



BaoSteel
Automotive Advanced
High Strength Steel



创享改变生活 CREATION BEYOND VISION

宝钢汽车板 Racesteel Automotive Sheet

Overview of Baosteel Automotive AHSS

BaoSteel has been working on R&D of high-end products. In recent years, to meet the demand of light-weighting of auto-body and environment protection, BaoSteel invested a lot in developing high strength steel, especially advanced high strength steel (AHSS) strengthened by phase transformation as shown in Fig.1. The product line of AHSS is listed below.

- 1. DP(Dual Phase Steel)
- 2. TRIP(Transformation Induced Plasticity Steel)
- 3. CP(Complex Phase Steel)
- 4. MS(Martensitic Steel)
- 5. Q&P(Quenching and Partitioning Steel)
- 6. TWIP(Twinning Induced Plasticity Steel)
- 7. PH/B(Press Hardening/Boron Steel)

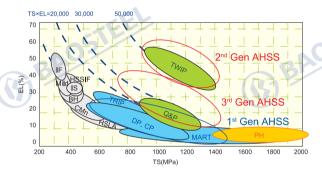


Fig.1 Automotive AHSS Family



AHSS is well suited for automotive structural and safety parts (Fig. 2), contributing to both the weight reduction of car body and the promotion of passive safety and increasing the cost benefit of automotive.



Fig.2 Main applications of AHSS for auto body (Baosteel Car Body)



Commercialized AHSS products are listed in Table 1. The highest strength of cold rolled (CR) products is 1700MPa, for hot-dip galvanized (HDG) ones is 1180MPa, and for electrolytic galvanized (EG) ones is 780MPa.

Table1 The AHSS Products in BaoSteel

| | Variety | Grade | CR | EG | GI | GA |
|---|---------|-------------------|-----|------------|-----|----|
| | | DP450 | | • 1 | | |
| | | DP500 | | | | |
| | | DP590(Low Yield) | | | • | |
| | DP | DP590(Low Yield) | | | | |
| | Di | DP780 | | | | |
| | | DP980(低YP) | | - | | |
| | | DP980(High Yield) | | _ | • | • |
| | | DP1180 | | _ | | |
| | | TRIP590 | | | • | |
| | TRIP | TRIP690 | | _ | • | |
| - | | TRIP780 | | _ | • 6 | |
| | | MS980 | | _ | | _ |
| | | MS1180 | • | 8 | | |
| | Mart | MS1300 | | | _ | _ |
| | iviait | MS1400 | | ソ - | _ | _ |
| | | MS1500 | | _ | _ | _ |
| | | MS1700 | 0 | _ | _ | _ |
| | Q&P | QP980 | | _ | • | 0 |
| | Qar | QP1180 | • | _ | • | 0 |
| | | CP780 | • | _ | • | |
| | CP | CP980 | • | _ | • | 28 |
| - | | CP1180 | 0 | _ | 0 | |
| | | PH1200 | • | _ | 0 | 0 |
| | PH | PH1500 | | 8 | 0 | 0 |
| | | PH1800 | 0[] | | 0 | 0 |
| | TWIP | TWIP950 | | <i></i> | 0 | _ |

- . Commercialized
- Under development, consultation needed before placing orders
- -: Not available

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Note: In the table, even there are differences between BaoSteel products and some similar steel nominated by other standards or companies, they belong to the same grade, and the difference of tensile strength values should be less than 20 MPa. So, please refer to BaoSteel product category in the steel selection, for example, DP590 and DP600 are the same grade so refer DP590 for the product ability. TRIP 780 and TRIP 800 are the same too.

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Technical characteristics

Microstructure: The microstructure of these steel is composed of ferrite and martensite. Martensite islands distribute dispersively in the ferrite matrix. Due to the soft ferrite matrix, DP steel exhibits good formability, while the hard martensite islands contribute to its high strength. Products with different yield ratio can be produced for different applications.



