LKAB	Document type **TECHNICAL INSTRUCTION**	Document number LKT 1520.520.002	Page 1	of 13

Prepared by	Replaces	Project number	Revision	Date
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Approved by	Title	Lang	Technical area
Per-Erik Jönsson	Wear-resistant parts	en	General

Status	Subtitle	Plant reference code/ object
Approved	Selection of wear-resistant materials in wearing applications	

Dependence on/from other documents	Replaced by
	Supplier
Working process Design, operation and maintenance, purchasing, storage	Replaced by
Keywords Instruction	Supplier's reference designation

Document history

Revision	Date	Signature	Comments
01	2005-11-17	LS	Instruction reworked
02	2005-12-12	MLPRJO	Instruction approved
03	2006-02-24	MLPRJO	Layout and pagination changed
04	2010-12-28	MLPRJO	Updated designations of standards for materials
05	2012-11-22	MLPRJO	Inserted alternative design of holes, materials, images. Corrections. New numbering of tables and images.
06	2018-02-02	KLJRLE	Drawings of edgings updated

Latest translated revision

This document is a translation from Swedish of LKAB Technical Instruction LKT 1520.520.001. In the event of disagreement concerning the interpretation and content of this text, the Swedish version shall have priority. The latest revision of this instruction can be obtained from e-mail address: *tekadm.krn@lkab.com* or *tekadm.mbgt@lkab.com*

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References

SS 709 Mining equipment - Wear plates for mineral handling equipment (withdrawn 2006)
LKAB Drawings No. 441720, 441721, 4-4262-120, 4-4262-121

Definitions

Background and purpose

LKAB processes large quantities of abrasive materials such as ore, gangue and concentrates in crushers, feeders, transfer chutes, pipes, etc. These require different types of wear-resistant materials in applications exposed to intense wear down.

This instruction provides guidelines for selecting wear-resistant materials in design and purchasing in LKAB's applications, as well as a description of the relative length of life of the most commonly used wear-resistant materials.

The data below on wear-resistant materials is based partly on experience from operation and maintenance.

General

Material flow through e.g. transfer chutes and bins that affects on wearing requires reinforcement of replaceable wear plates made of appropriate materials that resists wear and impact. Wear plates can be made of steel, cast iron and rubber. Plastic and ceramic materials can also be used sometimes.

Wear plates and fasteners should be designed in such a way that minimum wear initiation occurs.

When choosing wear-resistant materials, the coarseness of the goods as well as the height of drop (Table 1) must be considered.

Steel

The wear resistance of steel is directly dependent on its hardness (see page 6). The hardness of a given quality of steel fluctuates due to the heat treatment and hardening of the steel. The wear plates are to be marked with hardness according to Vickers (HV). The Vickers number is used on drawings and when ordering steel plates.

Recommendations

Wear-resistant steel is grouped by its hardness number (see page 7). The fields of application for these groups are described below.

Hardness	**Applications**
200-380 HV	By low and normal requirements of wear resistance. The material is appropriate for replaceable wear-resistant details such as buckets on wheel loaders and excavators as well as dump truck bodies.
380-500 HV	By demanding requirements of wear resistance. The material cannot be machined after hardening, but can be welded. **Note:** If welding takes place after hardening, the welded joint becomes the weakest part of the construction, due to quenching cracks.
500- HV	By extremely demanding requirements of wear resistance. Cannot be machined. Inappropriate for welding. Should not be exposed to high impact force.

As far as possible, welding should be avoided for wear plates of steel with hardness above 500 HV.

Standard format
The format, hole spacing and thickness of wear plates are standardised according to the information below (extracts from Swedish Standard SS 709). Edging according to LKAB drawing numbers at Kiruna works (or Malmberget works) 441720 (4-4262-120), 441721 (4-4262-121).

Rubber

Transfer and loading chutes, hoppers, screens, mills, skips and dump truck bodies can be lined with hard rubber. This meets requirements for useful life, sound levels and dust levels. When choosing and installing hard rubber, the factors in the following sections must be evaluated.

Impact angle
The incidence angle of the material at the rubber surface has a large influence on the wearing process. As shown in image 1, an incidence angle between 10-300° is very destructive. Due to that, constructions based on hard rubber are to be designed so that they can provide either a perpendicular or nearly parallel incidence angle at the rubber surface. Profiled wearing surfaces can to a certain extent relieve the problems of unfavourable incidence angles.

