
- The position and contours of bedrock face must always be determined when the piles are to bear on rock. Utmost precision is required when the rock face is not overlaid by a layer providing sufficient lateral support to prevent the sliding of the pile tip:
  - Fine-grained soil layers extend to the sloping rock face.
  - The sloping rock face is overlaid by loose coarse-grained soil or moraine.
  - The coarse-grained layer of soil or moraine is thin.

Horizontally loaded piles

When making use of the lateral capacity of a pile, for instance, with horizontally loaded or bending-stressed piles, especially the strength and deformation characteristics of the soil layers supporting the top part of the pile must be determined.

- By vane tests with fine-grained soil layers.
- Strength properties of coarse-grained and moraine layers can be determined indirectly on the basis of soil type and sounding resistance. If horizontal loads and moment stresses are heavy, soil samples need to be taken in order to determine compressibility and/or strength by an oedometer and/or triaxial tests.

The groundwater level is monitored and the range of variation is estimated.

4. RR pile materials and reinforcements

Steel grades and standards

The raw material of RR piles is steel grade S440J2H presented in Table 1.

Table 1. Properties of steel grade S440J2H

Chemical composition, max.				
C [%]	Mn [%]	P [%]	S [%]	CEV
0.18	1.60	0.020	0.018	0.39

Mechanical properties				
f_y min	f_u	A_5 min	Impact strength*)	
[MPa]	[MPa]	[%]	T [°C]	KV min [J]
440	490–630	17	-40	27

*Impact strength requirement must be agreed separately with material thicknesses over 10 mm.

RR pile sizes RR60-RR220 meet the requirements for steel grade S440J2H. The bearing capacity and strength of RR60-RR115/6.3 piles are, however, based on 355 MPa yield strength. The technical delivery terms for piles conform to Standard EN 10219 except for straightness and length tolerance which are 1.25/1000 and ± 50 mm, respectively.

RR pile sections and accessories

The components of RR piles are shown in Fig. 1. Manufactured pile types, their dimensions and sectional properties are presented in Table 4. Table 5 shows the stock lengths and project-specific lengths of RR piles with external friction splices. These are effective lengths of piles. Special lengths are manufactured to order. Pile pipes up to a maximum length of 16 metres without a splice are also available.

Especially in the case of hard-to-penetrate layers, pile slenderness must be a consideration when choosing section length. Particularly in the case of small diameter piles (RR60-RR115) an excessively long section may result in buckling of the pile in installation.

RR75 or larger diameter piles can be used in projects under piling classes IB and II. All piles may be used in piling class III projects. The most common pile sizes for detached and row houses (RR75 and RR90) are generally designed for piling class II.

Splices

Splices manufactured by Ruukki are used with RR piles. They meet the requirements which have been set in Finland to the rigid pile splices. The splice is realized by a double conical sleeve which attaches to the pile shaft by friction.

The staying in place of the external splice during driving is ensured by welding, which is done at the factory as the splice is made. No welding of the splice is needed on site. RR pile splices are type approved. Type approval is marked on each pile section near the splice.

Table 2. Minimum requirements for strength and stiffness properties of splice

Pile type	Tensile strength [kN]	Compres-sive-strength	Yield moment M	Bending stiffness EI (0.3-0.8 M)
RR60	57			
RR75	74			
RR90	87			
RR115/6.3	114			
RR115/8	176			
RR140/8	218	P_{pile}	M_{pile}	$0.75xEI_{pile}$
RR140/10	269			
RR170/10	328			
RR170/12.5	404			
RR220/10	434			
RR220/12.5	535			

Tip

The tip of a pile is protected either by a bottom plate or a rock shoe. The bottom plate is more common. The site investigator generally determines whether a rock shoe is required.

Bearing plate

The head of the pile normally connects to the superstructure via a bearing plate. Table 3 gives the sizes of standard bearing plates.

Table 3. Standard sizes of RR bearing plates

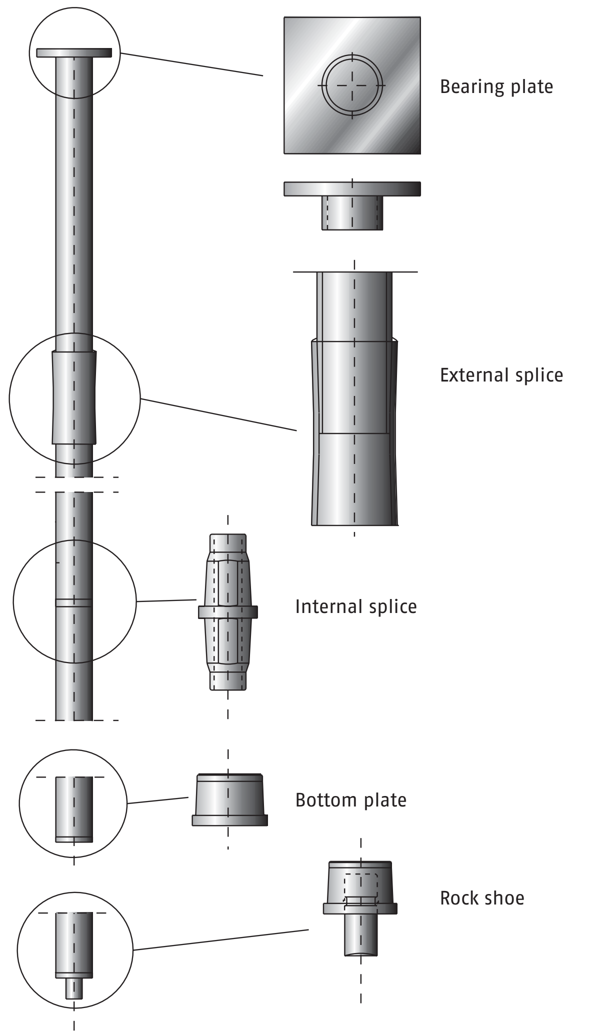
Pile type	Bearing-plate dimensions [mm x mm x mm]
RR60	120 x 120 x 15
RR75, RR90	150 x 150 x 15
RR115	200 x 200 x 20
RR140	250 x 250 x 25
RR170, RR220	300 x 300 x 30

Table 5. Lengths of pile sections when using fixed external sleeves

Pile length	Pile type								
	RR60	RR75	RR90	RR115/6.3	RR115/8	RR140/8	RR140/10	RR170/10	RR170/12.5
12 m	–	–	–	0	X	X	X	X	0
6 m	X	X	X	X	X	X	X	0	0
4 m	0	0	0	0	0	0	0	0	0
3 m	0	0	0	0	0	0	0	0	0
2 m	0	0	0	0	0	0	0	0	0
1.5 m	0	0	0	0	0	0	0	0	0
1.2 m	0	0	0	0	0	0	0	0	0
1.0 m	0	0	0	0	0	0	0	0	0

X=stock length 0=project-specific length –=not manufactured

Fig. 1. Structure of RR pile



5. Design

The bearing capacity of a pile is determined on the basis of geotechnical bearing capacity, structural bearing capacity and buckling resistance
The lowest value is decisive.

