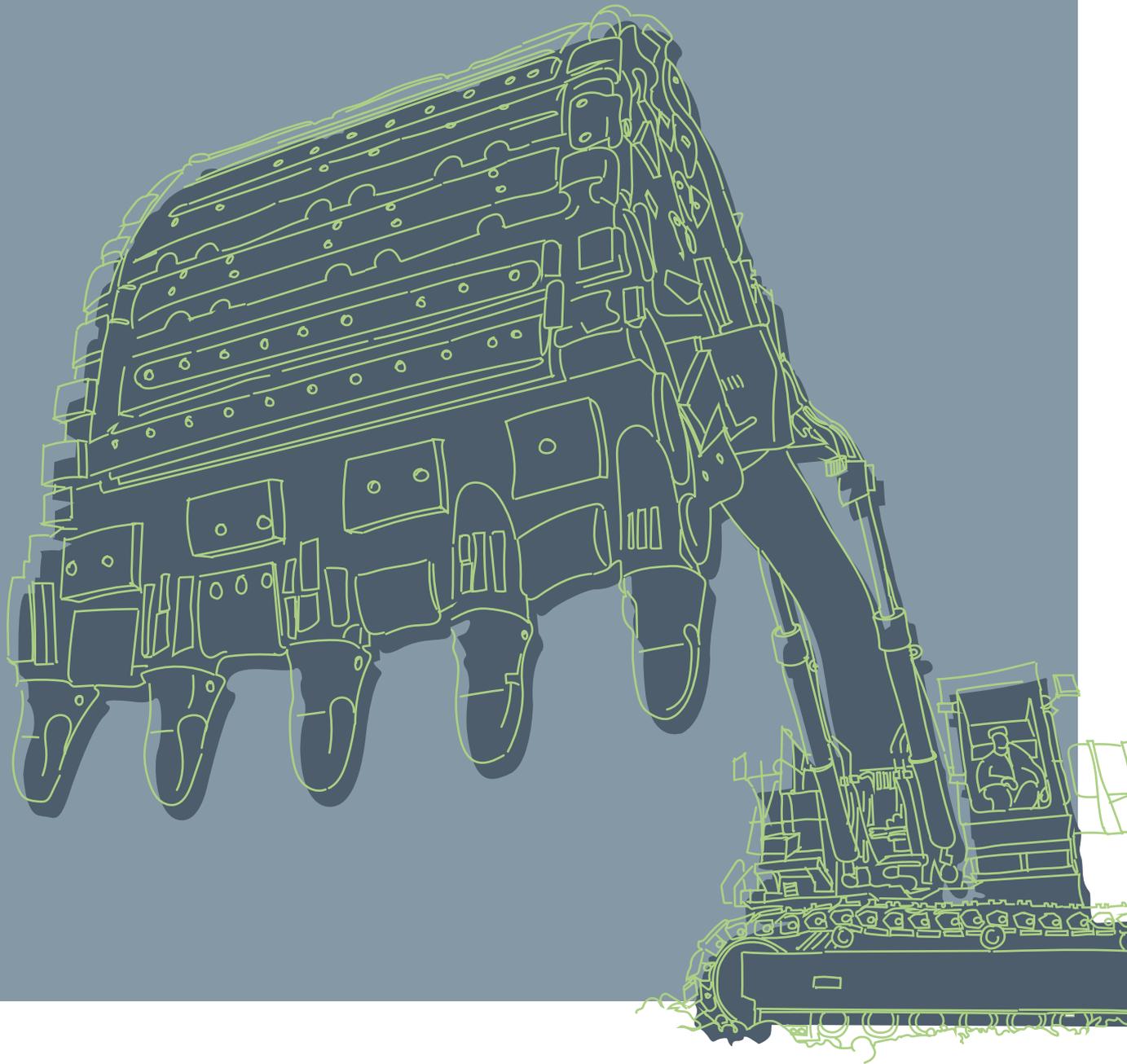


DILLIMAX & DILLIDUR

High strength and wear resistant plates



Dillinger

Pure steel, pure future

For about 340 years, we have put pure expertise and innovation in steel into practice. We are committed to progress, the climate, and future generations. Europe's leading heavy plate manufacturer is achieving great things – together and for each other.