Flow speed
The degree of wearing and tearing is affected by the speed of the material flow. At speeds over 6 m/s, wearing increases rapidly. Measures to reduce the speed should therefore be taken.

Height of drop
The combination of high height of drop and high item weight requires a very thick rubber plate if the rubber is to be able to absorb the kinetic energy so that damage due to crushing and penetration can be avoided. Table 1 recommends the required thicknesses.

Rubber qualities
The hardness of wear-resistant hard rubber is usually between 40-80 Shore. The softer qualities is used for materials smaller than 5 mm in diameter and the harder type, lager than 60 Shore, is used for larger size of materials. The Suppliers have standard qualities for different purposes and can recommend appropriate materials.

Standard format
Wear plates secured with bolts shall be prepared with a hole spacing of 250 mm and be manufactured with a width and length corresponding to the wear plate standard, but without any space between the plates. The dimensions will be multiples of 250 mm and facilitates choosing between hard rubber or metal wear plates.

Plastic

The plastic materials most often used in wear-resistant applications are sold under the trade mark Oxolit, Robalon and Polythene HD. They belong to the Ethene family of plastics and have wear-resistant characteristics depending on their composition and method of manufacturing.

Characteristics

Polyethene has low friction and the paraffin like surface prevents adhesion and freeze-bonding of damp or sticky material. The wear resistance against wearing due to sliding is good. The resistance against cutting is low. The bendability and the tenacity are good.

Application areas

Polyethene is best suited as wear-resistant material in chutes and slopes for concentrates and aggregates especially when the materials are damp or sticky. Polyethene should not be used when the material flow speed is high and if the material size is larger than 25 mm.

Mounting methods

Wear plates can be mounted with countersunk screws and without space between the plates. The plate's hole spacing, width and length are to be chosen according to this instruction. (This instruction is based on the standard for wear plates SS 709 and LKAB's previous product standardization LKS 198.01).

Ceramic material

Ceramic wear-resistant material is used, for example, as a bottom lining in mixers. Rubellite and Carbofrax are examples of wear-resistant ceramic materials.

Characteristics

Hardness is about 8 on the Mohs scale, which means that it is about three times harder than, e.g., Ni-Hard. They are generally brittle. Certain types tolerate heat up to 1300 °C. They are very resistant against wearing due to gliding. Friction is lower than for steel. They are manufactured as plates, trapeze-formed moulding or hexagonal plates, and can be cast in the form of elbow pipes, pump gears, etc.

Application areas

They are most suited as chute linings for concentrates and aggregate where minor impacts occur, as well as for elbow pipes, fan housings in dust removal fans and process fans where the air is full of particles. They are even suitable as wear-resistant edges on scrapers and ploughs used on conveyor belts. They are not suitable for use in areas where explosives are used to clear jams or build ups.

Mounting methods

Gluing, bolts and dovetail rails are common methods.