Geotechnical bearing capacity

Geotechnical bearing capacity is ensured by driving the piles to sufficient driving resistance. Steel piles are generally point-bearing piles whose geotechnical bearing capacity equals the capacity of the base.

The bearing-capacity values of Table 8 apply to piles longer than 5 metres. The pile capacity reduction factors of Table 6 are to be applied to piles shorter than 5 metres. If lateral displacement of piles can be prevented, as in large raft and beam foundations and joined separate foundations, unreduced capacity values can be applied to piles at least 3 metres. Use of driven piles under 1.5 metres is not recommended.

Table 6. Determination of bearing capacity of short piles

Pile length	Reduction factor by which capacity of long pile is multiplied
1.5 – 3 m	0.6
3 – 5 m	0.8
over 5 m	1.0

Bearing capacity of pile bearing on rock
A pile may be assumed to be bearing on rock when it is established that the pile tip has reached solid rock based on observations during pile driving and site investigations. Contact with rock can be ensured in unclear cases by stress-wave measurements.

A sufficient number of blows makes the dowel of the RR pile's rock shoe penetrate into rock so that the whole base of the pile becomes bearing. The bearing capacity of a pile bearing on rock is not determined by its geotechnical bearing capacity – it is defined either by structural bearing capacity or buckling resistance. At the end of driving, permanent set of pile and temporary elastic compression of pile and soil must be checked.

Bearing capacity of pile bearing on ground
The geotechnical bearing capacity of a pile bearing on ground may be clearly smaller than its structural bearing capacity.

Structural bearing capacity

The maximum allowed structural bearing capacity of RR piles based only on compression can be derived from the formula:

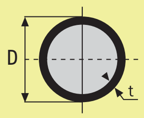
$$P_{all} = \zeta A_{red} f_y$$

ζ 0.33 Piling class III
0.40 Piling class II
0.50 Piling class IB, when at least 10% of the piles have been subjected to PDA measurement

A_{red} cross-section area of pile reduced by corrosion

f_y yield strength of steel

Table 4. Dimensions and sectional properties of RR piles



A = Cross-section area
A_u = External surface area
A_b = Pile base area
Z = Pile impedance
I = Moment of inertia
W_{el} = Section modulus

Cross-sectional values reduced by corrosion allowance
$A_{1,2}$ = Cross-section area after 1.2 mm allowance for corrosion

Pile type	D	t	M	A	A_u	A_b	W_{el}	I	EI	Z	$A_{1,2}$	$A_{2,0}$	$I_{1,2}$	$I_{2,0}$	$EI_{1,2}$	$EI_{2,0}$
	[mm]	[mm]	[kg/m]	[mm²]	[m²/m]	[mm²]	[cm³]	[cm⁴]	[kNm²]	[kNs/m]	[mm²]	[mm²]	[cm⁴]	[cm⁴]	[kNm²]	[kNm²]
RR60	60.3	6.3	8.4	1069	0.19	2856	13.1	39.5	83	43.4	846	702	29.8	23.9	62	50
RR75	76.1	6.3	10.8	1381	0.24	4548	22.3	84.8	178	56.1	1099	916	65.0	52.8	137	111
RR90	88.9	6.3	12.8	1635	0.28	6207	31.6	140.2	295	66.4	1304	1089	108.4	88.7	228	186
RR115/6.3	114.3	6.3	16.8	2137	0.36	10261	54.7	312.7	657	86.8	1711	1432	244.5	201.4	513	423
RR115/8	114.3	8.0	21.0	2672	0.36	10261	66.4	379.5	797	108.5	2245	1966	311.3	268.2	654	563
RR140/8	139.7	8.0	26.0	3310	0.44	15327	103.1	720.3	1513	134.4	2788	2445	595.1	515.2	1250	1082
RR140/10	139.7	10.0	32.0	4075	0.44	15327	123.4	861.9	1810	165.4	3552	3209	736.7	656.8	1547	1379
RR170/10	168.3	10.0	39.0	4973	0.53	22246	185.9	1564.0	3284	201.9	4343	3928	1344.1	1202.7	2823	2526
RR170/12.5	168.3	12.5	48.0	6118	0.53	22246	222.0	1868.3	3923	248.4	5488	5073	1648.4	1507.0	3462	3165
RR220/10	219.1	10.0	51.6	6569	0.69	37702	328.4	3598.4	7557	266.7	5747	5205	3110.8	2794.6	6533	5869
RR220/12.5	219.1	12.5	63.7	8113	0.69	37702	396.6	4344.5	9123	329.4	7291	6749	3856.9	3540.8	8100	7436

Table 8 shows the allowed structural bearing capacity of piles by classes. Bearing capacities have been calculated using three different radi of curvature considering the impact of buckling in soil layers providing poor lateral support. The largest radius of curvature is generally realized when using long pile sections (6-12 m) and the piles are driven into soil layers containing no stones. Correspondingly, the smallest radius is normally realized when using short (1-2 m) pile sections in difficult soil conditions.

Corrosion

Separate corrosion investigations are normally not needed except in industrial, or other possibly polluted, sites and with soil layers containing sulphide clay.

The surrounding conditions are considered in estimating the corrosion rate of RR piles. Corrosion is usually taken into account in the form of corrosion allowance. The magnitude of the corrosion allowance depends on the designed service life of the structure and estimated corrosion rate.

In clean soil corrosion is generally so low that piles can be protected by increasing wall thickness. The service life of foundations is generally estimated at 100 years, which sets the recommended corrosion allowance at 1.2-2 mm according to Eurocode 3 which deals with the design of steel structures (Table 7). Internal corrosion of piles with a closed base and top is so minimal that it can be ignored.

Piles may be concreted inside if necessary. Then, they can be dimensioned as a composite structure. In difficult corrosive conditions, such as polluted soils, protection may be realized by, for instance, concrete structures. Separate protection may also be provided by organic or inorganic surface treatments or cathodic protection. When using them, one must consider their durability during installation and service life. Surface treatments may become damaged when piles are installed in a stony or similar "scratching" layer. In such instances the rate of the occurring pit corrosion may exceed that of even corrosion.

If cathodic protection is used, the life time of the protection is to be considered.

Table 7. Corrosion allowances [mm] according to EN 1993-5 Eurocode 3: Design of Steel Structures – Part 5: Piling

Soil conditions	Required design working life [year]				
	5	25	50	75	100
Undisturbed natural soils (sand, silt, clay, schist, ...)	0.00	0.30	0.60	0.90	1.20
Polluted natural soils and industrial sites	0.15	0.75	1.50	2.25	3.00
Aggressive natural soils (swamp, marsh, peat, ...)	0.20	1.00	1.75	2.50	3.25
Non-compacted non-aggressive fills (clay, schist, sand, silt, ...)	0.18	0.70	1.20	1.70	2.20
Non-compacted aggressive fills (ashes, slag, ...)	0.50	2.00	3.25	4.50	5.75

- Corrosion rates in compacted fills are lower than those in non-compacted ones. In compacted fills the figures in the table should be divided by two.
- The values given are only for guidance. Local conditions should be considered and suitable values that take into account local conditions should be given in the National Annex.
- The values corresponding given for 5 and 25 years are based on measurements, whereas the other values are extrapolated.