Fig.3 Typical microstructure of DP steel

Properties: No Yield point; No room-temperature aging; Low Yield/Tensile Strength Ratio; High strain hardening exponent and high bake hardening value.

Applications: DP high strength steel are preferred to manufacture structural parts. It is widely applied to structural components, reinforcement and anti-collision components, such as underbody cross member, track, bumper, bumper reinforcement structure etc.

Application cases



Fig.4 Kick-down reinforcement, HC550/980DPD+Z (Coating mass: 50/50g/m², 1.4mm×1150mm)

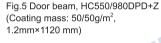




Fig.6 Car seat bracket parts, HC550/980DPD+Z (Coating mass: 50/50g/m², 1.25mm×1120 mm)

Mechanical properties



The products listed in the tables below can be supplied in accordance with EN, ASTM, JIS, and BaoSteel standards. Ordering according to customer's standard or requirement is also available.

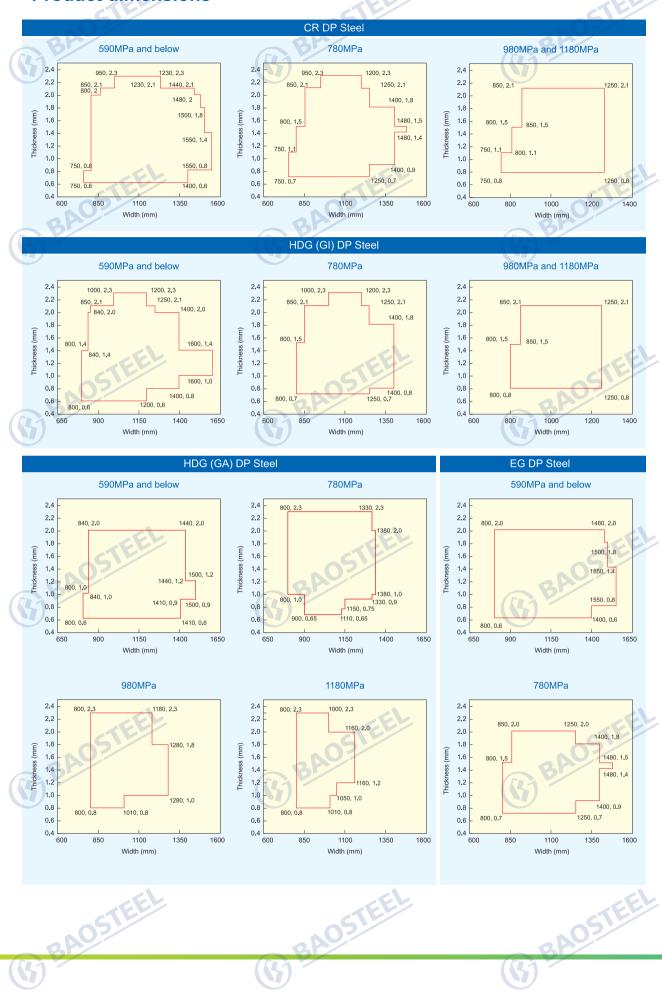
Table 2 CR DP Steel

| Table 2 CR DP Steel | | | | | |
|---------------------|---|--------------------------------|-----------------------------------|---------------------|--|
| Steel Grade | YS ^{a, b} R _{P0.2} , MPa | TS R _m ,MPa ≽ | EL° A _{50mm} , % ≽ | n ^d ≽ | |
| HC250/450DP | 250~320 | 450 | 28 | 0.16 | |
| HC290/490DP | 290~390 | 490 | 26 | 0.15 | |
| HC340/590DP | 340~440 | 590 | 22 | 0.14 | |
| HC420/780DP | 420~550 | 780 | 15 | | |
| HC500/780DP | 500~650 | 780 | 12 | - | |
| HC550/980DP | 550~720 | 980 | 9 | - | |
| HC650/980DP | 650~900 | 980 | 8 | _ | |
| HC700/980DP | 700~920 | 980 | 8 | - | |
| HC820/1180DP | 820~1150 | 1180 | 5 | _ | |