Image 1

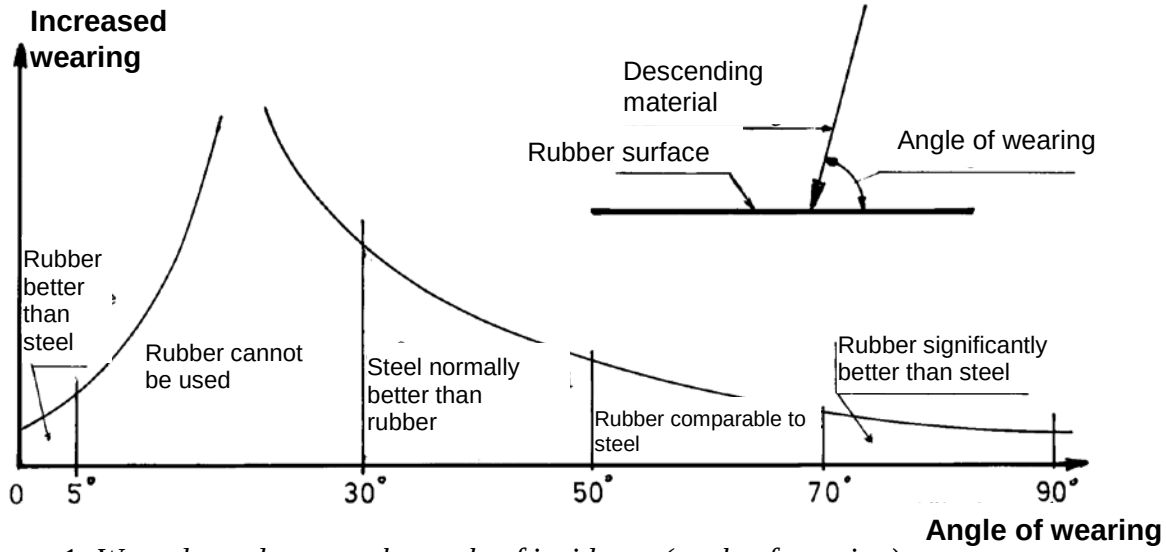


Image 1: *Wear dependence on the angle of incidence (angle of wearing)*

Table 1: *Recommended wear plate thickness and material depending on material size and height of drop*

Material size mm	Material height of drop m	Wear plate thickness mm Chute Bottom	Wear plate thickness mm Side walls	Material
> 250	> 5	100	40	Steel
	5 - 3	60	40	Rubber
	< 3	40	25	
250-100	> 5	60	40	Steel
	5 - 3	40	25	Ni-Hard
	< 3	40	25	Rubber
100-25	> 5	40	25	Steel
	5 - 3	25	15	Ni-Hard
	< 3	25	15	Rubber
< 25	> 5	25	15	Steel
	5 - 3	15	15 (8)	Ni-Hard Rubber
	< 3	15	15 (8)	Plastic Ceramics

Note: These thicknesses apply to steel. Thicker plates are recommended for rubber (see Image 1). Figures in parentheses refer to Ni-Hard.