Atmospheric corrosion in 100 years:
– 1 mm in normal atmosphere – 2 mm in marine conditions

Attachment of pile to superstructure

The head of a pile generally attaches to the superstructure via a bearing plate. The size of the plate must be selected on the basis of the strength of the superstructure. The connection of the pile and the superstructure can be dimensioned as a hinge. An exception are piles shorter than 3 m. They should be attached to the superstructure by a rigid joint. A pile normally joins the superstructure rigidly when at least a 2 x D section of the pile head (200 mm at a minimum) is set in concrete. When the poured concrete is vibrated, it must be ensured that the bearing plate cap does not rise.

If the groundwater level of the surroundings is higher than the pile cut-off level, bearing plates must be welded tightly to the piles.

Fig. 2. Principle drawing of ventilated crawl space of house founded on RR piles.

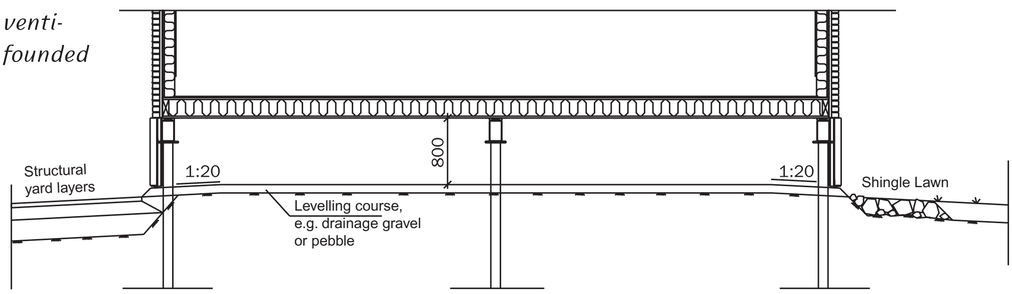


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Table 8. Allowed structural bearing capacity of RR piles, P_{all} [kN] with 1.2 mm and 2.0 mm corrosion allowances

Corrosion allowance 1.2 mm		Allowed bearing capacity with respect to buckling					Highest allowed bearing capacity by piling classes		
Pile type	Radius of curvature [m]	Undrained shear strength of soil, c_{uk} [kPa]							
		5	7	10	15	20	III	II	IB
RR60/6.3	150	99	99	99	99	99	99		
	100	86	99	99	99	99			
	70	73	94	99	99	99			
RR75/6.3	150	140	163	181	195	195	129	156	195
	100	119	151	169	187	195			
	70	100	129	157	175	187			
RR90/6.3	200	187	207	228	231	231	153	185	231
	150	174	199	219	231	231			
	100	146	184	204	224	231			
RR115/6.3	300	273	298	304	304	304	200	243	304
	200	257	282	304	304	304			
	150	244	269	294	304	304			
RR115/8	300	338	405	453	494	494	326	395	494
	200	296	372	431	481	494			
	150	263	334	411	461	493			
RR140/8	400	486	545	603	613	613	405	491	613
	250	424	513	571	613	613			
	150	344	439	524	583	613			
RR140/10	400	528	633	712	782	782	516	625	782
	250	454	570	671	752	782			
	150	363	466	602	693	745			
RR170/10	500	734	832	925	956	956	631	764	956
	300	629	780	870	956	956			
	200	533	679	815	908	956			
RR170/12.5	500	791	959	1081	1207	1207	797	966	1207
	300	670	843	1015	1141	1207			
	200	563	720	927	1071	1153			
RR220/10	500	1049	1165	1264	1264	1264	835	1012	1264
	350	956	1108	1221	1264	1264			
	250	836	1046	1156	1264	1264			
RR220/12.5	500	1156	1363	1516	1604	1604	1059	1283	1604
	350	1023	1286	1444	1601	1604			
	250	887	1130	1364	1520	1604			

Corrosion allowance 2.0 mm		Allowed bearing capacity with respect to buckling					Highest allowed bearing capacity by piling classes		
Pile type	Radius of curvature [m]	Undrained shear strength of soil, c_{uk} [kPa]							
		5	7	10	15	20	III	II	IB
RR60/6.3	150 100 70	82 82 82	82 82 82	82 82 82	82 82 82	82 82 82	82		
RR75/6.3	150 100 70	129 112 95	143 134 122	157 147 137	163 162 152	163 163 162	107	130	163
RR90/6.3	200 150 100	165 158 139	181 174 162	193 190 178	193 193 193	193 193 193	128	155	193
RR115/6.3	300 200 150	239 226 215	254 247 235	254 254 254	254 254 254	254 254 254	168	203	254
RR115/8	300 200 150	320 282 252	369 350 319	411 391 374	433 433 416	433 433 433	286	346	433
RR140/8	400 250 150	445 404 331	496 468 421	538 517 476	538 538 527	538 538 538	355	430	538
RR140/10	400 250 150	506 438 353	591 549 451	661 624 573	706 696 642	706 706 689	466	565	706
RR170/10	500 300 200	693 606 517	775 728 657	858 808 758	864 864 840	864 864 864	570	691	864
RR170/12.5	500 300 200	766 652 550	910 818 702	1022 960 897	1116 1075 1010	1116 1116 1085	737	893	1116
RR220/10	500 350 250	980 923 811	1083 1032 975	1145 1132 1073	1145 1145 1145	1145 1145 1145	756	916	1145
RR220/12.5	500 350 250	1122 996 866	1291 1228 1103	1431 1365 1290	1485 1485 1432	1485 1485 1485	980	1188	1485

6. Confirming bearing capacity

End-of-driving criterion for drop and hydraulic hammers
Pile driving ends with the final blows which confirms a pile's geotechnical bearing capacity. The final blows consist of a minimum of three series of ten blows. Each series must meet the end-of-driving criteria of the pertaining tables. In case of equipment not shown in the tables, the designer's instructions are followed.

The end-of-driving criterion for class IB piles must be checked and/or established based on dynamic load tests.

End-of-driving criterion using pneumatic hammers
When using a pneumatic hammer, driving can be continued until set of pile is less than 5 mm/min and remains constant or decreases. The blow count must be at least 80 % of the nominal number. By following the above procedure, piles attain the geotechnical bearing capacity of Table 9 which, especially with the smallest RR piles, is higher than the allowed structural bearing capacity.

The bearing capacity of piles can be checked by stress-wave measurements. Mobilization of sufficient bearing capacity may require using drop or hydraulic hammers.