- a If the yield point is not pronounced, the values of $R_{\rm p0.2}$ apply. Otherwise, the values of $R_{\rm eL}$ apply.
- b Guaranteed for No.5 tensile specimens according to standard JIS Z 2241. For the tensile axis of specimens, Coated is parallel to the rolling direction. Uncoated is vertical to the rolling direction.
- c When the specified nominal thickness is in the range of 0.5~0.7 mm, the minimum value of EL should be reduced by 2%. For thickness less than 0.5 mm, the minimum value of EL should be reduced by 4%.
- d n-value should be determined by the strain range of 10-20%. If maximum uniform elongation is less than 20% but more than 12%, n-value should be determined by the strain range from 10% to end uniform elongation. If uniform elongation is less than 12%, n-value shall be reported as uniform elongation equals true strain at uniform elongation.($n_{\text{UF}} = \epsilon_{\text{UF}}$)
- Please confirm the specifications of product before official order.
 The specifications are negotiable.

Table 3 HDG DP Steel

| Steel Grade | YS ^{a, b} R _{P0,2} , MPa | TS R _m , MPa ≽ | EL° A _{50mm} , % ≽ | n ^d ≽ |
|------------------|---|---------------------------------|-----------------------------------|---------------------|
| HC250/450DPD+Z | 250~340 | 450 | 29 | 0.16 |
| HC250/450DPD+ZF | 230 340 | 430 | 27 | 0.10 |
| HC300/500DPD+Z | 290~370 | 500 | 27 | 0.15 |
| HC300/500DPD+ZF | 290~370 | 500 | 25 | 0.15 |
| HC340/590DPD+Z | 340~440 | 590 | 22 | 0.40 |
| HC340/590DPD+ZF | 340~440 | 590 | 20 | 0.13 |
| HC420/780DPD+Z | 420~550 | 780 | 17 | |
| HC420/780DPD+ZF | 420~550 | 700 | 15 | _ |
| HC500/780DPD+Z | 500 050 | 780 | 14 | |
| HC500/780DPD+ZF | 500~650 | 700 | 12 | |
| HC550/980DPD+Z | EE0 700 | 980 | 10 | |
| HC550/980DPD+ZF | 550~730 | 900 | 8 | |
| HC650/980DPD+Z | 650~900 | 980 | 8 | |
| HC650/980DPD+ZF | 650~900 | 900 | 6 | _ |
| HC700/980DPD+Z | 700~900 | 980 | 8 | |
| HC700/980DPD+ZF | 700~900 | 900 | 6 | |
| HC740/1180DPD+Z | 740-090 | 1180 | 7 | |
| HC740/1180DPD+ZF | 740~980 | 1100 | 5 | _ |
| HC820/1180DPD+Z | 820~1150 | 1180 | 6 | |
| HC820/1180DPD+ZF | 020~1150 | 1160 | 4 | |



TRIP (Transformation Induced Plasticity) Steel

Technical characteristics

Microstructure: The microstructure of these steel is composed of ferrite, bainite and retained austenite with a volume fraction of 7~15%.(Fig.7)

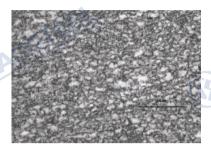


Fig.7 Typical microstructure of TRIP steel

Properties: These steel have good formability due to the transformation of retained austenite into martensite during plastic deformation (transformation induced plasticity effect). TRIP steel exhibit good combination of high strength and high ductility. Moreover, TRIP steel show high energy absorption and high strain hardening capacity.

Application: Structural and reinforcement parts of complex shape, such as B-pillar reinforcement panels.

Application cases



Fig.8 B-pillar reinforcement, HC420/780 TR (1.8mm×615mm)

Mechanical properties

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The products listed in the tables below can be supplied in accordance with EN, ASTM, JIS, and BaoSteel standards. Ordering according to customer's standard or requirement is also available.

