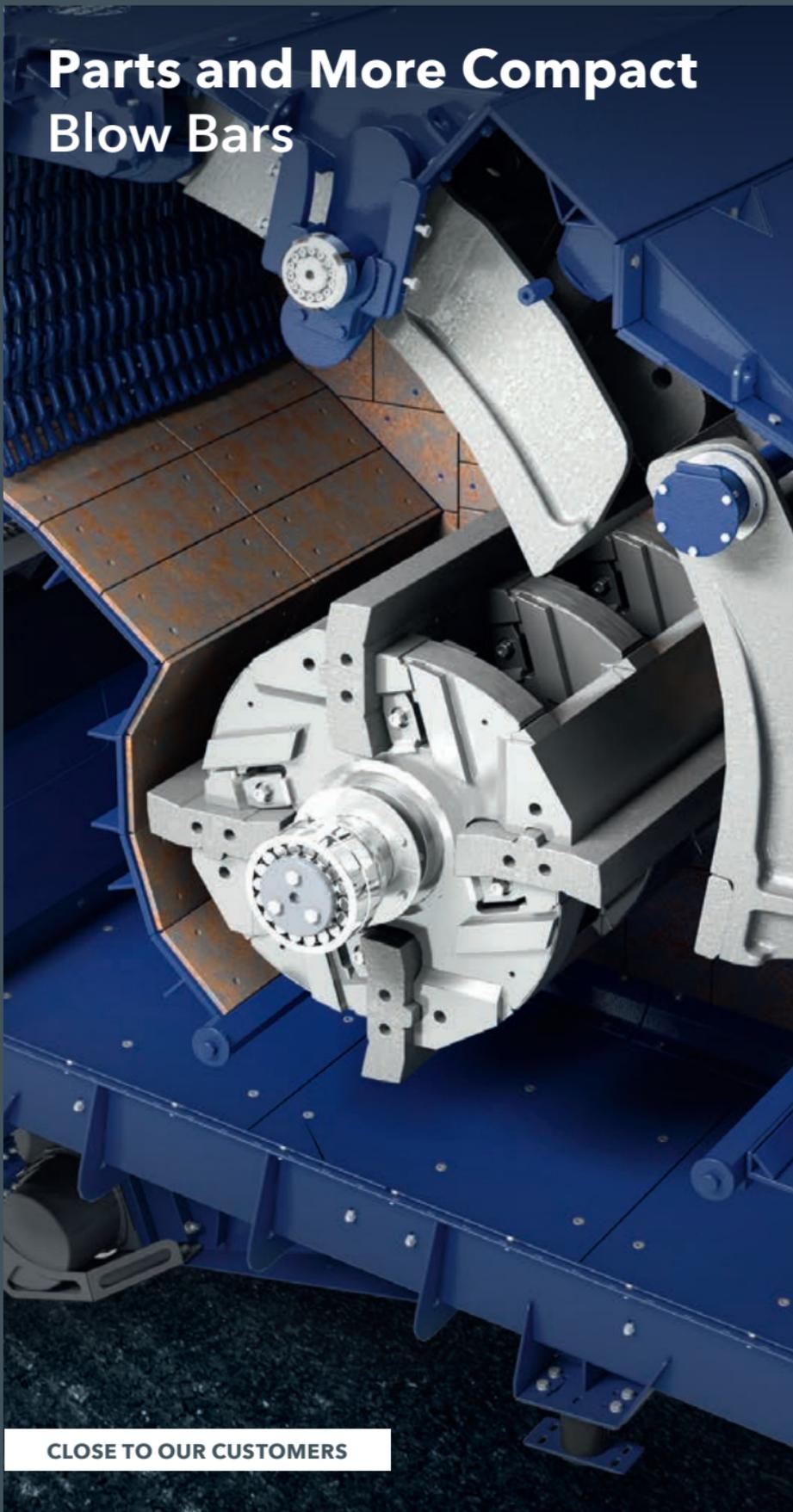




Parts and More Compact Blow Bars



CLOSE TO OUR CUSTOMERS

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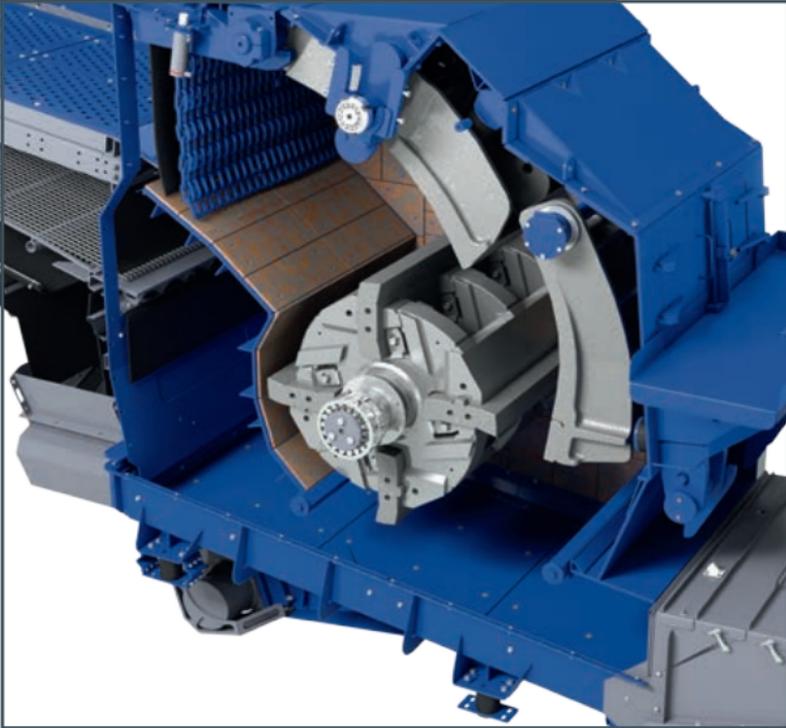


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ORIGINAL KLEEMANN BLOW BARS



OPTIMUM BREAKING CAPACITY FOR YOUR SUCCESS

The application areas of a KLEEMANN impact crusher range from conventional natural stone processing through the recycling of construction waste on to mining applications. The focus is thereby primarily on two objectives: increasing the blow bar service life and reducing the operating costs. The economical operation is not only ensured by the blow bar purchase price but mainly by choosing the right blow bar for a particular application. Only this way can the impact crusher deliver optimum results.

The wear during the crushing process depends on numerous factors with interactions that are often difficult to analyse.

These include:

- > Selection of the crushing parameters
- > Material the blow bar is made of (strength)
- > Shape

The way the crusher is loaded and the amount of material in the crusher also influence the blow bar service life.

KLEEMANN offers blow bars of suitable material for each application. Because the quality of the wear-resistant casting makes a primary contribution to the service life, KLEEMANN only works together with renowned foundries that adhere to KLEEMANN's strict manufacturing standards, such as testing the quality of castings and controlling the dimensional accuracy. The foundries ensure compliance with the requisite tolerances through state-of-the-art manufacturing processes.

Selecting the right blow bar for the material being broken up, foreign objects and the task size ensures that the impact crusher provides the required service performance and cost-efficient breakage.

PARTS AND MORE COMPACT BLOW BARS

This brochure will inform you about the different blow bars and give you guidance on maintenance and timely replacement. Use the guidelines to find the right blow bar for your application.