Pile bearing capacity may also be confirmed by static load tests.

Dynamic load tests
The geotechnical bearing capacity of class IB piles must be confirmed by load tests.

Presently, dynamic load tests are suited for setting the end-of-driving criterion when using a drop hammer, a hydraulic hammer or a pneumatic hammer. If a hydraulic ram is used, end-of-driving criteria have to be set based on comparison measurements with other driving equipment.

The person conducting the dynamic load tests as well as the analyzer of the results must be familiar with driven piling and especially with pile behaviour during driving stress while also possessing adequate knowledge about stress-wave theory. Stress-wave measurements allow setting end-of-driving criteria for piles that provide the required ultimate geotechnical bearing capacity.

At sites where class IB piles are used, dynamic load tests should be performed for each pile size, pile type and soil-condition type. At least 10 percent of the piles should be tested.

In addition to geotechnical bearing capacity, dynamic load tests also provide information about the behaviour and integrity of a pile and the condition and effectiveness of piling equipment.

7. Execution

Different driving methods

RR piles can be driven with different types of equipment. The driving equipment divide into three classes:

- Drop and hydraulic hammers
- Pneumatic hammers
- Hydraulic rams

Drop and hydraulic hammers
The drop and hydraulic hammers used in Finland to drive RR piles generally weigh 0.25-5 tons.

The drop height of a drop hammer can be freely selected within the limits of used equipment. The maximum drop height with hydraulic hammers is normally in the 0.4-1.5 m range. Hydraulic hammers may be accelerated or the free-fall type. The recommended masses of the rams used in pile driving are presented

Table 9. Allowed geotechnical bearing capacities [kN] using the most common pneumatic hammers.

RR-pile	RR60	RR75	RR90	RR115/6.3	RR115/8	RR140/8	RR140/10	RR170/10	RR170/12.5	RR220/10	RR220/12.5
MKT 5 / BSP 500	170	210	230	260	290	300	320				
BSP 500N	190	240	260	290	320	340	380				
MKT 6 / BSP 600			330	390	450	480	540	580	610	580	620
MKT 7 / BSP 700					500	570	670	730	810	750	830

in more detail in the RR Piling Handbook.

Pneumatic hammers

These equipment are operated by compressed air and deliver 100-400 blows per minute. The recommended masses of the moving part of pneumatic hammers are presented in the RR Piling Handbook.

Hydraulic rams

Hydraulic rams generally deliver 300-1,000 blows per minute. They are hydraulically operated. Pile driving with the lightest rams corresponds most closely to vibrating. Vibration reduces the friction or cohesion between the skin of the pile and soil, and the blows are delivered to the pile base. This causes the pile to penetrate into the ground.

The lightest hydraulic rams are poorly suited for driving piles in stony soil conditions.

Pile driving

A pile must be driven without long interruptions or causing damage to the pile. Blows must be parallel to the longitudinal axis and centred. Drop heights exceeding those shown in the end-of- driving table must not be used.

The pile tip is equipped with a bottom plate or a rock shoe whose attachment to the pile pipe must be secured before driving commences.

RR piles are driven by two methods depending on the location of the splice. The splice may be either external or internal. An external splice may be at the head or bottom of the pile section.

When the splice is at the bottom of the section, driving is usually commenced with a section containing no splice, for instance, a waste end of a previously cut pipe. The pile is driven into ground the factory-cut end first.

When driving a pile with the splice up, an adapter is to be used to transmit the blow past the external friction splice to the pile pipe. The pile splice must under no conditions be struck!

When the first section has been driven into the ground, the condition of the pile head is checked. If the pile needs to be spliced, the instructions of the next chapter are to be followed.

In soft soil layers the pile must not be driven using the drop height required by the end-of-driving criterion; considerably lower driving energy must be applied. Using excessive energy in soft soil layers may result in considerable tensile stresses in the pile that may cause splices to open. Pile splices close permanently only at the end-of-driving phase.

Pile driving may be discontinued when the pile reaches the designed depth and meets its end-of-driving criterion.

The level of the pile head must be determined after the final blows. The head level must be checked after installing a pile group as the piles may rise when a dense, bearing soil layer is overlaid only by soft ones. Piles are to be subjected to redriving where necessary.

Splicing

External splice

A pile is spliced by installing the next section on top of the previous one. In soft soil layers splices may close finally only at the end-of-driving phase.

Internal splice

An internal splice is made at the head of a pile so that the groove in the splicing insert fits over the longitudinal weld of the pile. The insert is pressed or tapped carefully in part of the way leaving a gap between the pile and the flange of the insert. The next pile section is then installed onto the insert. Splices close permanently only at the end of driving.

Table 10. Radius of curvature, R, of RR piles determined by flashlight test.

	R [m]	light visible [m]
RR60	70 100 150	5.2 6.2 7.6
RR75	70 100 150	6.0 7.1 8.7
RR90	100 150 200	7.8 9.6 11.0
RR115/6.3	150 200 300	11.0 12.8 15.6
RR115/8	150 200 300	11.0 12.8 15.6
RR140/8	150 250 400	12.2 15.7 19.9
RR140/10	150 250 400	12.0 15.5 19.6
RR170/10	200 300 500	15.1 18.5 23.9
RR170/12.5	200 300 500	15.1 18.5 23.9
RR220/10	250 350 500	20.0 23.6 28.2
RR220/12.5	250 350 500	19.7 23.3 27.9

Cutting of piles

Pile ends must be closed after driving in order to prevent unwanted material from getting inside. Moreover, low lying open pile ends are also a safety hazard.

Piles are cut at the planned height at right angles to the pile axis. The maximum allowed slope of the top from a plane perpendicular to the pile axis is 1:50 unless otherwise indicated in the designs. The ends of piles must be closed after cutting.

8. Monitoring

A piling record in accordance with the RR Piling Handbook is kept on piling work. All observations regarding factors affecting bearing capacity are to be entered in it.

The end-of-driving criteria for piles must be met. Final set should decrease to the required value, and elastic compression must not be higher than normal.

The straightness of a pile must be checked after driving. This can be done using an inclinometer or by probing with a gauge. Pile straightness may also be evaluated by lowering a flashlight down a pile in accordance with Table 10. If the radius of curvature of a pile is below the requirement of the piling plan, further measures must be agreed with the structural and geotechnical engineer.