Steel Grade

HC380/590TRD+Z

HC380/590TRD+ZF

HC400/690TRD+ZF

HC420/780TRD+Z

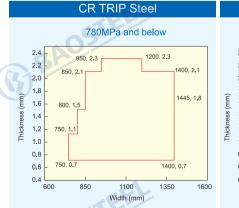
HC420/780TRD+ZF

Table 4 CR TRIP Steel

| Steel Grade | YS ^{a, b} R _{P0.2} , MPa | TS R _m , MPa ≽ | EL° A _{50mm} , % ≽ | n ^d ≽ | |
|-------------|---|---------------------------------|-----------------------------------|---------------------|--|
| HC380/590TR | 380~480 | 590 | 28 | 0.20 | |
| HC400/690TR | 400~520 | 690 | 26 | 0.19 | |
| HC420/780TR | 420~570 | 780 | 23 | 0.16 | |

- a If the yield point is not pronounced, the values of $R_{\rm p0.2}$ apply. Otherwise, the values of $R_{\rm aL}$ apply.
- b Guaranteed for No.5 tensile specimens according to standard JIS Z 2241. For the tensile axis of specimens, Coated is parallel to the rolling direction, Uncoated is vertical to the rolling direction.
- c When the specified nominal thickness is in the range of 0.5~0.7 mm, the minimum value of EL should be reduced by 2%. For thickness less than 0.5 mm, the minimum value of EL should be reduced by 4%.
- d n-value should be determined by the strain range of 10-20%. If maximum uniform elongation is less than 20% but more than 12%, n-value should be determined by the strain range from 10% to end uniform elongation. If uniform elongation is less than 12%, n-value shall be reported as uniform elongation equals true strain at uniform elongation. ($n_{UE} = \varepsilon_{UE}$)
- * Please confirm the specifications of product before official order. The specifications are negotiable.

Product dimensions



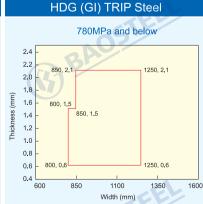




Table 5 HDG TRIP Steel

MPa

590

690

780

27

26

24

23

0.20

0.19

0.16

YSa, b

R_{P0.2}, MPa

380~480

400~510

420~560

Technical characteristics

Microstructure: Almost full martensite. (Fig.9)

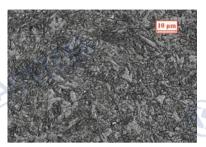


Fig.9 Typical microstructure of MS steel

Properties: High Yield/Tensile Strength Ratio; High tensile strength; Relatively low elongation; Delayed fracture should be considered.

Applications: MS steel are suited for simple cold stamped parts and roll formed parts with a relatively single interface, such as bumper, threshold reinforcing plate and the side door anti-collision rod.

Application cases



Fig.10 Rocker, HC950/1180MS (1.4mm×919mm)

Mechanical properties



The products listed in the tables below can be supplied in accordance with EN, ASTM, JIS, and BaoSteel standards. Ordering according to customer's standard or requirement is also available.

Table 6 CR MS Steel

| | Steel grade | YS ^{a, b} R _{P0.2} , MPa | TS R _m , MPa ≽ | EL A _{50mm} , % ≽ | Recommended inner bending radius |
|---|---------------|---|---------------------------------|----------------------------------|---|
| | HC700/980MS | 700~960 | 980 | 4 | 3 times of thickness |
| 4 | HC950/1180MS | 950~1200 | 1180 | 4 | 4 times of thickness |
| | HC1030/1300MS | 1030~1300 | 1300 | 4 | 4 times of thickness |
| | HC1150/1400MS | 1150~1400 | 1400 | 3 | 4 times of thickness |
| | HC1200/1500MS | 1200~1500 | 1500 | 3 | 4 times of thickness |
| | HC1350/1700MS | 1350~1700 | 1700 | 3 | 4 times of thickness |

a If the yield point is not pronounced, the values of $R_{\rm p0.2}$ apply. Otherwise, the values of $R_{\rm eL}$ apply.