The steel's resistance to wear compared to the hardness

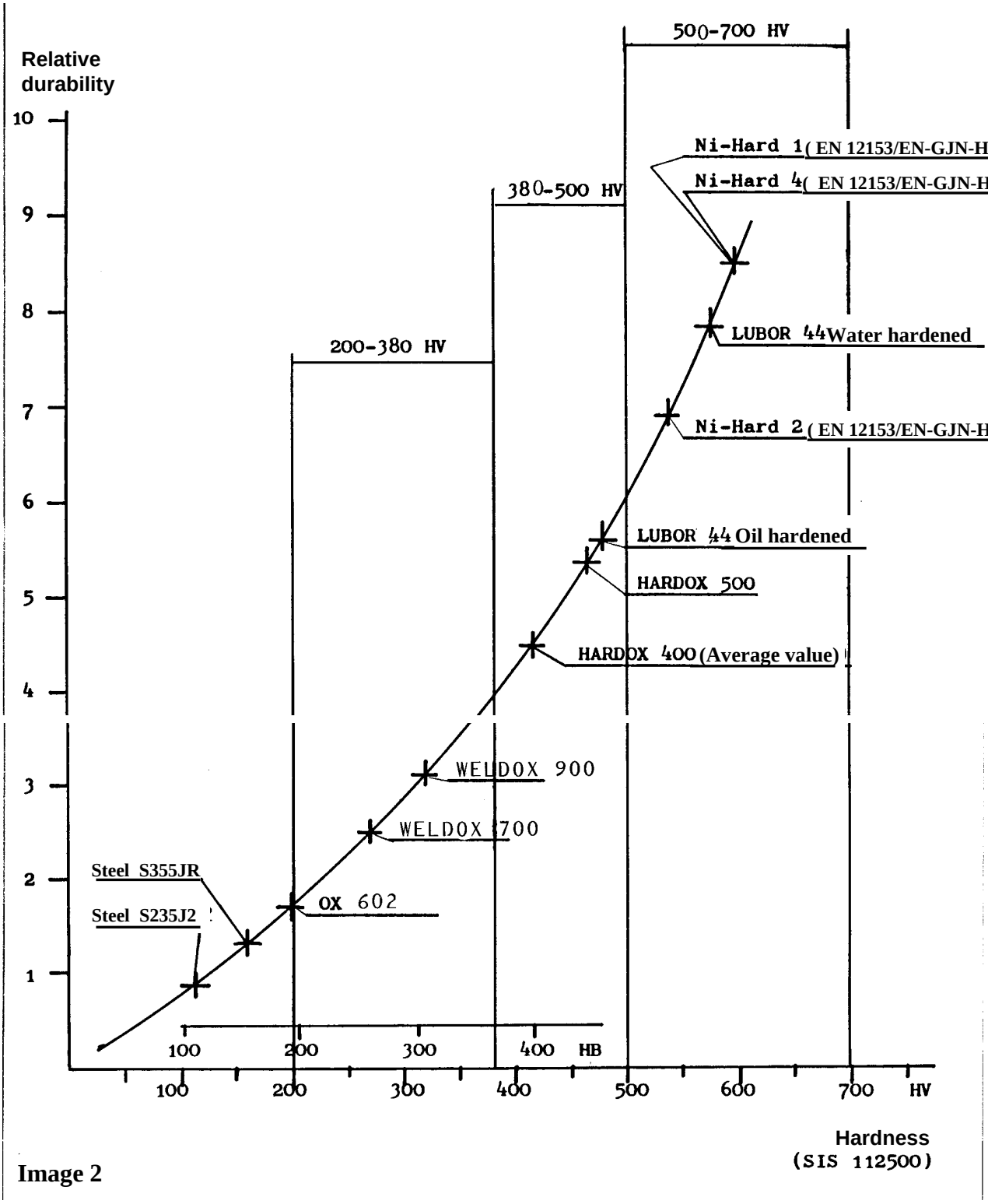


Image 2

Table 2: Hardness groups

Group	Material	Supplier	Hardness HV	Weldable	Impact resistance	Note
	EN 10025-2					
	S235J2		115	Yes	Good	SS 1312 **
	S355JR		160	Yes	Good	SS 2172 **
200-380 HV	SS-EN 10083-3					
	25CrMo4		200	Yes	Good	SS 2225 **
			200	Yes	Good	
			270	Yes	Good	
			320	Yes	Good	
			360-450	Yes*	Good	*at t >20 mm the working temperature should be 150-200° C.
380-500 HV		Hardox 500	450-550	Yes*	Good	* at 200-250°C
		Lubor 44	480	Yes	Good	Oil-hardened
500- HV	SS-EN 12513/					
	EN-GJN-HV550	Ni-Hard 1	600	No		Not weldable SS 0513
	EN-GJN-HV520	Ni-Hard 2	540	No		SS 0512 **
	EN-GJN-HV600	Ni-Hard 4	600	No		SS 0457 **
		Lubor 44	575	Yes	Good	Water-hardened
		Hardox 600	600	Yes	Good	
		Hardox 700	700	Yes	Good	

** Designation of former Swedish Standard

EN 12 513 is comparable to ISO 21988 where;

EN 12513/EN-GJN-HV550 is comparable to ISO 21988 HBW510
EN 12513/EN-GJN-HV520 is comparable to ISO 21988 HBW555
EN 12513/EN-GJN-HV600 is comparable to ISO 21988 HBW550

Standard dimensions

Wear plates should have a thickness (T) according to Table 3 as well as a Length (L) and With (B) according to Table 4 and the drawings in the drawings index.