Steel is the future

Steel is unique: Its strength, elasticity and processing properties enable a wide range of applications and impressive constructions. Its 100% recyclability makes it unbeatable when it comes to sustainability. As a reliable partner to our customers, we design excellent products for key industries such as steel construction, mechanical engineering, and the energy sector. Our steel plates are already accelerating the energy transition – in offshore wind turbines and in storage and solar power plants.

Pure future

Our aim is to ensure a sustainable future today as well as tomorrow. We are committed to achieving carbon-neutrality by 2045 and are actively accelerating the development and use of technologies such as hydrogen and electric steel production. Our decarbonization project Power4Steel is an important milestone in this regard and is paving the way for a climate-neutral tomorrow. We already offer carbon-reduced heavy plate under the D-PURE+ label, and we will be producing carbon-reduced steel on the new DRI-EAF production route starting in 2027/28.

Pure quality

At Dillinger, the entire manufacturing process – from research to steel production to the rolling mill – is focused solely on the heavy plate product. This specialization gives us unparalleled expertise, which we use to benefit our customers. We use our knowledge, the latest technology and state-of-the-art AI applications to produce our steel plate to a consistently high quality and to advance the development of our products and services. Dillinger offers an incomparable product portfolio with more than 2,000 different types of steel and an impressive range of dimensions. Personalized customer advice and an increasingly digital range of services perfectly complete our range of services.

Pure commitment

We take responsibility together and for each other. For our employees, our environment, our products, and our future. Our cooperation is defined by partnership and a culture of appreciation. We are the backbone of a reliable power supply and secure infrastructure. Inquisitive and open-minded, flexible and focused on solutions – we are creating the future for generations to come. We are “Made in Europe” – and prove our value worldwide.