ORIGINAL KLEEMANN BLOW BAR COMPONENTS

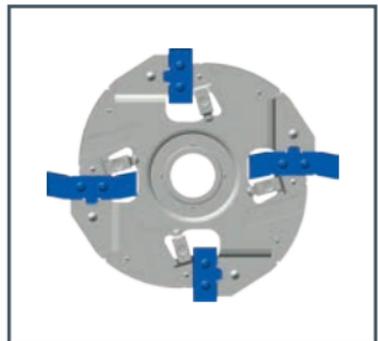
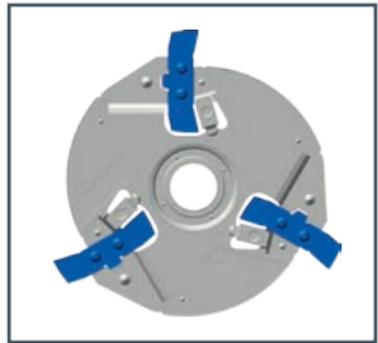
Altogether, in addition to its shape, the blow bar benefits from the respective components:

- > The **impact edge**, pointed in the rotor's rotational direction, is chamfered to maintain the impact edge longer, thus providing for better crushing over a lengthy period.
- > The **holes** on the side ensure easy and quick handling when turning or exchanging a blow bar.
- > The **lug** mounted on the back provides for the ideal transfer of the centrifugal forces to the rotor (only with C-shape).
- > The clamping wedges affix the blow bars and thus ensure the proper position on the contact areas of the rotor. The modified **clamping surface** provides exact fit along the entire length, with a reduced danger of breakage.



KLEEMANN impact crushers are equipped with different rotors depending on the size of the crusher and the application. The number of built-in blow bars primarily depends on the crushing chamber geometry and its associated intake behaviour.

For smaller crushing chamber geometries (inlet width of under 1,100 mm with rotor diameter under 1,100 mm), rotors with two or three blow bars are used. Larger crushing chamber geometries (over 1,200 mm with larger rotor diameter over 1,200 mm) are equipped with rotors featuring four blow bars to increase the operational spectrum. In the majority of applications, these rotors are operated with two high blow bars and two low blow bars.



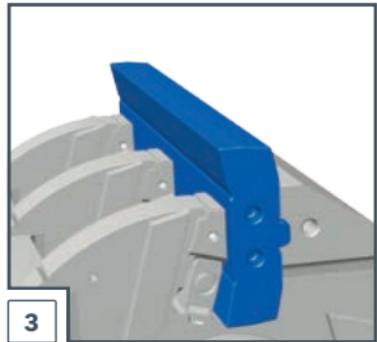
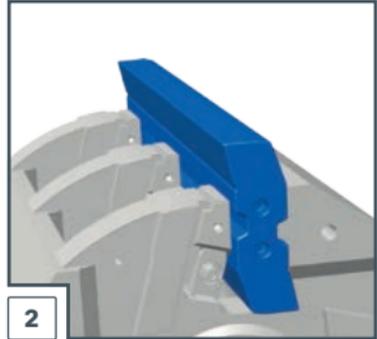
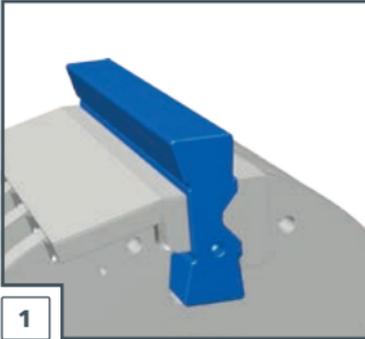
ORIGINAL KLEEMANN GEOMETRY OF THE BLOW BARS

Depending on the model series of the machines, different blow bar shapes are used. KLEEMANN offers three different shapes: X-shape, S-shape and C-shape.

The **X-shape** blow bars are fitted to the MR 100, MR 122, MR 150 and MR 170. They are pushed into the rotor from the side and affixed. In contrast to the other systems, the blow bars rest loosely in the rotor. The use of highly wear-resistant blow bars, e. g. chrome steel or chrome steel with ceramic insert, is not recommended for these mounting variants due to the increased risk of breakage.

A newly developed clamping system is now used with the **S-shape** blow bars installed in the MR 130. The blow bars are fastened to the rotor without any play using clamping wedges. This reduces the risk of breakage for wear-resistant blow bars, such as those made of chrome steel or chrome steel with ceramic insert. In contrast to the X-shaped blow bars, the blow bars can be mounted and dismantled from above.

Further developed for the EVO generation, the design is known as the **C-shape**. The blow bar affixing to the rotor is handled here by means of the lug of the blow bar. These are made thicker at this place, so that the clamp cross-section is strengthened in the highly-stressed area. The rigid mounting also ensures that impact energy is optimally transferred to the rotor, which substantially further reduces the risk of breakage in highly wear-resistant chrome steel blow bars.



- 1 > X-shape
- 2 > S-shape
- 3 > C-shape

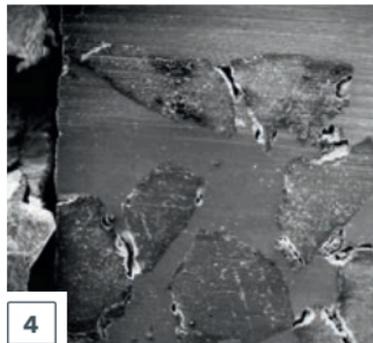
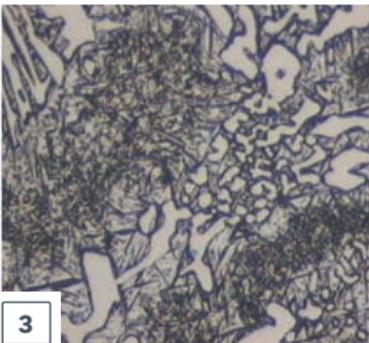
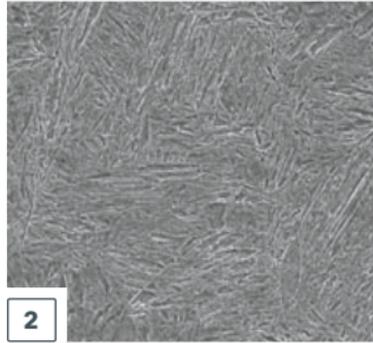
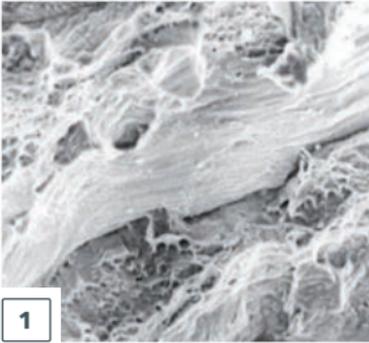
The material from which the blow bars are cast could be identical for all shapes, but this is not always recommended practice, however. Based on the different shapes and attachment systems, different areas of application arise.