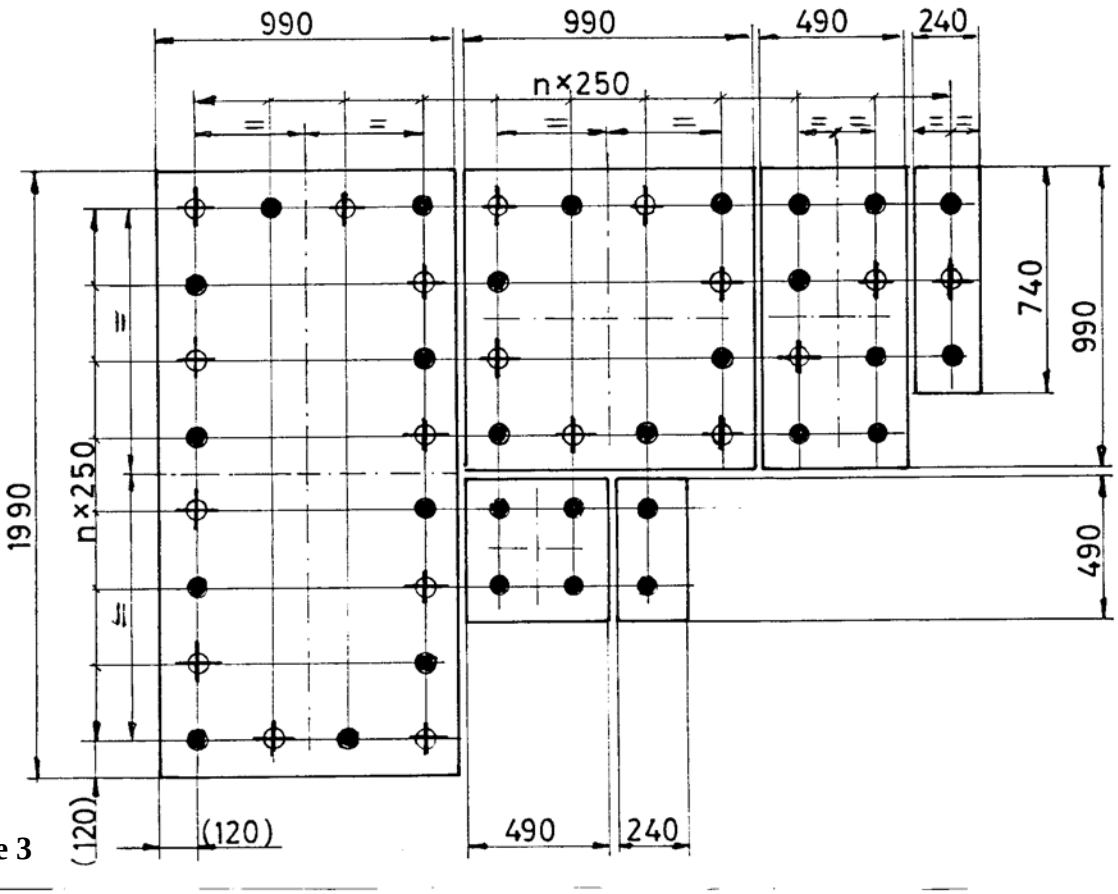


Image 3

Designation given when purchasing

Wear plates SS 709 - T x L x B - Material - Hardness - Hole design
E.g. Wear plate SS 709 - 8 x 990 x 490 - Lubor 44 - 480 HV - Conical

Marking

The wear plate shall be marked on the edge of the short side with the following information:
SS 709 - Material – Hardness and Hole design.
Example: SS 709 - Lubor 44 - 480 HV – Konisk (Use Swedish designations)

Table 3

Base dimension T								
6	8	10	15	20	25	40	60	100

Table 4

L x B								
Base dimension	Cast wear plate		Punched or cut wear plate					
			T ≤ 10		10 < T < 25		T ≥ 25	
	Tolerance		Tolerance		Tolerance		Tolerance	
	Over	Under	Over	Under	Over	Under	Over	Under
490 x 240	0	- 7	+ 4	0	+ 2	- 2	0	- 7
490 x 490	0	- 7	+ 4	0	+ 2	- 2	0	- 7
740 x 240	0	- 10	+ 4	0	+ 2	- 2	0	- 7
990 x 490	0	- 10	+ 2	- 5	+ 2	- 5	0	- 10
990 x 990	0	- 10	+ 2	- 5	+ 2	- 5	0	- 10
1990x 990	0	- 10	+ 2	- 5	+ 2	- 5	0	- 10

Hole spacing

All wear plates shall have holes in the places marked with ●. Wear plates with a thickness T< 25 mm shall also have the holes marked with ⌖. Hole distances according to Image 3.

Hole design

Conical

Wear plates with conical countersunk holes are intended for mounting with countersunk screws of sizes M10, M12, M16 and M20, or by welding.