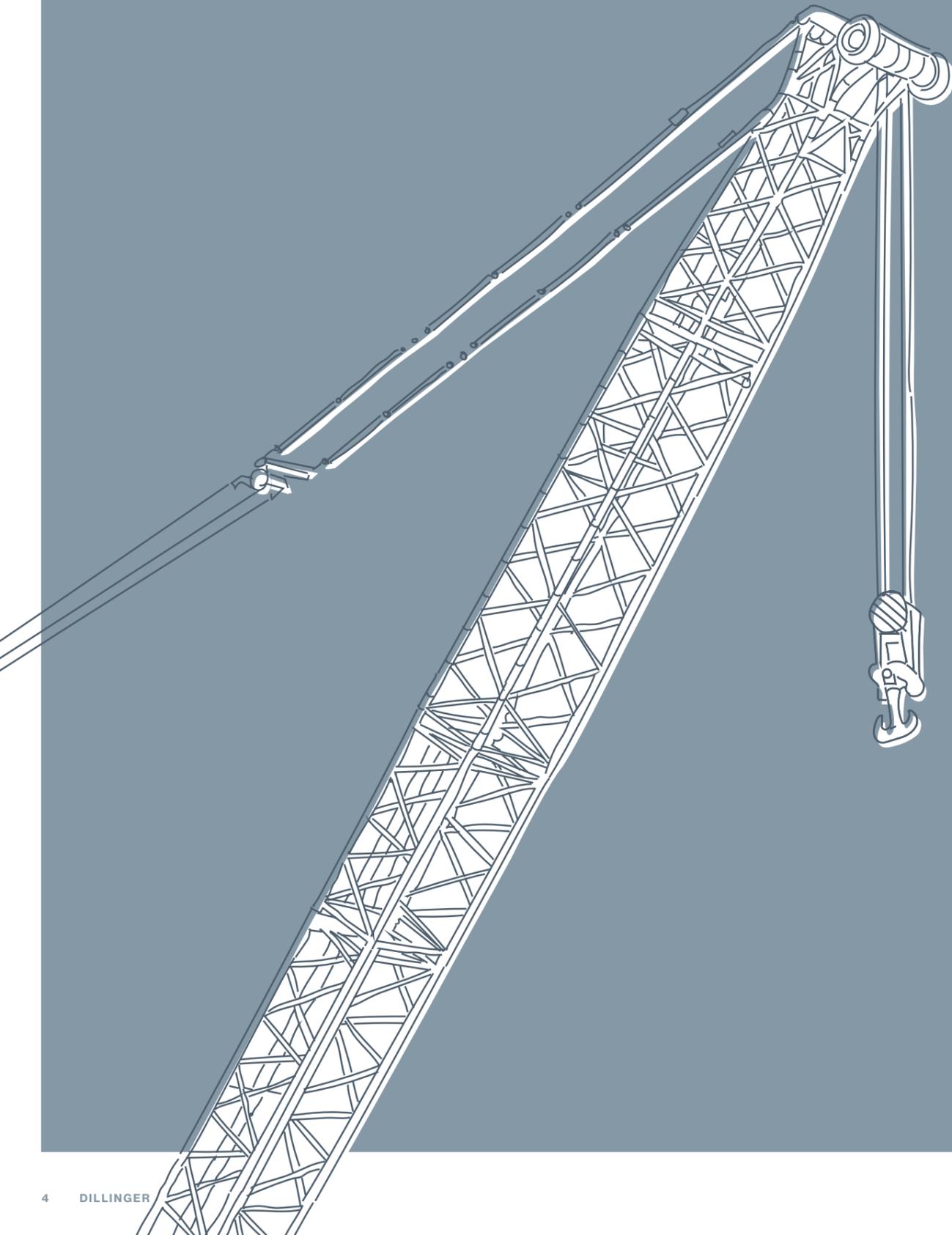
We are Dillinger. We are Pure Steel+

Dillinger

at a glance



Mechanical strengths and plate thicknesses have increased, cleanness and toughness have been refined. The result: More efficiency and maximum safety – a development that assures measurable added value.



DILLIMAX und DILLIDUR – specialists in diversity

Top performance demands top materials. The reason, DILLIMAX and DILLIDUR were originally developed: for half a century, these specialists in ultra-heavy loads and rough abrasive wear have grown – with their applications and with our customers.

Lightweight designs cut costs

Anyone aiming to conserve resources will need to save. Thinner and therefore lighter plates with elevated mechanical strengths are used to reduce the weight of moving parts. They also make fabrication more efficient: thinner and lighter designs can be achieved with smaller welds, consuming less welding time.

Demands for ever higher maximum loads

Lifting equipment and machinery used in mining have grown to a giant size. The forces arising here necessitate even higher mechanical strengths, combined with exceptional plate thicknesses.

Your product benefits at a glance

- Broad range of grades
- Individually tailored specifications
- Extreme thicknesses
- Large dimensions and formats
- Extra-heavy precision-cut plates

DILLIMAX

- Ultra-high mechanical strengths, with yield strengths of up to 1100 MPa
- For ultra-high loads

DILLIDUR

- Hardnesses of 325 to 600 Brinell
- For maximum wear resistance

New potentials need greater safety

Precisely under difficult service conditions – such as the installation offshore wind farms using giant cranes – the plates selected must meet extremely high standards for internal cleanness and resistance to fracture.

Your service benefits at a glance

- The experience of our technical and commercial specialists assures comprehensive advice
- Fabrication services available
- Flexible delivery logistics



Discover our E-Service system: it's packed with useful tools and features, your own personal myE-Service area, providing all information on your orders, as well as the E-Connect app for plate identification.

From a dream combination to a unique material

The foundation for the high-quality heavy plates produced by Dillinger is laid in our own steelmaking plant. This is where homogeneous feed material for DILLIMAX and DILLIDUR originates, after which the plate is rolled with the application of extraordinarily high forces and the use of ultra-smart technologies in the rolling mill.

It all starts in the steelmaking plant

Anyone aiming to meet high safety standards needs plates of enormous toughness and extremely homogeneous properties. The so-called Z grades guarantee exactly that: the plate features special deformation properties in the thickness direction at the most challenging point, the plate centre. High strength DILLIMAX and wear resistant DILLIDUR steels are degassed under vacuum. This, in combination with sophisticated secondary metallurgy, reduces the amount of undesirable tramp elements, such as sulphur, for instance, to a minimum. A high-quality plate – especially in large plate thicknesses – necessitates sufficiently thick and especially homogenous feed material. Dillinger casts this steel, using the continuous-casting process, into so-called slabs of up to record thicknesses of 600 mm. A homogenous internal quality is assured at Dillinger as a standard feature: all DILLIMAX plates are delivered in accordance with ultrasonic class S₁E₁ – or to even more demanding customer specifications.