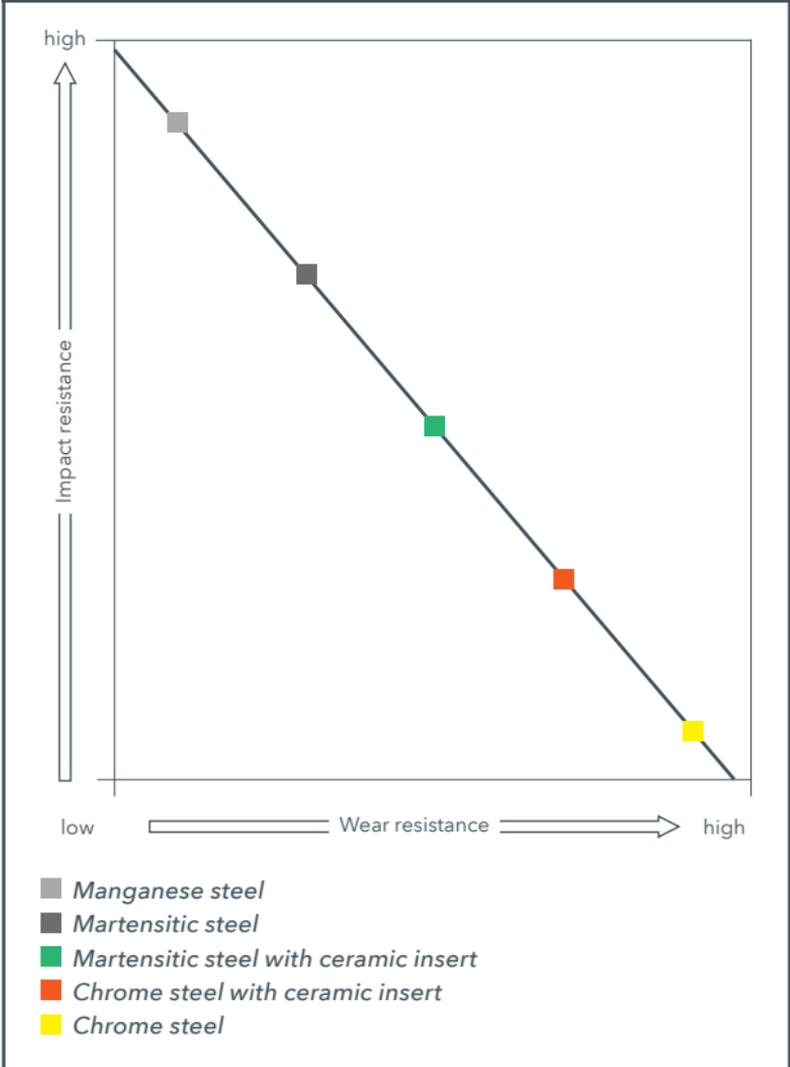
ORIGINAL KLEEMANN METALLURGY OF THE BLOW BARS

In practise, different materials for manufacturing blow bars have established themselves. These include manganese steels, steels with martensitic structure (referred to in the following as martensitic steels), chrome steels and the Metal Matrix Composites (MMC, e.g. ceramic), in which the various steels are combined with a special type of ceramic.

- 1 > *Manganese steel*
- 2 > *Martensitic steel*
- 3 > *Chrome steel*
- 4 > *Martensitic steel with ceramic insert*



Impact resistance compared to wear resistance



An increase in the steel's wear resistance (hardness) is usually accompanied by a reduction in toughness (impact resistance) of the material.

ORIGINAL KLEEMANN METALLURGY OF THE BLOW BARS

MANGANESE STEEL

The wear resistance of manganese steel with austenitic structure is attributable to the phenomenon of work hardening. The impact and pressure load results in a hardening of the austenitic structure on the surface. The initial hardness of manganese steel is approx. 200 HV (20 HRC, hardness test according to Rockwell). The impact strength is approx. 250 J/cm².

After the work hardening, the initial hardness can thereby increase to an operational hardness of up to approx. 500 HV (50 HRC). The deeper-set, not yet hardened layers thereby provide for the great toughness of this steel. The depth and hardness of the work-hardened surfaces depend on the application and type of manganese steel. The hardened layer penetrates down to a depth of approx. 10 mm.

Manganese steel has a long history. Today, this steel is used mostly for crusher jaws, crushing cones and crushing shells. In the impact crusher, it is only recommended to use manganese blow bars when crushing less abrasive and very large feed material (e.g. limestone).

MARTENSITIC STEEL

Martensite is a completely carbon-saturated type of iron that is made by quick cooling-off. It is only in the subsequent heat treatment that carbon is removed from the martensite, which improves the strength and wear properties. The hardness of this steel ranges between 44 to 57 HRC and the impact strength between 100 and 300 J/cm².

Thus, with regard to hardness and toughness, martensitic steels lie between manganese steel and chrome steel. They are used if the impact load is too little to harden the manganese steel, and/or good wear resistance is required along with good impact stress resistance.

CHROME STEEL

With chrome steel, the carbon is chemically bonded in the form of chromium carbide. The wear resistance of chrome steel is based on these hard carbides of the hard matrix, whereby the movement is hindered by offsets, which provides for a high degree of strength but at the same time less toughness.

To prevent the material from becoming brittle, the blow bars must be heat-treated. It must thereby be observed that the temperature and annealing time parameters are exactly adhered to. Chrome steel typically has a hardness of 60 to 64 HRC and a very low impact strength of 10 J/cm².

To prevent breakage of chrome steel blow bars, there may not be any unbreakable elements in the feed material.

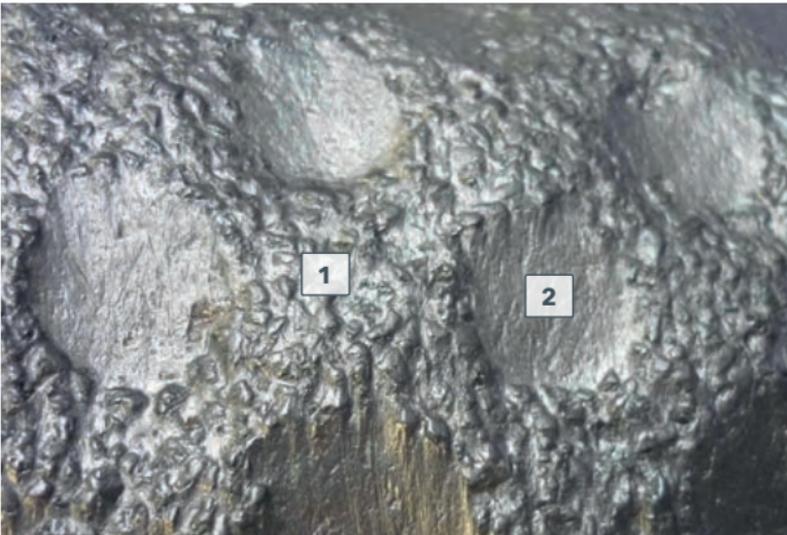
ORIGINAL KLEEMANN METALLURGY OF THE BLOW BARS

METAL MATRIX COMPOSITES

Metal Matrix Composites, ergo **MMC** combine the high resistance of the metal matrix with extremely hard ceramics. Porous preforms made of ceramic particles are produced in the process. The metallic molten mass penetrates into the porous ceramic network. The experience and knowledge are particular to the casting process in which two different materials - steel with a thickness of 7.85 g/cm^3 and ceramic with a thickness of $1-3 \text{ g/cm}^3$ - are combined and there is a thorough infiltration.

This combination makes the blow bars especially wear-resistant but at the same time very impact-resistant. With blow bars made of composites from the field of ceramics, a service life that is three to five times as long as that of martensitic steel can be achieved.

- 1 > *Ceramic particles*
- 2 > *Basic material
(martensite or chrome steel)*

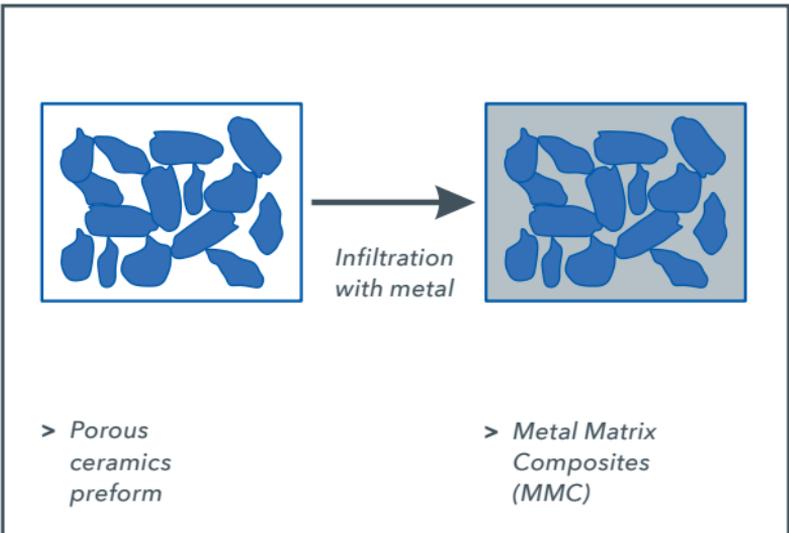




> *Different arrangement of the ceramic inserts in the basic material*

The advantages of blow bars with ceramic insert:

- > Very wear-resistant
- > High impact resistance (depending on the base material)
- > A higher service life than that of conventional steel, hence lower costs per tonne



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WEAR OF BLOW BARS

The crusher tools are subject to more or less wear, depending on various influencing factors.