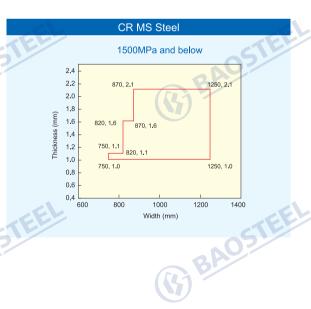
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Product dimensions



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In addition, further agreement for trial production can be achieved when the requirements exceed the dimensions (TS > 1500MPa, thickness < 2.3mm).



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b Guaranteed for No.5 tensile specimens according to standard JIS
 Z 2241 with the tensile axis parallel to the rolling direction.

Please confirm the specifications of product before official order.
 The specifications are negotiable.

CP (Complex Phase) Steel

Technical characteristics

Microstructure: Ferrite/bainite matrix with small amounts of martensite, retained austenite and pearlite. (Fig.11)



Fig.11 Typical microstructure of cold rolled CP steel

Properties: An extreme grain refinement is created by retarded recrystallization or precipitation of micro-alloying elements like Ti or Cr. In comparison with DP steel, CP steel show significantly higher yield strength, bendability and hole expansion ratio at the same strength level. CP steel are characterized with high energy absorption and good stretch flanging formability.

Applications: Suspension parts, B-pillar, bumpers, seat slide.

Application cases



Fig.12 Control arm, HD680/780CP (3.2mm×1050mm)

Mechanical properties

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The products listed in the tables below can be supplied in accordance with EN, ASTM, JIS, and BaoSteel standards. Ordering according to customer's standard or requirement is also available.

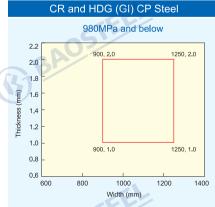
Table 7 CR CP Steel

| Steel Grade | YS ^{a, b} R _{P0,2} , MPa | TS R _m , MPa ≽ | EL A _{50mm} , % ≽ | λ % ≽ | |
|--------------|---|---------------------------------|----------------------------------|-------------|--|
| HC570/780CP | 570~700 | 780 | 11 | 40 | |
| HD680/780CP | 680~830 | 780 | 10 | 50 | |
| HC780/980CP | 780~950 | 980 | 7 | 50 | |
| HC900/1180CP | 900~1100 | 1180 | 6 | 30 | |
| | | | | | |

Table 8 HDG CP Steel

| Steel Grade | YS ^{a, b} R _{P0,2} , MPa | TS R _m , MPa ≽ | EL A _{50mm} , % ≽ | λ % ≽ |
|--|---|---------------------------------|----------------------------------|-------------|
| HC570/780CPD+Z | 570~720 | 780~920 | 11 | 40 |
| HC780/980CPD+Z | 780~950 | 980~1140 | 7 | 40 |
| HD660/760CPD+Z | 660~820 | 760~950 | 11 | 35 |
| and the second s | | | | |

- a If the yield point is not pronounced, the values of $R_{p0.2}$ apply. Otherwise, the values of R_{p1} apply.
- b Guaranteed for No.5 tensile specimens according to standard JIS Z 2241 with the tensile axis parallel to the rolling direction.
- * Please confirm the specifications of product before official order. The specifications are negotiable.







Q&P (Quenching and Partitioning) Steel

Technical characteristics

Microstructure: The microstructure is composed of ferrite, martensite and retained austenite with a volume fraction of 5~10%. (Fig.13)

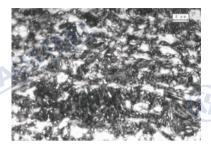


Fig.13 Typical microstructure of Q&P steel

Mechanical properties



The products listed in the tables below can be supplied in accordance with EN, ASTM, JIS, and BaoSteel standards. Ordering according to customer's standard or requirement is also available.