Precision work in the rolling mill

Extraordinary forces act at the Dillinger plant: in the rolling process, the plate is rolled under forces of up to 108 MN (approx. 11,000 t) from the feed material, i.e. either a slab or an ingot. Rolling progresses in the largest possible “steps”, so-called “rolling passes”; the rolling schedule, in other

words, the temperature-dependant sequence of rolling passes, is decisive in this process. Thanks to this “high-shape rolling”, not only the surface, but also the plate centre, is defined and the most homogenous possible plate is thus produced; the steel’s remarkable mechanical strength or wear resistance is achieved in quenching and tempering installations. Extremely rapid cooling using water results in a hardened microstructure, distributed uniformly across the entire plate surface – and thus in the high wear resistance of the DILLIDUR 400 to 600 grades.

In the case of DILLIMAX steels, this is followed by a further heat-treatment operation, so-called tempering. The plate’s microstructure is thus relaxed. At the same time, hardness and mechanical strength are adjusted to exactly the required values and toughness is raised to an extremely high level.

Individualised end product

Other production operations follow, such as marking, leveling and/or blasting and coating, depending on the customer’s specifications. Our customers decide what they need, such as temporary corrosion protection (shop primer), for instance; although often a good idea, to permit temporary storage of plates in the open air, primer may, on the other hand, sometimes simply not be desirable for technical reasons connected with welding processes.

Tempering of DILLIDUR and DILLIMAX

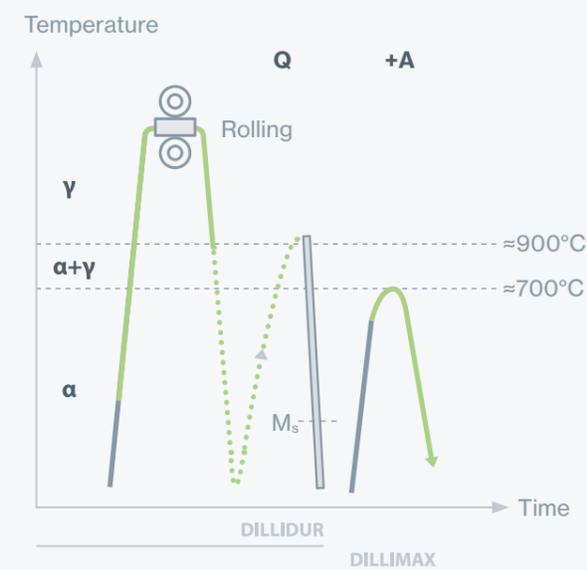
Quenching in water from the austenitisation temperature

(>Ac₃ ≈ 900° C)