Dirt, incorrect installation or elements from different manufacturers that are not identical will degrade not only the productivity and/or crusher performance of the machine, but can also damage the rotor's attachment systems. In extreme cases breakage can also occur, resulting in massive damage to the impact crusher.

The most common reasons for an unusually short service life of blow bars include the following:

- > Caking of crushed material around the impact area of the ceramics blow bar
- > Selecting the wrong blow bar for the material to be crushed (see usage recommendations, page 40-41)
- > Machine parameter settings that are inappropriate for the application (e.g. rotor speed or crushing ratio)

WHAT IS WEAR?

Wear is produced by two elements pressing against each other with relative movement (e.g. between the blow bar and the crushing material). During this process small particles become detached from the surfaces of both elements.

The primary agent of wear in the crushing process is abrasion. There is also material fatigue, as the crusher tools are subjected to numerous pressure and impact stresses.

Stresses and deformations occur due to mechanical contact forces, which worsen the ensuing abrasion if the opposing object is substantially harder and rougher than the basic material or if individual hard particles (bound or unbound) are pressed into the opposing object.

Increasing service life means:

- > Cleaning thoroughly each day,
- > Regularly inspecting the blow bars in order to act promptly, to counteract any wear or damage,
- > Performing regular checks and maintenance of the entire crusher housing,
- > Selecting the right blow bars for an application,
- > Adjusting all machine parameters to match the application (rotor speed, gap etc.).

Correct installation of the blow bar:

- > Inspect the degree of soiling and remove possible loosely clinging dirt on the rotor, blow bars and tensioning devices.
- > Usage of appropriate tools and suitable lifting gear for the hoist, e.g. block and tackle.
- > Only turn the rotor with the rotor turning device (where available). Do not remove the rotor safeguard.

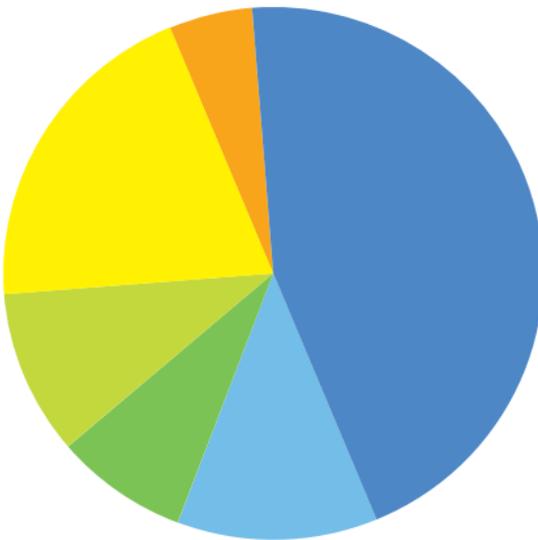
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INFLUENCING FACTORS FOR THE WEAR OF BLOW BARS

When assessing the service life of a blow bar, further influencing factors must be taken into account in addition to the blow bar material. The figure shows examples of the main influencing factors and the respective blow bar wear.

Generally, the various influencing factors - which are mutually interactive - can be divided up into various categories.

Influencing factors for the wear



■ Feed material
(rock infeed): 45%

■ Crushing ratio: 8%

■ Rotor speed: 20%

■ Moisture content
of material: 12%

■ Fine-particle proportion in the
crushed material: 10%

■ Ratio of the upper to the lower
toggle: 5%



Material-related factors:

- > Abrasiveness
- > Breakability
- > Grain size
- > Grain shape
- > Fine-particle proportion
- > Moisture content
- > Proportion of unbreakable elements

Machine-/process-related:

- > Crushing ratio
- > Ratio of the upper to the lower impact toggle
- > Rotor speed
- > Type of loading
- > Screening mesh of the prescreen
- > Contamination in the crushing chamber

Application-/operation-related factors:

- > Continuity of feed
- > Correct adjustment of machine parameters
- > Replacement of wear parts in due time
- > Selection of the right blow bars

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INFLUENCING FACTORS FOR THE WEAR OF BLOW BARS

FEED MATERIAL FACTOR

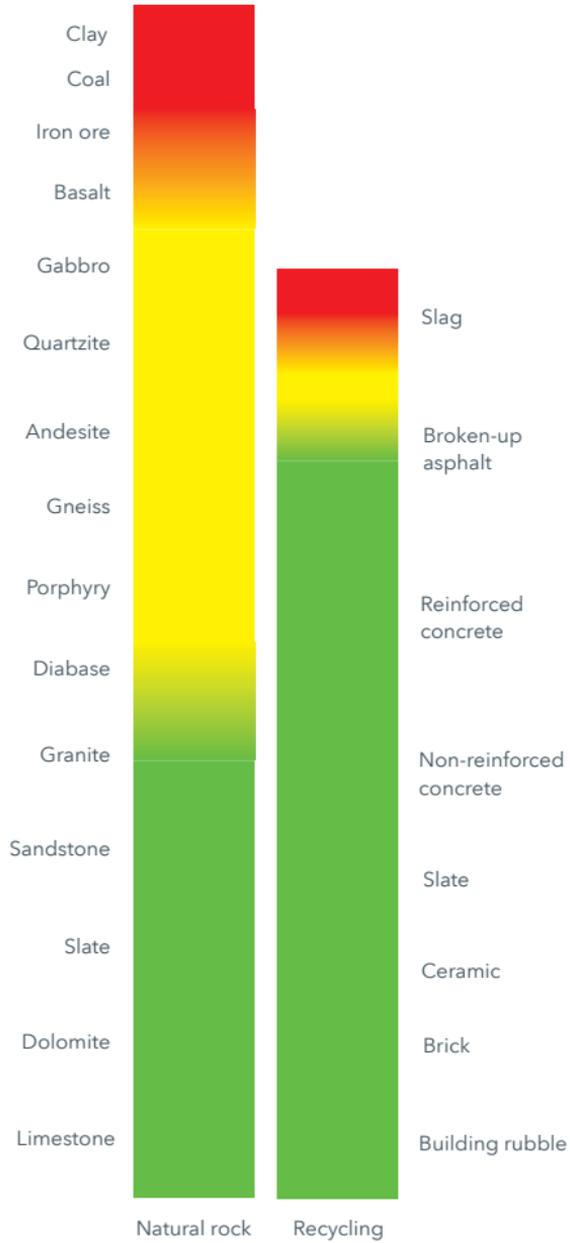
The most important factor with regard to the blow bar wear is the composition of the material. The boundary between the economic and non-economic work areas fluctuates. Natural stone is subject to natural fluctuations and can also exhibit severe differences depending on the origin.

The diagram serves as a guideline. The area shown in green marks the cost-effective, optimum use spectrum for impact crushers. The materials shown in yellow should be more exactly analysed by KLEEMANN. The materials in the red area generally cannot be cost-effectively processed with an impact crusher.



To prevent high costs due to wear, the material to be crushed must be sufficiently analysed.

Range of application



ORIGINAL KLEEMANN INFLUENCING FACTORS FOR THE WEAR OF BLOW BARS

ROTOR SPEED FACTOR

Tips on setting the rotational speed of the rotor:

- > Start with the medium speeds (only for the EVO series),
- > Monitor the material flow,
- > Monitor the grain size and fine-particle proportion in the final product,
- > Change the rotor speed in consideration of the material flow and final product quality.