T = 6 – 100 mm

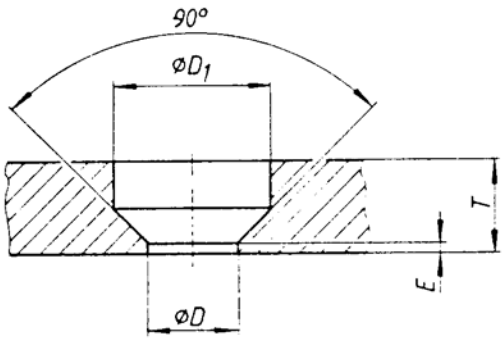


Image 4

Table 5

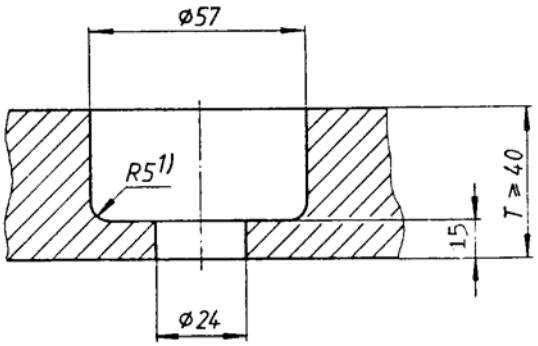
T	D	D_1	E
6	12	21	1,5
(6) – 10	15	26	2
(10) – 25	19	34	3
(25) – 100	24	42	3

Hole design

Flat

Wear plates > 40 mm can be obtained with flat countersunk holes. These plates are intended for mounting with hex screws or T-slotted screws with nuts.

T = 40 – 100 mm



1) Applies to cast wear plates

Image 5

Hole design

WRC conical hole

Wear plates with conical WRC holes are intended for attachment with WRC screw in dimensions M10, M12, M16 and M20. WRC (Wear Resistant Cone) may be seen as a replacement for welded stud.

The WRC screw is available in two different variants:

1. Flat head where the screw is tightened from the nut side.
2. Socket bolt where the screw is tightened from the wear plate side. The break-away head is either snapped off when adequate torque is applied or is cut off so that surface becomes flat.

T = 6 - 100

1. Tightening from nut side

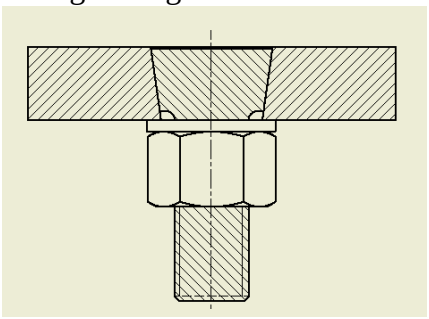


Image 6

2. Tightening from wear plate side

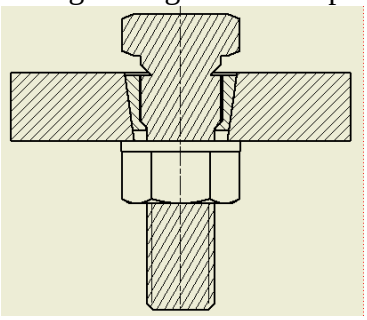


Image 7

WRC hole

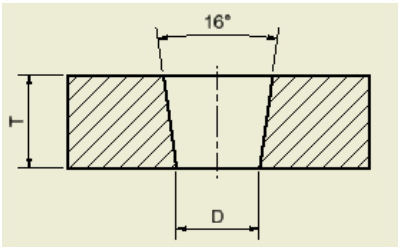


Image 8

Table 6

Wear plate thickness mm	D	WRC screw
6	17	M 10
(6) - 10	17	M 12
(10) - 25	22	M 16
(25) - 100	28	M 20

Welded joints

Wear plates that cannot be mounted with screws e.g. due to inaccessible surfaces are welded in place if the materials in the plate and the base surface are weldable. See image 9.

If only the material in the base surface is weldable, a cone made of weldable material is required, according to image 10 and Table 7. The cone is welded according to image 11.