Table 9 CR Q&P Steel

| Steel Grade | YS ^{a, b} R _{P0.2} , MPa | TS R _m , MPa ≽ | EL A _{50mm} , % ≽ |
|-----------------|---|---------------------------------|----------------------------------|
| HC600/980QP | 600~850 | 980 | 15 |
| HC600/980QP-EL | 600~850 | 980 | 20 |
| HC820/1180QP | 820~1100 | 1180 | 8 |
| HC820/1180QP-EL | 820~1100 | 1180 | 14 |

- a If the yield point is not pronounced, the values of $R_{\rm p0,2}$ apply. Otherwise, the values of $R_{\rm sL}$ apply.
- b Guaranteed for No.5 tensile specimens according to standard JIS Z2241 with the tensile axis vertical to the rolling direction.
- Please confirm the specifications of product before official order.
 The specifications are negotiable.

Table 10 HDG Q&P Steel

| Steel Grade | YS ^{a, b} R _{P0.2} , MPa | TS R _m , MPa ≽ | EL A _{50mm} , % ≽ |
|--------------------|---|---------------------------------|----------------------------------|
| HC600/980QPD+Z | 600~850 | 980 | 15 |
| HC600/980QP-ELD+Z | 550~800 | 980 | 20 |
| HC820/1180QPD+Z | 820~1100 | 1180 | 8 |
| HC820/1180QP-ELD+Z | 820~1100 | 1180 | 14 |

- a If the yield point is not pronounced, the values of $R_{\rm p0.2}$ apply. Otherwise, the values of $R_{\rm sL}$ apply.
- b Guaranteed for No.5 tensile specimens according to standard JIS Z2241 with the tensile axis vertical to the rolling direction.
- * Please confirm the specifications of product before official order. The specifications are negotiable.

Properties: Benefiting from the TRIP effect of retained austenite, Q&P steel exhibit quite high strain hardening capacity, and higher ductility and formability than other UHSS with same strength level.

Applications: Q&P steel are suited for the automotive structural and safety parts with complex shapes.

Application cases



HC600/980QP was a "world first" product of BaoSteel, and now has already commercially supplied to the manufacturing of B-pillar reinforcement used in a domestic self-own brand car. Moreover, Q&P steel are suited for manufacturing structural and safety parts with complex shapes, such as A-pillar inner and hinge-pillar reinforcement.



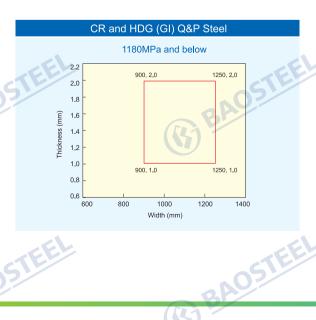
Fig.14 B-pillar reinforcement, HC600/980QP (2.0mm×1100mm)



Fig.15 A-pillar inner, HC600/980QPD+Z (1.0mm×950mm)



Fig.16 B-pillar inner, HC600/980QP (1.2mm×1200mm)



TWIP (Twinning Induced Plasticity) Steel

Technical characteristics

Microstructure: Full austenite (Fig.17)

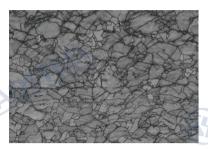


Fig.17 Typical microstructure of TWIP steel

Properties: TWIP steel are full austenitic steel with high C, Mn and Al. TWIP steel have very high strain hardening capacity due to dynamic refinement effect caused by the continuous activation of twining during cold deformation. TWIP steel developed by BaoSteel exhibit an elongation of over 50% with the tensile strength of 1000MPa.

Applications: TWIP steel have very good formability and ultra-high strength, which are suited for manufacturing structural and safety parts with very complex shapes.

Mechanical properties



The products listed in the tables below can be supplied in accordance with EN, ASTM, JIS, and BaoSteel standards. Ordering according to customer's standard or requirement is also available.