Increasing the rotor speed results in:

- > Generally, more wear of blow bars, impact toggles and abrasion plates,
- > A tendency, to a higher fine-particle proportion,
- > In some cases, to greater output.

Rotor speed	Wear	Fines	Rate over-sized gain
Low	↓	↓	↑
High	↑	↑	↓

↑ Tendency to high values ↓ Tendency to low values

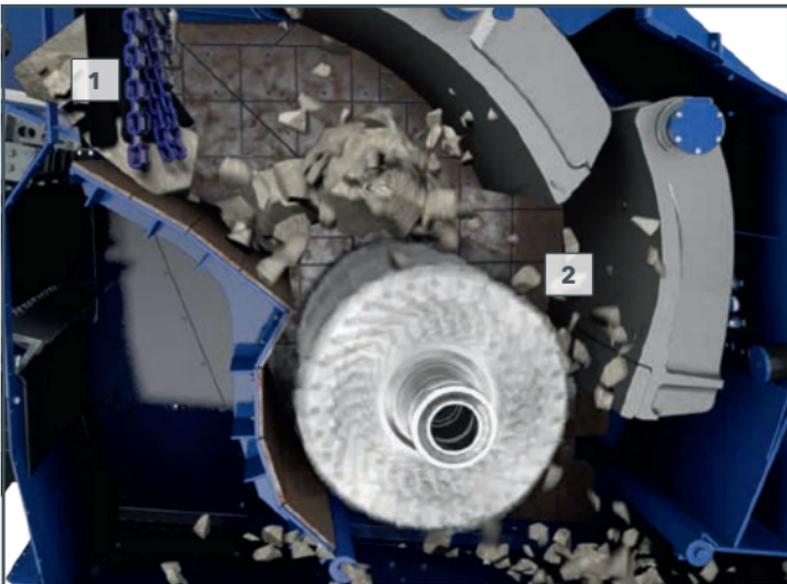


ORIGINAL KLEEMANN INFLUENCING FACTORS FOR THE WEAR OF BLOW BARS

CRUSHING RATIO FACTOR

The maximum crushing ratio as the ratio of the size of the feed particles (1) to the size of the discharged particles (2) essentially depends on the physical properties of the feed material. This results in the reference values seen here:

Feed material	Theoretical crushing ratio, considering the maximum feed size
Limestone, non-reinforced building rubble, asphalt	approx. 15:1
Steel reinforced concrete (depending on the quality of the concrete and iron content)	approx. 10:1-15:1
Medium-hard natural stone	approx. 18:1



CRUSHER CONFIGURATION FACTOR

Rotors with two or three blow bars are always equipped with high blow bars and are universal in use, particularly where materials are changed frequently.

Rotors with four blow bars are usually operated with two high blow bars and two low blow bars so that the maximum feed size can be processed with the maximum crushing ratio. In cases where the feed size is under 250 mm, the rotor can be equipped for targeted crushing, e.g. down to an end product of up to 10 mm, with four high blow bars. If the rotor speed is also increased here, the crushing effect is enhanced even further.

Note that the wear on blow bars, the crusher abrasion lining and impact toggles increases considerably here. If the selected blow bars and rotor speed are not optimised for the feed material, excessive wear and reduced feed capacity will result due to the hampered intake of material.

Blow bar configuration	4 x high	2 x high 2 x low	3 x high
Feed size	less than 0-400 mm	larger than 0-400 mm	0-600 mm

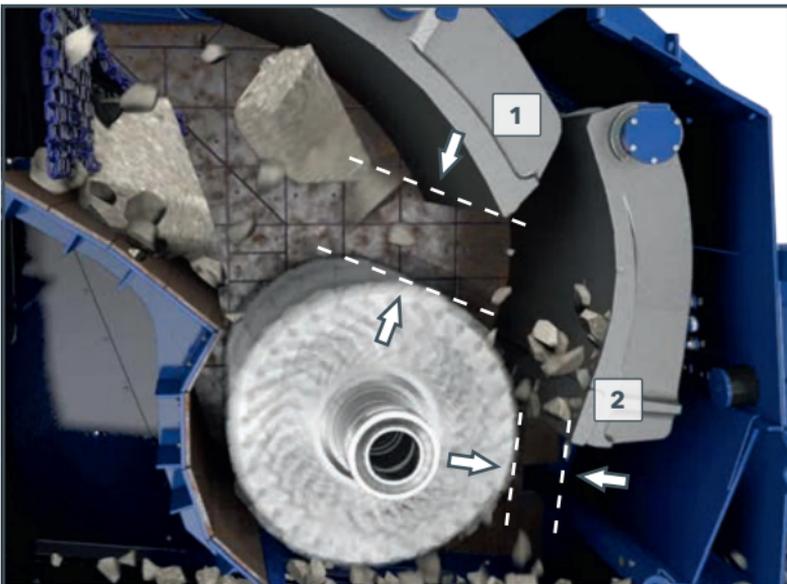
ORIGINAL KLEEMANN INFLUENCING FACTORS FOR THE WEAR OF BLOW BARS

SPLITTING RATIO FACTOR

In order to ensure the material flow and uniform filling of the crushing chamber, the ratio between the upper and lower crusher gap must be correctly selected.

An incorrectly adjusted ratio will result in increased wear on the blow bars and the crusher tools:

- > Upper crusher gap:
approx. 30% of the maximum feed size (1).
- > Lower crusher gap:
100% of the desired final grain size (2).



Calculation example - determination of the splitting ratio:

Values: specified grain size = 0-45 mm, feed size = 0-600 mm

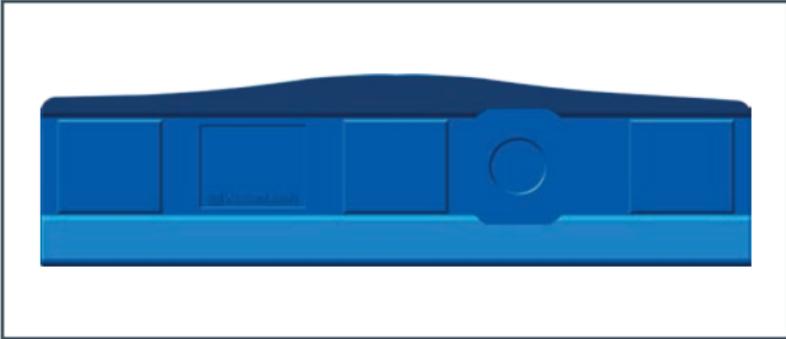
- > Crushing ratio test ($600 : 45 = 13.33$)
- > Setting of the lower crusher gap = 45 mm
- > Upper crusher gap 30% of 600 = 180 mm
- > Fine-tuning of the gap to achieve the desired final particle size
- > Monitoring the oversize grain content: If it comprises more than 10-15% of the feed material, the crushing gaps should be reduced accordingly.

**FACTOR OF PRE-SCREENING -
FINE-PARTICLE PROPORTION IN THE CRUSHER**

Depending on the properties of the feed material, active primary screening should be used to reduce the load on the crusher and to reduce wear. Because of the screening of the feed material, less sticky fine material and less soiled or cohesive material ends up in the crusher; this reduces wear.