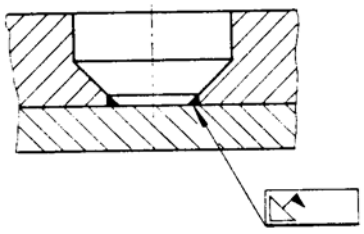


Image 9

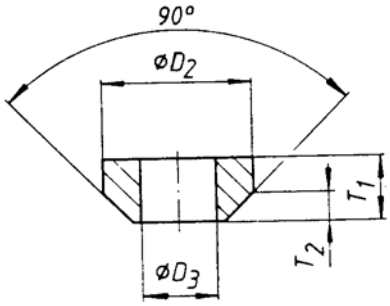


Image 10

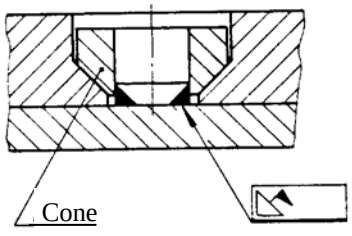


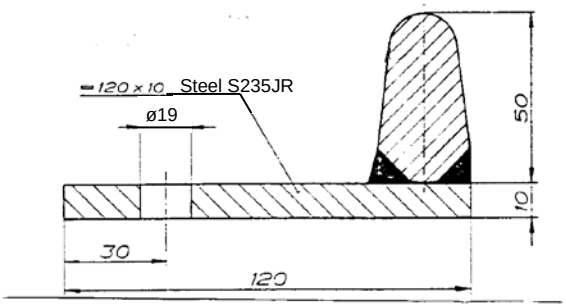
Image 11

Table 7

Wear plate thickness T	D_2	D_3	T_1	T_2
6	20	10	5	4,5
(6) – 10	25	11	7	6
(10) – 25	32[1)]	16	12	7
(25) – 100	40[1)]	20	17	9

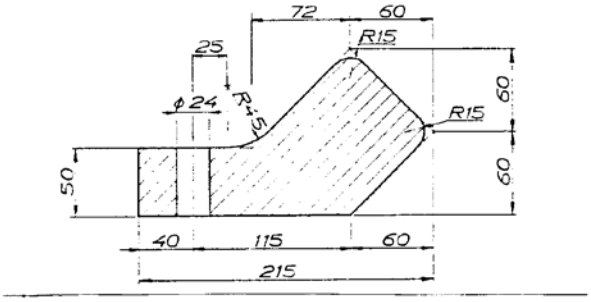
[1)] Matches mechanical tubing according to ISO 2938

Edging



Grouser bar
Profile 92
Steel N 92-22376939 (Bofors)
Hardened to Minimum HV500

Image 12



Edging
Cast in armoured Ni-Hard

Image 13

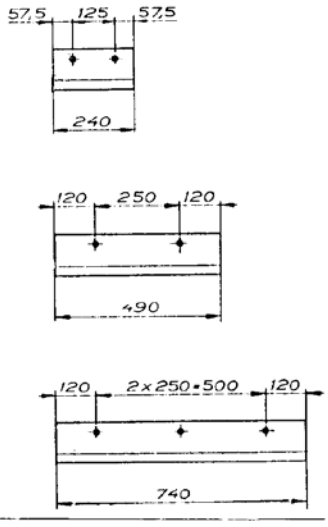


Image 14

Tolerances according to Table 4 and Swedish Standard SS 709

Screws

This instruction recommends which screws should be used for mounting wear plates.
Reference: SS 709

Screws for wear plates with conical countersunk holes

Hole diameter in the plate	Screw	Class	Screw type	Hex wrench
12	M 10	10,9	M F 6 S	6 mm
15	M 12	10,9	M F 6 S	8 mm
19	M 16	8,8	M F 6 S	10 mm
24	M 20	8,8	M F 6 S	12 mm

Table 8

Screws for wear plates with straight countersunk holes

Hole diameter in the plate	Screw	Class	Screw type	A/F (Across the flats)
24	M 20	8,8	M 6 S	36 mm
24	M 20	12,9	M C 6S	Hex 17 mm

Table 9

Screw for wear plate with WRC hole

WRC screw according to Table 6

Drawing index for standard formats

The drawing below covers wear plates according to LKAB Technical instruction and Swedish Standard SS 709.

Designation	Dimension	Kiruna drawing no.	Malmberget drawing no.
Wear plate	990 x 1990	441701	4-4262-101
Wear plate	990 x 990	441702	4-4262-102
Wear plate	990 x 490	441703	4-4262-103
Wear plate	490 x 490	441704	4-4262-104
Wear plate	740 x 240	441705	4-4262-105
Wear plate	490 x 240	441706	4-4262-106

Table 10

Note: Every plate is manufactured in thicknesses according to Table 3. Selection of material is carried out according to this instruction.

Designation	Note	Kiruna drawing no.	Malmberget drawing no.
Edging	Cast in arm. Ni-Hard	441720	4-4262-120
Edging	Hardened ribbed steel	441721	4-4262-121

Table 11

Suggestions for improvements

LKAB carries out continual improvements in accordance with the LKAB quality policy (SS-ISO 10006, sections 8.2 and 5.2.7) and this also applies to instructions and codes of practice. Comments and suggested improvements are welcome at the following e-mail address: *instructions@lkab.com*

The LKAB internal address in Outlook: *SE SM Anvisningar LKT*