= Q (Quenched), e.g. DILLIDUR 500

+ additional tempering

= Q + A or Q + T (Quenched + Tempered), e.g. DILLIMAX 965 E

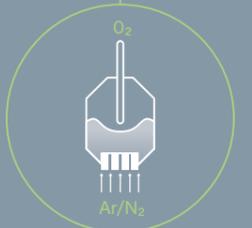


M_s = Martensite Start Temperature | γ = Austenite | α = Ferrite

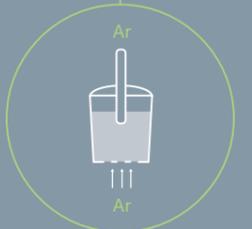
Hot-metal desulphurisation



Oxygen top-blowing converter



Argon bubbling process



Degassing process

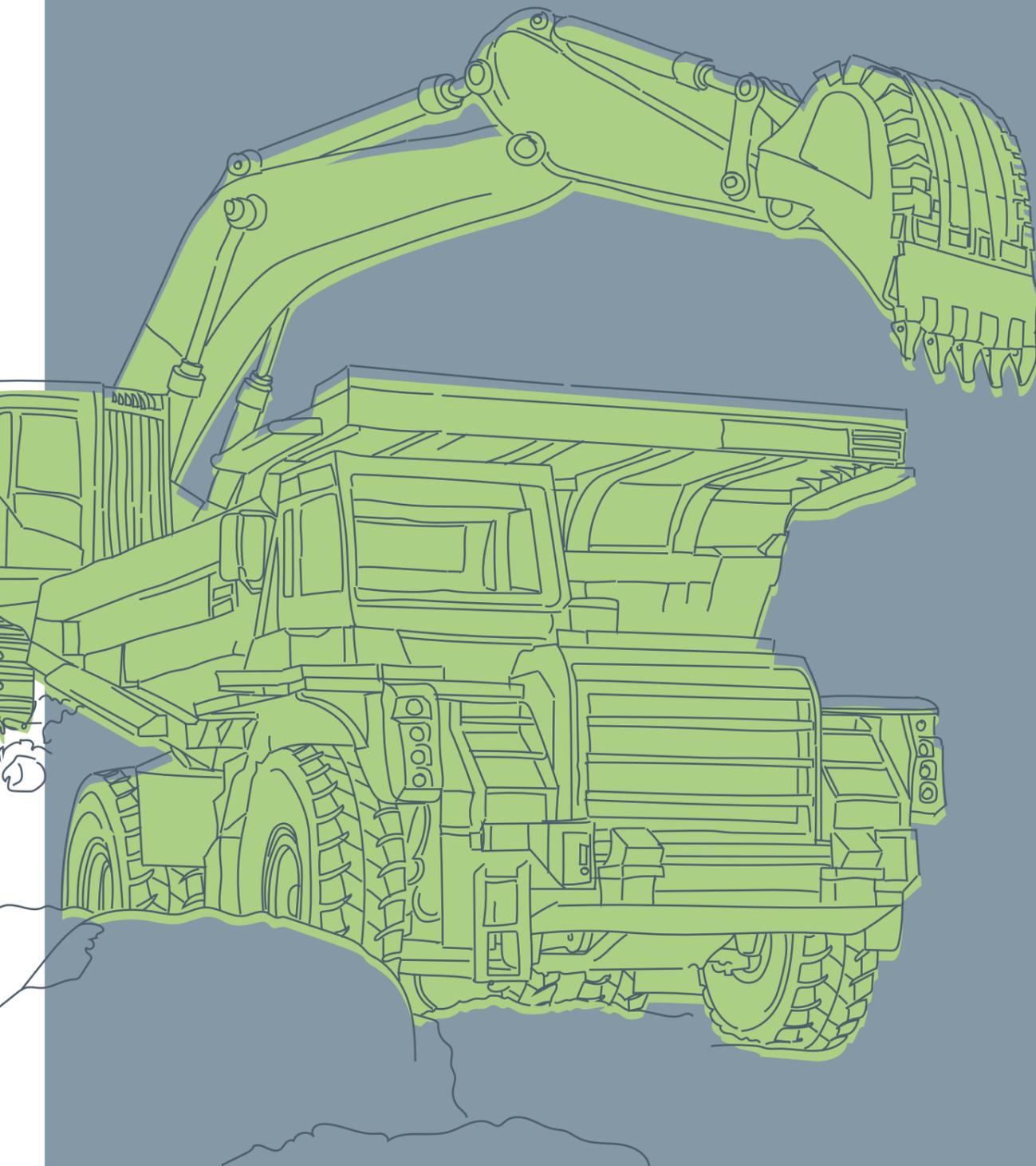


CaSi treatment



Casting





DILLIDUR

when hard really means hard

Hard in service, but easy to work – and therefore a success for more than 50 years. Wear resistant DILLIDUR steels combine ultra-high wear resistance with constant, simple and cost-efficient workability.

Used around the globe

DILLIDUR is convincing: Excavators, demolition and recycling equipment, as well as gigantic machines for recovery of mineral resources, are all equipped with Dillinger's wear resistant proprietary steel. A carefully tailored series of grades up to a hardness of 600 Brinell are available for our customers' specialised needs.