ORIGINAL KLEEMANN EXAMPLES OF BLOW BAR WEAR



Condition:

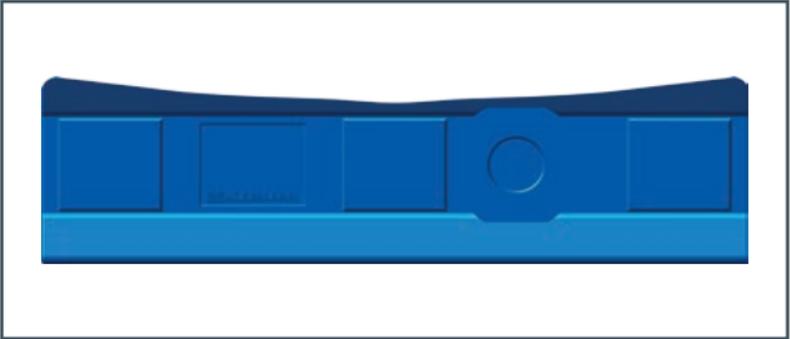
Systematic wear on the side of the blow bar

Possible cause:

- > Higher fine-particle proportion in the feed material
- > Non-homogeneous feed material
- > Contaminated crushing chamber: Due to the caking of material on the sides, the friction wear increases there

Solution:

- > Daily checking of the crushing chamber and cleaning if necessary

**Condition:**

Wear in the centre of the blow bar

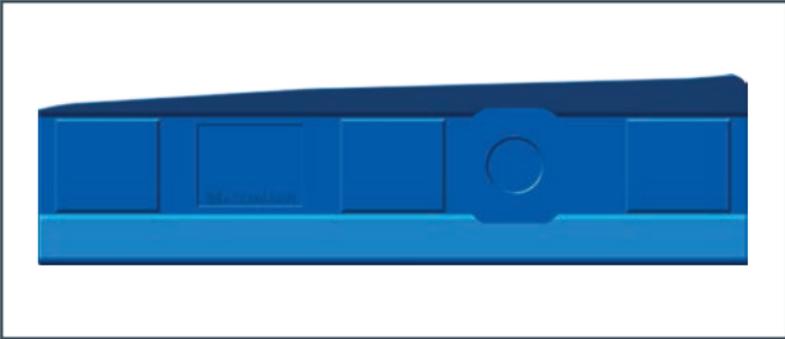
Possible cause:

- > Insufficient filling of the crushing chamber with an increased proportion of coarse, large feed material
- > Non-homogeneous feed material

Solution:

- > Continuous loading of the crusher
- > Change the setting parameters on the feed chute
- > Check excavator and the wheel loader

ORIGINAL KLEEMANN EXAMPLES OF BLOW BAR WEAR



Condition:

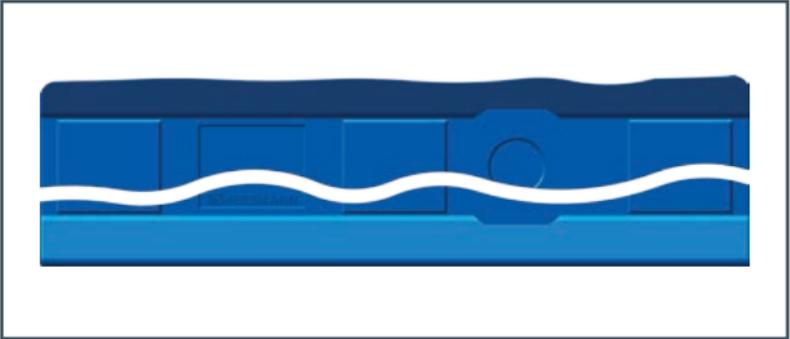
Severe wear on one side of the blow bar

Possible cause:

- > Increasing oversize particle return due to incorrectly set C.S.S. (closed gap width)
- > Machine not positioned horizontally
- > Material supply through the feed chute too low

Solution:

- > Levelling of the system
- > Continuous loading
- > Set the appropriate C.S.S. to reduce the oversize grain content

**Condition:**

Blow bar breakage

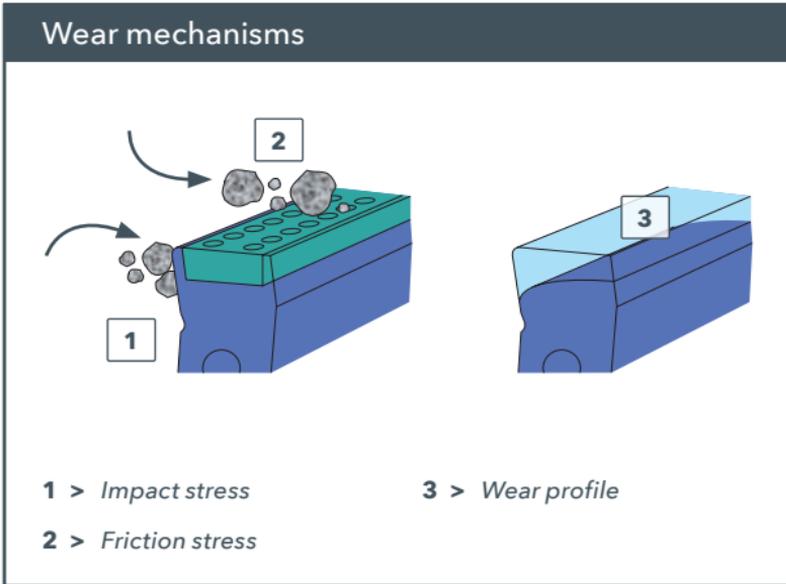
Possible cause:

- > The blow bar is inappropriate for the application
- > Unbreakable elements in the feed material
- > Feed size too large
- > Use of dimensionally non-compliant blow bars

Solution:

- > Select blow bars appropriate for the application
- > Use genuine KLEEMANN products
- > Reduce feed size

ORIGINAL KLEEMANN EXAMPLES OF BLOW BAR WEAR

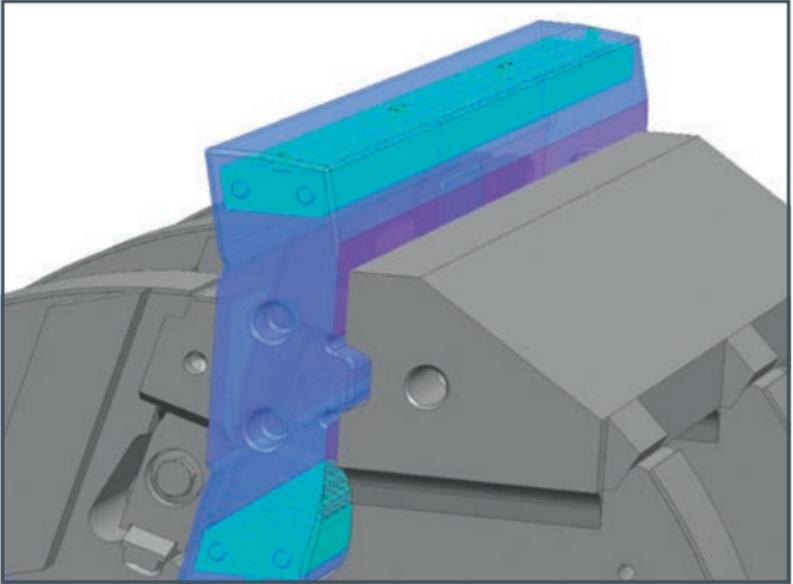


EXAMPLES OF WEAR FOR BLOW BARS WITH CERAMIC INSERTS

The main source of wear experienced by the impact edge is impact contact with the crushed material. The ceramic insert reduces the edge and friction wear on the top of the blow bar. The honeycomb structure of the ceramic, which occurs automatically in the blow bar as a result of the casting process, is only visible after a number of operating hours. If the ceramic insert is completely worn down, the wear is characteristically the same as for a blow bar without ceramic.

REFERENCE VALUE

Whether or not the ceramic blow bar provides the desired effect can only be judged if there are ceramic deposits on the carrier material as shown in the picture. If a difference is visible here, then the ceramic advantage is tangible.



ORIGINAL KLEEMANN MAINTENANCE AND REPLACEMENT OF THE BLOW BARS

The correct assessment of the blow bar wear is a prerequisite for the cost-effective operation of an impact crusher. Replacing blow bars at the right time ensures successful operation and reduces operating costs significantly.