End-of-driving criteria for RR piles

RR60									
							Drop height [m]		
Piling class	Corrosion allowance [mm]	Allowed bearing capacity [kN]	Hammer [kg]	Pile length [m]	Elastic compres-sion [mm]	Set /10 blows [mm]	Drop hammer	Hydraulic hammer	Accelerated hydraulic hammer
III	1.2	99	250	5	5	5	0.40	0.30	0.25
				10	9	5	0.65	0.45	0.40
				20	11	5	0.75	0.55	0.45
				30	13	5	0.95	0.65	0.55
			350	5	5	5	0.30	0.20	0.15
				10	9	5	0.45	0.35	0.30
				20	11	5	0.55	0.40	0.35
				30	13	5	0.70	0.50	0.40
			500	5	5	5	0.20	0.15	0.10
				10	9	5	0.35	0.25	0.15
				20	11	5	0.40	0.25	0.25
				30	13	5	0.45	0.35	0.30
	2.0	82	250	5	4	5	0.30	0.20	0.15
				10	7	5	0.45	0.30	0.25
				20	9	5	0.55	0.40	0.30
				30	11	5	0.65	0.45	0.40
			350	5	4	5	0.20	0.15	0.10
				10	7	5	0.35	0.25	0.15
				20	9	5	0.40	0.25	0.25
				30	11	5	0.45	0.35	0.30
			500	5	4	5	0.15	0.10	0.10
				10	7	5	0.25	0.15	0.10
				20	9	5	0.25	0.20	0.15
				30	11	5	0.35	0.25	0.20

RR75

Piling class	Corrosion allowance [mm]	Allowed bearing capacity [kN]	Hammer [kg]	Pile length [m]	Elastic compres-sion [mm]	Set /10 blows [mm]	Drop height [m]: Drop hammer	Drop height [m]: Hydraulic hammer	Drop height [m]: Accelerated hydraulic hammer
IB	1.2	195	End-of-driving criteria are established/checked by PDA measurements						
	2.0	163							
II	1.2	156	350	5	6	5	0.55	0.40	0.30
				10	11	5	0.90	0.60	0.55
				20	13	5	1.05	0.75	0.60
				30	16	5	1.30	0.90	0.75
			500	5	6	5	0.40	0.25	0.25
				10	11	5	0.60	0.45	0.35
				20	13	5	0.75	0.50	0.45
				30	16	5	0.90	0.65	0.55
			1000	5	6	5	0.20	0.15	0.10
				10	11	5	0.30	0.20	0.20
				20	13	5	0.35	0.25	0.20
				30	16	5	0.45	0.30	0.25
	2.0	130	350	5	5	5	0.40	0.25	0.25
				10	9	5	0.60	0.45	0.35
				20	11	5	0.75	0.50	0.45
				30	14	5	0.90	0.65	0.55
			500	5	5	5	0.25	0.20	0.15
				10	9	5	0.45	0.30	0.25
				20	11	5	0.50	0.35	0.30
				30	14	5	0.65	0.45	0.40
			1000	5	5	5	0.15	0.10	0.10
				10	9	5	0.20	0.15	0.15
				20	11	5	0.25	0.20	0.15
				30	14	5	0.30	0.25	0.20
III	1.2	129	250	5	5	5	0.55	0.35	0.30
				10	9	5	0.85	0.60	0.50
				20	11	5	1.00	0.70	0.60
				30	13	5	1.25	0.90	0.75
			350	5	5	5	0.40	0.25	0.25
				10	9	5	0.60	0.45	0.35
				20	11	5	0.70	0.50	0.45
				30	13	5	0.90	0.65	0.55
			500	5	5	5	0.25	0.20	0.15
				10	9	5	0.45	0.30	0.25
				20	11	5	0.50	0.35	0.30
				30	13	5	0.60	0.45	0.35
	2.0	107	250	5	4	5	0.40	0.25	0.25
				10	7	5	0.60	0.40	0.35
				20	9	5	0.70	0.50	0.40
				30	11	5	0.85	0.60	0.50
			350	5	4	5	0.25	0.20	0.15
				10	7	5	0.45	0.30	0.25
				20	9	5	0.50	0.35	0.30
				30	11	5	0.60	0.45	0.35
			500	5	4	5	0.20	0.15	0.10
				10	7	5	0.30	0.20	0.20
				20	9	5	0.35	0.25	0.20
				30	11	5	0.45	0.30	0.25

RR90									
							Drop height [m]		
Piling class	Corrosion allowance [mm]	Allowed bearing capacity [kN]	Hammer [kg]	Pile length [m]	Elastic compres-sion [mm]	Set /10 blows [mm]	Drop hammer	Hydraulic hammer	Accelerated hydraulic hammer
IB	1.2	231	End-of-driving criteria are established/checked by PDA measurements						
	2.0	193							
II	1.2	185	500	5	6	5	0.45	0.30	0.25
				10	11	5	0.75	0.50	0.45
				20	13	5	0.85	0.60	0.50
				30	16	5	1.05	0.75	0.65
			750	5	6	5	0.30	0.20	0.20
				10	11	5	0.50	0.35	0.30
				20	13	5	0.60	0.40	0.35
				30	16	5	0.70	0.50	0.45
			1000	5	6	5	0.20	0.15	0.15
				10	11	5	0.35	0.25	0.20
				20	13	5	0.45	0.30	0.25
				30	16	5	0.55	0.40	0.30
	2.0	155	350	5	5	5	0.45	0.30	0.30
				10	9	5	0.75	0.55	0.45
				20	11	5	0.90	0.60	0.55
				30	14	5	1.10	0.75	0.65
			500	5	5	5	0.30	0.25	0.20
				10	9	5	0.50	0.35	0.30
				20	11	5	0.60	0.45	0.35
				30	14	5	0.75	0.55	0.45
			1000	5	5	5	0.15	0.10	0.10
				10	9	5	0.25	0.20	0.15
				20	11	5	0.30	0.20	0.20
				30	14	5	0.40	0.25	0.25
III	1.2	153	350	5	5	5	0.45	0.30	0.25
				10	9	5	0.75	0.50	0.45
				20	11	5	0.85	0.60	0.50
				30	13	5	1.05	0.75	0.65
			500	5	5	5	0.30	0.20	0.20
				10	9	5	0.50	0.35	0.30
				20	11	5	0.60	0.40	0.35
				30	13	5	0.75	0.50	0.45
			750	5	5	5	0.20	0.15	0.15
				10	9	5	0.35	0.25	0.20
				20	11	5	0.40	0.30	0.25
				30	13	5	0.50	0.35	0.30
	2.0	128	350	5	4	5	0.30	0.25	0.20
				10	8	5	0.50	0.35	0.30
				20	9	5	0.60	0.45	0.35
				30	11	5	0.75	0.55	0.45
			500	5	4	5	0.25	0.15	0.15
				10	8	5	0.35	0.25	0.20
				20	9	5	0.45	0.30	0.25
				30	11	5	0.50	0.35	0.30
			750	5	4	5	0.15	0.10	0.10
				10	8	5	0.25	0.15	0.10
				20	9	5	0.30	0.20	0.15
				30	11	5	0.35	0.25	0.20