The basic DILLIDUR 400 grade is the convincing solution when easy workability combined with good wear resistance is needed. This grade, with its nominal hardness of 400 Brinell, is characterised by exceptionally low carbon contents and thus extremely good suitability for flame-cutting and welding, at economical low preheat temperatures – in fact, in many cases, with no cost-intensive preheating at all. DILLIDUR 500, despite its very high nominal hardness of 500 Brinell and its extremely high wear resistance, can be safely and cost-efficiently further worked using Dillinger's processing notes.

Special applications

Air-hardened DILLIDUR 325 L, with a nominal hardness of 325 Brinell, is used in special applications involving more elevated temperatures of up to around 500 °C and for hot-formed wear parts. Thanks to the alloying concept used, this grade hardens automatically even under slow cooling in air. After normalising – e.g. for hot forming –

the properties described in the data sheet are restored automatically. Thick-walled and, in many cases, welded wear parts, such as the cutting edges of high-capacity shovels for service under adverse conditions in mines, need a special level of resistance to cracking. This is provided by DILLIDUR IMPACT: plate thicknesses of 40 mm to 150 mm with guaranteed Charpy V-notch toughness.

Special grades are available on request to permit the use of extremely large plate thicknesses combined with special requirements for plate-centre properties. The Dillinger range includes the two DILLIDUR 550 and DILLIDUR 600 grades for particularly challenging service conditions.

DILLIDUR	600/550	500	450	400	IMPACT	325 L
Abrasive wear	++++	+++	++	+	+	+
Weldability	-	0	+	+	++	-
Cold formability	-	0	+	+	+	--
Hot formability	-	-	-	-	0	+
Service at elevated temperatures	-	-	-	-	0	+
Resistance to cracking	-	0	+	+	++	-
Machining	0	0	+	+	+	+
Nitriding	-	-	-	-	+	+

Grade	Plate thickness [mm] (in.)	Hardness
DILLIDUR 600	15 – 60 (0.6 to 2.4)	560 – 610 HBW
DILLIDUR 550	10 – 100 (0.4 to 4)	500 (520) – 580 HBW (depending on thickness)
DILLIDUR 500 ^a	8 – 100 (0.3 to 4)	450 (470) – 530 HBW (depending on thickness)
DILLIDUR 450 ^{a,b}	6 – 100 (0.25 to 4)	420 – 480 HBW
DILLIDUR 400 ^{a,b}	6 – 150 (0.25 to 6)	370 – 430 HBW
DILLIDUR IMPACT	40 – 150 (1.6 to 6)	310 – 370 HBW, with enhanced crack resistance
DILLIDUR 325 L	6 – 100 (0.25 to 4)	Nominal hardness 325 HBW, air-hardened for higher surface temperatures or hot forming

^a Through thickness hardness and impact properties upon request
^b Thickness < 8 mm (0.3 in.) upon request

DILLIMAX high efficiency makes slender designs possible

Extreme mechanical strength enhances design freedom: using DILLIMAX, the necessary plate thickness can be reduced to a minimum. The optimised steel analysis assures low carbon equivalents – and thus cost efficiency: despite its high mechanical strength, DILLIMAX can be welded after application of only moderate preheat temperatures.

No limits on cost-efficient slender designs

Gigantic machines, conveying systems and lifting equipment are in continuous use around the world. They are designed to move maximum loads cost-effectively while, at the same time, having the lowest possible deadweight. Even when extremely thick plates are selected, ever greater mechanical strengths in the steels are needed for load-bearing designs. Exceptionally high toughness ratings, as a safety margin for use under extreme loads, are vital in thick-walled welded designs in particular, and are therefore mandatorily prescribed in codes, standards and specifications, such as EN 1993-1-10, for example. DILLIMAX, with its nominal yield strengths of up to 1100 MPa, exceeds the standardised requirements for mechanical strength – very significantly, in some cases – and with genuinely achievable toughness data well above the requirements of the standards, even at the ultra-low temperature of -60 °C. The grade designation, such as DILLIMAX 690 B/T/E indicates the nominal yield strength (690 MPa, in this case) and the temperature at which toughness requirements are guaranteed (Basic: -20 °C, Tough: -40 °C and Extra Tough: -60 °C). In the case of DILLIMAX 690 B/T, Dillinger guarantees 60 J/40 J (longitudinal/transverse), instead of the 30 J/27 J specified in the EN 10025, Part 6 standard. This means: greater reserves of strength for the plate user at the design stage and during service.