It is common that blow bars do not wear evenly along the entire width. The wear limit is reached if on one part of the blow bar the specified minimum dimension has been attained (see picture 2).

The blow bars are symmetrically shaped and can therefore be turned around after the wear limit has been reached:

- > Open the impact crusher as per the instruction manual.
- > Switch off the system components and diesel generator.
- > Secure the rotor.
- > Visually inspect the wear limits on all blow bars.
- > Visually check the blow bars for cracks and protrusions.
- > Turn around or replace the blow bars as necessary.



Please note that changing the blow bars too late will result in increased wear on the rotor and the blow bar mounting. This results in expensive subsequent damage and prolonged machine downtimes. In addition to the necessary renewal of the rotor cladding (hard facing), the clamping wedges for blow bar mounting are also often damaged.



1 > Blow bar with heavy wear

2 > Wear limit is
15-20 millimetres

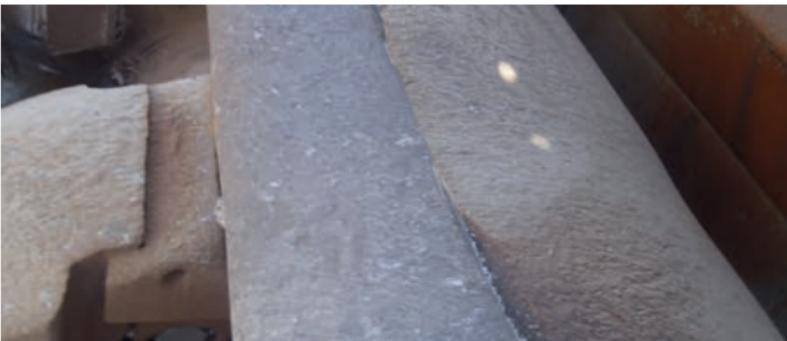
ORIGINAL KLEEMANN MAINTENANCE AND REPLACEMENT OF THE BLOW BARS

General notes on replacing the blow bars:

- > For rough cleaning of the crushing chamber it is recommended to fill the crusher for several minutes with clean, coarse material.
- > At least two people should always take part in installing and removing blow bars.
- > Always use suitable lifting gear and tackle.
- > Completely extend the crusher gap before blow bar replacement in order to prevent a collision between the blow bars and toggle after new blow bars have been installed.
- > Improper replacement of the blow bars can lead to crusher damage.
- > Only operate the rotor if the blow bars have been correctly installed.
- > Always replace blow bars in sequence.
- > Replace all blow bars even if only one of them is broken.



- > *Wear due to replacing the blow bars too late*



- > Before making the final settings, briefly operate the machine at the highest rotational speed (for the EVO 1800 rpm), then check the wedge clamps; tighten the screws if necessary.
- > Always use conical spring washers with the clamping bolts of the tensioning devices. Retighten the clamping bolts after approx. two operating hours.
- > **Caution: A non-secured rotor can lead to severe injuries. Therefore: Always observe safety instructions!**

A detailed description of how to replace blow bars can be found in the instruction manual for the respective machine.



- > *Border area wear on the rotor resulting from wear of the blow bar on exterior side*



ORIGINAL KLEEMANN GUIDELINE FOR SELECTING A BLOW BAR

The cost-effective use of the blow bars is influenced by many factors (e.g. feed material, rotor speed, moisture content, feed size, crushing ratio). Use the following pages to identify the optimum blow bar for your particular application. If this leads you to choose various blow bars, start with the most cost-effective crusher tool for your application.

Questions on selecting blow bars appropriate to the application:

(See right and our recommendation for application on the following page for details)

- > Which material will be crushed?
(Broken-up concrete, for example)
- > How can the feed size be classified?
(E.g. largest grain size 600 mm)
- > Is the material cubic or plate-like?
- > In which area is the abrasiveness?

Determining the possible blow bars:

- > See diagram: Feed material classification

Verification of the determined blow bar with regard to the availability of the crusher type:

- > You will find information on our product range in the Parts and More catalogue or online at www.partsandmore.net.

Material version	Designation KLEEMANN
Manganese steel	Manganese steel
Martensitic steel	Martensitic steel
Martensitic steel with ceramic insert	MartComp
	MartXpert
	MartXtra
	MartPower
Chrome steel	Chrome steel
Chrome steel with ceramic insert	ChromComp
	ChromXpert



1

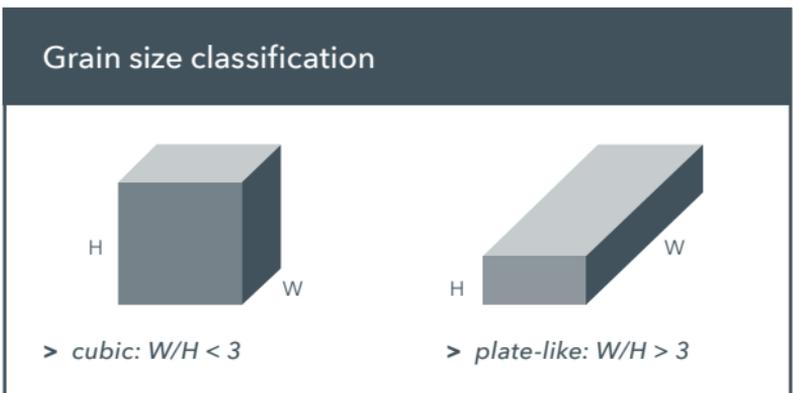


2



3

- 1 > Limestone (cubic)
- 2 > Asphalt (plate-like)
- 3 > River gravel (cubic)



Classification of the abrasiveness:

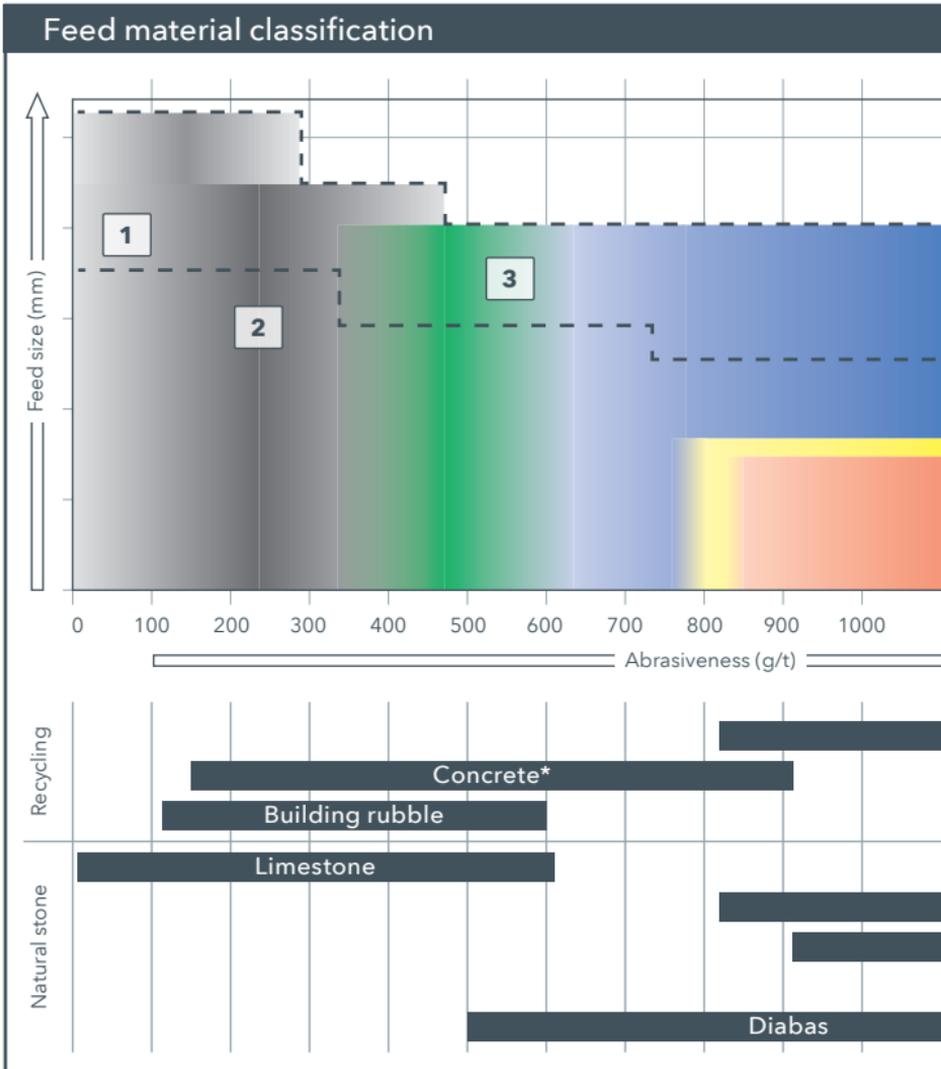
- > Non-abrasive (0-100 g/t)
- > Low abrasive (100-600 g/t)
- > Medium abrasive (600-1200 g/t)
- > Abrasive (1200-1700 g/t)
- > Very abrasive (< 1700 g/t)