RR115/6.3

Piling class	Corrosion allowance [mm]	Allowed bearing capacity [kN]	Hammer [kg]	Pile length [m]	Elastic compression [mm]	Set /10 blows [mm]	Drop height [m]: Drop hammer	Drop height [m]: Hydraulic hammer	Drop height [m]: Accelerated hydraulic hammer
IB	1.2	304	End-of-driving criteria are established/checked by PDA measurements						
	2.0	254							
II	1.2	243	750	5	6	5	0.40	0.30	0.25
				10	11	5	0.65	0.45	0.40
				20	13	5	0.75	0.55	0.45
				30	16	5	0.95	0.65	0.55
			1000	5	6	5	0.30	0.20	0.20
				10	11	5	0.50	0.35	0.30
				20	13	5	0.55	0.40	0.35
				30	16	5	0.70	0.50	0.40
			1500	5	6	5	0.20	0.15	0.10
				10	11	5	0.30	0.25	0.20
				20	13	5	0.40	0.25	0.25
				30	16	5	0.45	0.35	0.30
	2.0	203	750	5	5	5	0.30	0.20	0.15
				10	9	5	0.45	0.30	0.25
				20	11	5	0.55	0.40	0.30
				30	14	5	0.65	0.45	0.40
			1000	5	5	5	0.20	0.15	0.15
				10	9	5	0.35	0.25	0.20
				20	11	5	0.40	0.30	0.25
				30	14	5	0.50	0.35	0.30
			1500	5	5	5	0.15	0.10	0.10
				10	9	5	0.25	0.15	0.15
				20	11	5	0.25	0.20	0.15
				30	14	5	0.35	0.25	0.20
III	1.2	200	500	5	5	5	0.40	0.30	0.25
				10	9	5	0.65	0.45	0.40
				20	11	5	0.80	0.55	0.45
				30	13	5	0.95	0.70	0.60
			750	5	5	5	0.25	0.20	0.15
				10	9	5	0.45	0.30	0.25
				20	11	5	0.50	0.35	0.30
				30	13	5	0.65	0.45	0.40
			1000	5	5	5	0.20	0.15	0.10
				10	9	5	0.35	0.25	0.20
				20	11	5	0.40	0.30	0.25
				30	13	5	0.50	0.35	0.30
	2.0	168	500	5	4	5	0.30	0.20	0.20
				10	8	5	0.50	0.35	0.30
				20	9	5	0.55	0.40	0.35
				30	11	5	0.70	0.50	0.40
			750	5	4	5	0.20	0.15	0.15
				10	8	5	0.30	0.20	0.20
				20	9	5	0.35	0.25	0.25
				30	11	5	0.45	0.30	0.30
			1000	5	4	5	0.15	0.10	0.10
				10	8	5	0.25	0.15	0.10
				20	9	5	0.30	0.20	0.15
				30	11	5	0.35	0.25	0.20

RR115/8

Piling class	Corrosion allowance [mm]	Allowed bearing capacity [kN]	Hammer [kg]	Pile length [m]	Elastic compres-sion [mm]	Set /10 blows [mm]	Drop height [m]: Drop hammer	Drop height [m]: Hydraulic hammer	Drop height [m]: Accelerated hydraulic hammer
IB	1.2	494	End-of-driving criteria are established/checked by PDA measurements						
	2.0	433							
II	1.2	395	1000	5	8	5	0.60	0.45	0.35
				10	14	5	1.00	0.70	0.60
				20	17	5	1.20	0.85	0.70
				30	21	5	1.45	1.05	0.90
			1500	5	8	5	0.40	0.30	0.25
				10	14	5	0.65	0.45	0.40
				20	17	5	0.80	0.55	0.50
				30	21	5	1.00	0.70	0.60
			3000	5	8	5	0.20	0.15	0.10
				10	14	5	0.35	0.25	0.20
				20	17	5	0.40	0.30	0.25
				30	21	5	0.50	0.35	0.30
	2.0	346	750	5	7	5	0.65	0.45	0.40
				10	12	5	1.05	0.75	0.60
				20	15	5	1.20	0.85	0.75
				30	19	5	1.50	1.05	0.90
			1000	5	7	5	0.45	0.35	0.30
				10	12	5	0.75	0.55	0.45
				20	15	5	0.90	0.65	0.55
				30	19	5	1.15	0.80	0.70
			1500	5	7	5	0.30	0.20	0.20
				10	12	5	0.50	0.35	0.30
				20	15	5	0.60	0.45	0.35
				30	19	5	0.75	0.55	0.45
III	1.2	326	500	5	7	5	0.85	0.60	0.50
				10	12	5	1.40	0.95	0.85
				20	14	5	1.65	1.15	1.00
				30	18	5	2.00	1.40	1.20
			750	5	7	5	0.55	0.40	0.35
				10	12	5	0.90	0.65	0.55
				20	14	5	1.10	0.75	0.65
				30	18	5	1.35	0.95	0.80
			1000	5	7	5	0.40	0.30	0.25
				10	12	5	0.70	0.50	0.40
				20	14	5	0.80	0.60	0.50
				30	18	5	1.00	0.70	0.60
	2.0	285	500	5	6	5	0.65	0.45	0.40
				10	10	5	1.05	0.75	0.65
				20	12	5	1.25	0.90	0.75
				30	15	5	1.55	1.10	0.95
			750	5	6	5	0.45	0.30	0.25
				10	10	5	0.70	0.50	0.45
				20	12	5	0.85	0.60	0.50
				30	15	5	1.05	0.75	0.60
			1000	5	6	5	0.35	0.25	0.20
				10	10	5	0.55	0.40	0.30
				20	12	5	0.65	0.45	0.40
				30	15	5	0.80	0.55	0.45

RR140/8									
							Drop height [m]		
Piling class	Corrosion allowance [mm]	Allowed bearing capacity [kN]	Hammer [kg]	Pile length [m]	Elastic compres-sion [mm]	Set /10 blows [mm]	Drop hammer	Hydraulic hammer	Accelerated hydraulic hammer
IB	1.2	613	End-of-driving criteria are established/checked by PDA measurements						
	2.0	538							
II	1.2	491	1000	5 10 20 30	8 14 17 21	10 10 10 10	0.85 1.35 1.55 1.90	0.60 0.95 1.10 1.35	0.50 0.80 0.95 1.15
			1500	5 10 20 30	8 14 17 21	10 10 10 10	0.55 0.90 1.05 1.25	0.40 0.60 0.75 0.90	0.35 0.55 0.60 0.75
			3000	5 10 20 30	8 14 17 21	10 10 10 10	0.30 0.45 0.50 0.65	0.20 0.30 0.35 0.45	0.15 0.25 0.30 0.40
	2.0	430	750	5 10 20 30	7 12 15 19	10 10 10 10	0.90 1.40 1.60 2.00	0.60 0.95 1.15 1.40	0.55 0.85 0.95 1.20
			1500	5 10 20 30	7 12 15 19	10 10 10 10	0.45 0.70 0.80 1.00	0.30 0.50 0.55 0.70	0.25 0.40 0.50 0.60
			3000	5 10 20 30	7 12 15 19	10 10 10 10	0.20 0.35 0.40 0.50	0.15 0.25 0.30 0.35	0.15 0.20 0.25 0.30
III	1.2	405	750	5 10 20 30	7 12 14 18	10 10 10 10	0.80 1.25 1.45 1.75	0.55 0.85 1.00 1.25	0.45 0.75 0.85 1.05
			1500	5 10 20 30	7 12 14 18	10 10 10 10	0.40 0.60 0.70 0.90	0.30 0.45 0.50 0.60	0.25 0.35 0.45 0.55
			3000	5 10 20 30	7 12 14 18	10 10 10 10	0.20 0.30 0.35 0.45	0.15 0.20 0.25 0.30	0.10 0.20 0.20 0.25
	2.0	355	750	5 10 20 30	6 10 12 15	10 10 10 10	0.60 0.95 1.15 1.35	0.45 0.70 0.80 0.95	0.35 0.60 0.70 0.80
			1500	5 10 20 30	6 10 12 15	10 10 10 10	0.30 0.50 0.55 0.70	0.20 0.35 0.40 0.50	0.20 0.30 0.35 0.40
			3000	5 10 20 30	6 10 12 15	10 10 10 10	0.15 0.25 0.30 0.35	0.10 0.15 0.20 0.25	0.10 0.15 0.15 0.20