Because every kilo counts

Only minimal thickness deviations can be tolerated in weight-sensitive applications, such as the telescopic booms of mobile cranes. For this reason, DILLIMAX TL assures correspondingly tight tolerances for thickness and flatness.

Every extra millimetre consumes expensive machining time and causes enormous additional costs for large machined components, which are needed in mechanical engineering. To reduce thickness allowances, DILLIMAX plates of up to 200 mm plate thickness can also be ordered in accordance with the DIPLAN specification. This assures flatness within extremely tight tolerance limits across the entire surface of the plate.

Certified quality for offshore applications

High strength steels for offshore applications need an exceptionally high level of safety. Especially high strength properties, even in very thick plates, extreme Charpy V-notch toughness also at very low temperatures and, possibly, also in the plate centre are needed. In addition extraordinary properties in the plate-thickness direction (Z grades) may be required. Specially developed and adapted steels of yield strength class 690 MPa are available for such applications. They can be supplied in conformity to our DI-RACK material data sheet, as approved grades conforming to offshore rules, such as ABS and DNV, and also in accordance with individual project specifications.

Dependable safety: The Z grade

High stresses occur in the direction of the plate thickness in welded structures, even without subjection to load, as a result of the cooling and shrinking of deposited weld metal. The Z grades in accordance with EN 10164 and ASTM A770 bindingly specify mechanical properties in the plate thickness direction. Z 35 in accordance with EN 10164 indicates, for example, that a round specimen taken in the plate thickness direction necks-in by not less than 35% prior to fracture. This is achieved thanks to special treatment of the steel. This deformation capacity

assures safety to the designer, because he is then able to specify the necessary Z grade for his design – on the basis of EN 1993-1-10, for instance.



Stresses in the direction of plate thickness caused by welding



Z inspection: Assurance of the deformation capacity in the centre of the plate

Carbon equivalent – why?

Carbon equivalents provide quick and easy information on a steel's weldability. CE(V) and CET carbon equivalents can be used to calculate the preheat temperature on the basis of EN 1011, Part 2: the lower the value, the lower the preheat temperature. The US welding standard AWS D1.1 uses the formula P_{cm} .

$$P_{cm} = C + Si/30 + (Mn + Cu + Cr)/20 + Mo/15 + Ni/60 + V/10 + 5 \cdot B$$

$$CET = C + (Mn + Mo)/10 + (Cr + Cu)/20 + Ni/40$$

$$CE(V) = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$$

The material standard EN 10025, Part 6 states maximum data for carbon equivalent CEV for high strength steels. Lower, and thus more cost-efficient, preheat temperatures are specified for DILLIMAX.

Grade	Nominal minimum yield strength [MPa] (ksi)	Charpy V impact energy at [°C] (°F)	Plate thickness [mm] (in.)	Designation EN 10025, Part 6
DILLIMAX 1100	1100 (160)	-40 (-40)	8 – 40 (0.3 to 1.6)	n.a.
DILLIMAX 965 B/T/E	960 (140)		6 – 160 (0.25 to 6.3)	S960Q/QL/QL1
DILLIMAX 890 B/T/E	890 (130)			S890Q/QL/QL1
DILLIMAX 690 B/T/E	690 (100)	B/T/E -20/-40/-60 (-4/-40/-76)	6 – 290 ^a (0.25 to 11.4)	S690Q/QL/QL1
DILLIMAX 550 B/T/E	550 (80)			S550Q/QL/QL1
DILLIMAX 500 B/T/E	500 (72)		6 – 200 ^b (0.25 to 8)	S500Q/QL/QL1

^a DILLIMAX 690 E: up to 200 mm (8 in.)

^b DILLIMAX 500 T/E and DILLIMAX 550 T/E: up to 150 mm (6 in.)



Please contact one of our partners for individual advice, both technical or commercial.

Aktien-Gesellschaft der Dillinger Hüttenwerke

Werkstraße 1
D-66763 Dillingen/Saar
Germany
Telephone +49 6831 47-0
e-mail info@dillinger.biz
www.dillinger.de

2024 edition
Print: GBQ Saar mbH