ORIGINAL KLEEMANN GUIDELINE FOR SELECTING A BLOW BAR

Recommendations for blow bar application	
Version	Properties
Manganese steel	Manganese steel is used when increased impact resistance or elongation is required. When the impact force is sufficient, the manganese steel of the blow bar consolidates (cold consolidation) and therefore reduces the wear.
Martensitic steel	This steel combines hardness and impact resistance where using chromium steel would lead to breakage. Furthermore, martensite blow bars have a longer service life than manganese blow bars for applications with abrasive materials.
Martensitic steel with ceramic insert (MartComp/ MartXpert)	The blow bar comprises a martensite body which is reinforced on the inside with ceramic inlays. This composite material combines the hardness of a ceramic with the mechanical characteristics of steel and has a 2 to 4 times longer service life when compared to blow bars made of single alloys.
Martensitic steel with ceramic insert (MartXtra/ MartPower)	The ceramic inlay is cast in deeper and more elongated. The impact edge therefore is preserved until the end of the wear period, increasing the service life compared to the MartComp/MartXpert blow bar for abrasive applications.
Chrome steel	Chrome steel is characterised in particular by its increased hardness and has the advantage of being particularly wear resistant in applications where manganese and martensitic steels wear down more quickly.
Chrome steel with ceramic insert (ChromComp/ ChromXpert)	The bond between chrome body and ceramic inlays ensures a constant wear profile with very abrasive pre-crushed materials which are encountered especially in gravel pits and quarries.

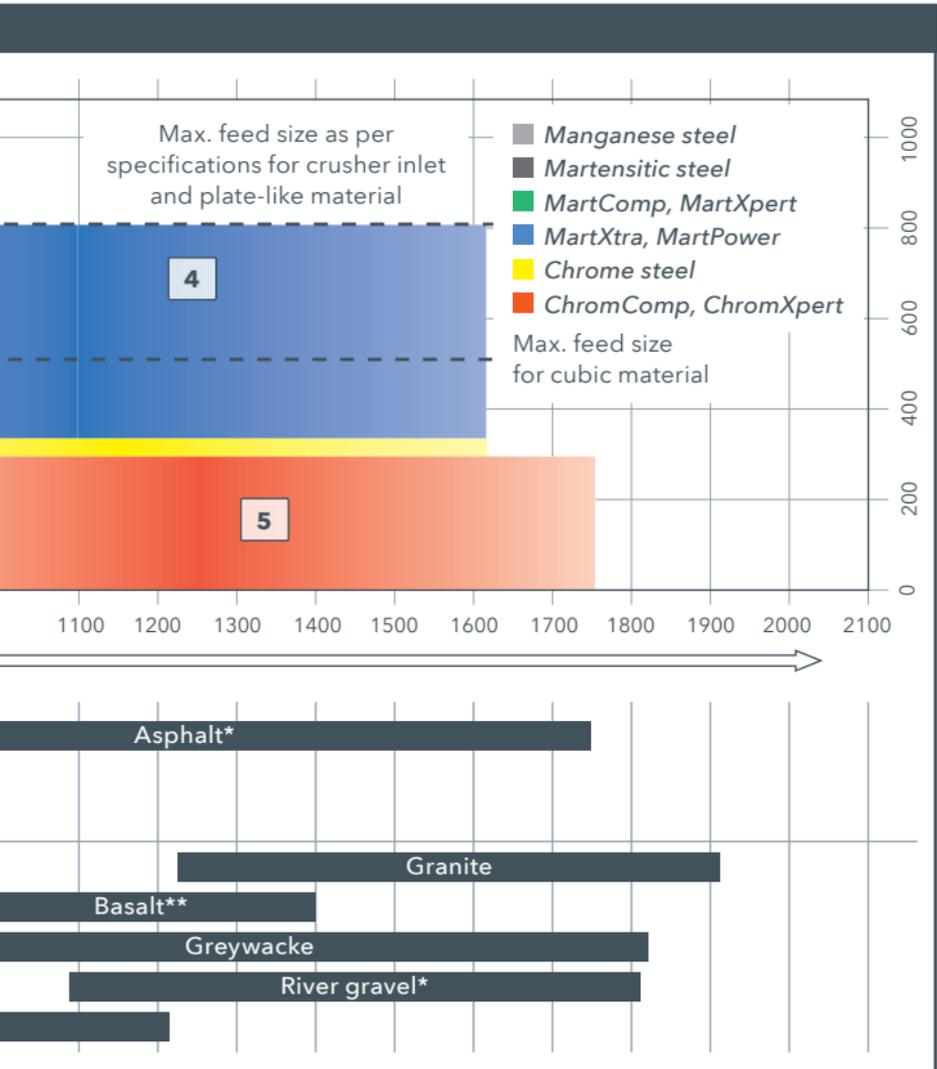
	Recommended application
	<ul style="list-style-type: none"> > Mild abrasiveness, e.g. limestone > In case of very large feed size > When there is a very high proportion of unbreakable objects in the feed material e.g. iron
	<ul style="list-style-type: none"> > Building rubble > Blasted limestone > In case of large feed material (depends on the geometry of the crusher inlet)
	<ul style="list-style-type: none"> > Recycling of building rubble with little to medium iron content > Concrete > Natural stone
	<ul style="list-style-type: none"> > Recycling of building rubble with little to medium iron content > Concrete > Natural stone > Asphalt
	<ul style="list-style-type: none"> > Secondary crushing level with natural stone or river gravel > In case of smaller feed sizes
	<ul style="list-style-type: none"> > Secondary crushing level with very abrasive natural stone or river gravel > Asphalt in case of smaller feed size > Milled material without any iron content

ORIGINAL KLEEMANN GUIDELINE FOR SELECTING A BLOW BAR

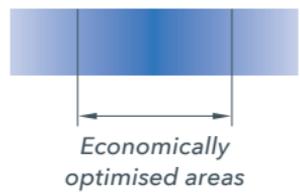


Examples of the classification of the feed material when selecting blow bars:

Nr.	Feed material	Max. feed size (mm)
1	Natural stone (soft limestone)	0-800
2	Natural stone (medium-abrasive limestone)	0-600
3	Concrete (medium-abrasive)	0-700
4	Asphalt	0-700
5	River gravel	0-200



	Grain size classification
	cubic
	cubic
	plate-like
	plate-like
	cubic



* Additional materials are decisive (e.g. granite, quartzite, basalt).

** Usage must be checked by KLEEMANN by means of a material sample.



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