RR140/10

Piling class	Corrosion allowance [mm]	Allowed bearing capacity [kN]	Hammer [kg]	Pile length [m]	Elastic compres-sion [mm]	Set /10 blows [mm]	Drop height [m]: Drop hammer	Drop height [m]: Hydraulic hammer	Drop height [m]: Accelerated hydraulic hammer
IB	1.2	782	End-of-driving criteria are established/checked by PDA measurements						
	2.0	706							
II	1.2	625	1500	5 10 20 30	8 15 18 22	10 10 10 10	0.75 1.15 1.35 1.65	0.50 0.80 0.95 1.20	0.45 0.70 0.80 1.00
			3000	5 10 20 30	8 15 18 22	10 10 10 10	0.35 0.60 0.70 0.85	0.25 0.40 0.50 0.60	0.20 0.35 0.40 0.50
			4000	5 10 20 30	8 15 18 22	10 10 10 10	0.25 0.45 0.50 0.65	0.20 0.30 0.35 0.45	0.15 0.25 0.30 0.40
	2.0	565	1500	5 10 20 30	8 13 16 20	10 10 10 10	0.60 0.95 1.15 1.40	0.45 0.70 0.80 0.95	0.35 0.60 0.70 0.85
			3000	5 10 20 30	8 13 16 20	10 10 10 10	0.30 0.50 0.55 0.70	0.20 0.35 0.40 0.50	0.20 0.30 0.35 0.40
			4000	5 10 20 30	8 13 16 20	10 10 10 10	0.25 0.35 0.40 0.50	0.15 0.25 0.30 0.35	0.15 0.20 0.25 0.30
III	1.2	516	1500	5 10 20 30	7 12 15 18	10 10 10 10	0.50 0.80 0.95 1.15	0.35 0.55 0.65 0.80	0.30 0.50 0.55 0.70
			3000	5 10 20 30	7 12 15 18	10 10 10 10	0.25 0.40 0.45 0.60	0.20 0.30 0.35 0.40	0.15 0.25 0.30 0.35
			4000	5 10 20 30	7 12 15 18	10 10 10 10	0.20 0.30 0.35 0.45	0.15 0.20 0.25 0.30	0.10 0.20 0.20 0.25
	2.0	466	1500	5 10 20 30	6 11 13 16	10 10 10 10	0.45 0.65 0.80 0.95	0.30 0.45 0.55 0.65	0.25 0.40 0.45 0.55
			3000	5 10 20 30	6 11 13 16	10 10 10 10	0.20 0.35 0.40 0.50	0.15 0.25 0.30 0.35	0.15 0.20 0.25 0.30
			4000	5 10 20 30	6 11 13 16	10 10 10 10	0.15 0.25 0.30 0.35	0.10 0.20 0.20 0.25	0.10 0.15 0.20 0.20

RR170/10

Piling class	Corrosion allowance [mm]	Allowed bearing capacity [kN]	Hammer [kg]	Pile length [m]	Elastic compres-sion [mm]	Set /10 blows [mm]	Drop height [m]		
							Drop hammer	Hydraulic hammer	Accelerated hydraulic hammer
IB	1.2	956	End-of-driving criteria are established/checked by PDA measurements						
	2.0	864							
II	1.2	764	3000	5	8	10	0.45	0.30	0.25
				10	15	10	0.70	0.50	0.45
				20	18	10	0.85	0.60	0.50
				30	22	10	1.00	0.70	0.60
			4000	5	8	10	0.35	0.25	0.20
				10	15	10	0.55	0.40	0.30
				20	18	10	0.65	0.45	0.40
				30	22	10	0.75	0.55	0.45
			5000	5	8	10	0.25	0.20	0.15
				10	15	10	0.45	0.30	0.25
				20	18	10	0.50	0.35	0.30
				30	22	10	0.60	0.45	0.35
	2.0	691	3000	5	8	10	0.35	0.25	0.20
				10	13	10	0.60	0.40	0.35
				20	16	10	0.70	0.50	0.40
				30	20	10	0.85	0.60	0.50
			4000	5	8	10	0.30	0.20	0.15
				10	13	10	0.45	0.30	0.25
				20	16	10	0.50	0.35	0.30
				30	20	10	0.65	0.45	0.40
			5000	5	8	10	0.20	0.15	0.15
				10	13	10	0.35	0.25	0.20
				20	16	10	0.40	0.30	0.25
				30	20	10	0.50	0.35	0.30
III	1.2	631	3000	5	7	10	0.30	0.20	0.20
				10	12	10	0.50	0.35	0.30
				20	15	10	0.60	0.40	0.35
				30	18	10	0.70	0.50	0.45
			4000	5	7	10	0.25	0.15	0.15
				10	12	10	0.35	0.25	0.20
				20	15	10	0.45	0.30	0.25
				30	18	10	0.55	0.40	0.30
			5000	5	7	10	0.20	0.15	0.10
				10	12	10	0.30	0.20	0.20
				20	15	10	0.35	0.25	0.20
				30	18	10	0.45	0.30	0.25
	2.0	570	3000	5	6	10	0.25	0.2	0.15
				10	11	10	0.40	0.3	0.25
				20	13	10	0.50	0.35	0.30
				30	16	10	0.60	0.40	0.35
			4000	5	6	10	0.20	0.15	0.10
				10	11	10	0.30	0.20	0.20
				20	13	10	0.35	0.25	0.20
				30	16	10	0.45	0.30	0.25
			5000	5	6	10	0.15	0.10	0.10
				10	11	10	0.25	0.15	0.15
				20	13	10	0.30	0.20	0.15
				30	16	10	0.35	0.25	0.20

RR170/12.5

Piling class	Corrosion allowance [mm]	Allowed bearing capacity [kN]	Hammer [kg]	Pile length [m]	Elastic compres-sion [mm]	Set /10 blows [mm]	Drop height [m]: Drop hammer	Drop height [m]: Hydraulic hammer	Drop height [m]: Accelerated hydraulic hammer
IB	1.2	1207	End-of-driving criteria are established/checked by PDA measurements						
	2.0	1116							
II	1.2	966	3000	5	11	10	0.70	0.50	0.40
				10	19	10	1.10	0.80	0.65
				20	22	10	1.30	0.90	0.80
				30	28	10	1.60	1.15	0.95
			4000	5	11	10	0.50	0.35	0.30
				10	19	10	0.85	0.60	0.50
				20	22	10	1.00	0.70	0.60
				30	28	10	1.20	0.85	0.70
			5000	5	11	10	0.40	0.30	0.25
				10	19	10	0.65	0.45	0.40
				20	22	10	0.80	0.55	0.45
				30	28	10	0.95	0.70	0.60
	2.0	893	3000	5	10	10	0.60	0.40	0.35
				10	17	10	0.95	0.65	0.55
				20	21	10	1.10	0.80	0.65
				30	26	10	1.40	0.95	0.85
			4000	5	10	10	0.45	0.30	0.25
				10	17	10	0.70	0.50	0.45
				20	21	10	0.85	0.60	0.50
				30	26	10	1.05	0.75	0.60
			5000	5	10	10	0.35	0.25	0.20
				10	17	10	0.55	0.40	0.35
				20	21	10	0.65	0.50	0.40
				30	26	10	0.85	0.60	0.50
III	1.2	797	3000	5	9	10	0.50	0.35	0.30
				10	15	10	0.75	0.55	0.45
				20	18	10	0.90	0.65	0.55
				30	23	10	1.10	0.80	0.65
			4000	5	9	10	0.35	0.25	0.20
				10	15	10	0.60	0.40	0.35
				20	18	10	0.70	0.50	0.40
				30	23	10	0.85	0.60	0.50
			5000	5	9	10	0.30	0.20	0.15
				10	15	10	0.45	0.35	0.30
				20	18	10	0.55	0.40	0.35
				30	23	10	0.65	0.45	0.40
	2.0	737	3000	5	8	10	0.40	0.30	0.25
				10	14	10	0.65	0.45	0.40
				20	17	10	0.80	0.55	0.45
				30	21	10	0.95	0.65	0.55
			4000	5	8	10	0.30	0.20	0.20
				10	14	10	0.50	0.35	0.30
				20	17	10	0.60	0.40	0.35
				30	21	10	0.70	0.50	0.45
			5000	5	8	10	0.25	0.20	0.15
				10	14	10	0.40	0.30	0.25
				20	17	10	0.45	0.35	0.30
				30	21	10	0.55	0.40	0.35

RR220/10

Piling class	Corrosion allowance [mm]	Allowed bearing capacity [kN]	Hammer [kg]	Pile length [m]	Elastic compres-sion [mm]	Set /10 blows [mm]	Drop height [m]: Drop hammer	Drop height [m]: Hydraulic hammer	Drop height [m]: Accelerated hydraulic hammer
IB	1.2	1264	End-of-driving criteria are established/checked by PDA measurements						
	2.0	1146							
II	1.2	1012	4000	5	8	10	0.45	0.30	0.25
				10	5	10	0.70	0.50	0.40
				20	18	10	0.85	0.60	0.50
				30	22	10	1.00	0.70	0.60
			5000	5	8	10	0.35	0.25	0.20
				10	15	10	0.55	0.40	0.35
				20	18	10	0.65	0.45	0.40
				30	22	10	0.80	0.60	0.50
	2.0	916	4000	5	8	10	0.35	0.25	0.20
				10	13	10	0.60	0.40	0.35
				20	16	10	0.70	0.50	0.40
				30	20	10	0.85	0.60	0.50
			5000	5	8	10	0.30	0.20	0.20
				10	13	10	0.45	0.35	0.30
				20	16	10	0.55	0.40	0.35
				30	20	10	0.65	0.50	0.40
III	1.2	835	4000	5	7	10	0.30	0.20	0.20
				10	12	10	0.50	0.35	0.30
				20	15	10	0.60	0.40	0.35
				30	18	10	0.70	0.50	0.40
			5000	5	7	10	0.25	0.20	0.15
				10	12	10	0.40	0.30	0.25
				20	15	10	0.45	0.35	0.30
				30	18	10	0.55	0.40	0.35
	2.0	756	4000	5	6	10	0.25	0.20	0.15
				10	11	10	0.40	0.30	0.25
				20	13	10	0.50	0.35	0.30
				30	17	10	0.60	0.40	0.35
			5000	5	6	10	0.20	0.15	0.15
				10	11	10	0.35	0.25	0.20
				20	13	10	0.40	0.25	0.25
				30	17	10	0.45	0.35	0.30

RR220/12.5									
							Drop height [m]		
Piling class	Corrosion allowance [mm]	Allowed bearing capacity [kN]	Hammer [kg]	Pile length [m]	Elastic compres-sion [mm]	Set /10 blows [mm]	Drop hammer	Hydraulic hammer	Accelerated hydraulic hammer
IB	1.2	1604	End-of-driving criteria are established/checked by PDA measurements						
	2.0	1485							
II	1.2	1283	4000	5	9	10	0.55	0.40	0.35
				10	15	10	0.90	0.65	0.55
				20	18	10	1.10	0.75	0.65
				30	23	10	1.30	0.95	0.80
			5000	5	9	10	0.45	0.30	0.25
				10	15	10	0.75	0.50	0.45
				20	18	10	0.85	0.60	0.50
				30	23	10	1.05	0.75	0.65
	2.0	1188	4000	5	8	10	0.50	0.35	0.30
				10	14	10	0.80	0.55	0.50
				20	17	10	0.95	0.65	0.55
				30	21	10	1.15	0.80	0.70
			5000	5	8	10	0.40	0.30	0.25
				10	14	10	0.65	0.45	0.40
				20	17	10	0.75	0.55	0.45
				30	21	10	0.90	0.65	0.55
III	1.2	1059	4000	5	7	10	0.40	0.30	0.25
				10	13	10	0.65	0.45	0.40
				20	15	10	0.75	0.55	0.45
				30	19	10	0.90	0.65	0.55
			5000	5	7	10	0.30	0.25	0.20
				10	13	10	0.50	0.35	0.30
				20	15	10	0.60	0.40	0.35
				30	19	10	0.75	0.50	0.45
	2.0	980	4000	5	7	10	0.35	0.25	0.20
				10	12	10	0.55	0.40	0.35
				20	14	10	0.65	0.45	0.40
				30	17	10	0.80	0.55	0.45
			5000	5	7	10	0.30	0.20	0.15
				10	12	10	0.45	0.30	0.25
				20	14	10	0.50	0.35	0.30
				30	17	10	0.65	0.45	0.40

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