Table 11 CR TWIP Steel

| Steel Grade | YS ^{a, b} R _{P0,2} , MPa | TS R _m , MPa ≽ | EL A _{50mm} , % <i>≫</i> | n ≽ |
|-------------|---|---------------------------------|---|--------|
| HC450/950TW | 450~600 | 950 | 47 | 0.35 |

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- a If the yield point is not pronounced, the values of $R_{p0.2}$ apply. Otherwise, the values of R_{eL} apply.
- b Guaranteed for P17 tensile specimens according to standard GB/T 228 with the tensile axis parallel to the rolling direction.
- * Please confirm the specifications of product before official order. The specifications are negotiable.

Application cases

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TWIP steel exhibit the combination of ultra-high strength and ultra-high formability, which could lead to remarkable change in auto-part designation. According to their properties, TWIP steel could be suited for manufacturing structural and safety parts with ultra-high strength and very complex shape, including bumper and B-pillar.



PH/B (Press Hardening/Boron) Steel

Technical characteristics

Microstructure: Ferrite-Pearlite (before quenching), Martensite (after quenching), as shown in Fig.18.





Before quenching

After quenching

Fig.18 Typical microstructure of PH/B steel

Application cases



Fig.19 Front bumper, HD950/1300HS (2.35mm×1035mm)



Fig.20 B-pillar, HC950/1300HS (1.8mm×1025mm)

Properties: Extra High strength(1500MPa), improved Crash Performance, high light-weighting potential, design of complex shape, good formability; high product dimension accuracy.

Application: Structural and safety parts, such as front and rear bumper, A-pillar, B-pillar, floor and roof reinforcements.

Mechanical properties



The products listed in the tables below can be supplied in accordance with EN, ASTM, JIS, and BaoSteel standards. Ordering according to customer's standard or requirement is also available.

Table 12 PH/B Steel

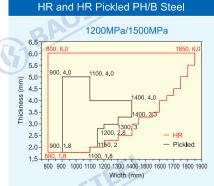
| Table 12 I TI/D Steel | | | | | |
|---|---|--|--|--|--|
| YS ^{a, b} R _{P0.2} , MPa | TS R _m , MPa | EL ^c A _{50mm} , % | | | |
| 280~450 | ≥430 | ≥20 | | | |
| 260~420 | ≥410 | ≥25 | | | |
| 300~450 | ≥450 | ≥20 | | | |
| 280~420 | ≥440 | ≥25 | | | |
| ≥280 | ≤700 | ≥18 | | | |
| ≥220 | 380~700 | ≥22 | | | |
| 320~630 | 480~800 | ≥16 | | | |
| 280~450 | ≥450 | ≥20 | | | |
| ≥300 | ≥500 | ≥17 | | | |
| ≥350 | ≥500 | ≥14 | | | |
| ≥300 | ≥450 | ≥18 | | | |
| | YS ^{a, b} $R_{P0.2}$, MPa 280~450 260~420 300~450 280~420 ≥280 ≥220 320~630 280~450 ≥300 ≥350 | YS ^{a,b} R _{p0,2} , MPa 280~450 | | | |

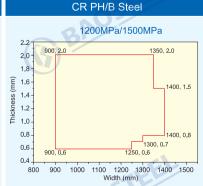
- a Guaranteed for No.5 tensile specimens according to standard JIS Z2241 with the tensile axis vertical to the rolling direction.
- b If the yield point is not pronounced, the values of R_{p0.2} apply. Otherwise, the values of R_{el} apply.
- c When the specified nominal thickness is in the range of 0.5~0.7 mm, the minimum value of EL should be reduced by 2%. For thickness less than 0.5 mm, the minimum value of EL should be reduced by 4%.
- * The properties after quenching strongly depend on quenching process.

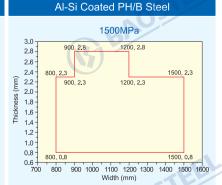
Please confirm the specifications of product before official order. The specifications are negotiable.

Product dimensions

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Processing and Distribution for UHSS



To satisfy the demand of UHSS processing and ensure the quality and delivery. Baosteel International has already built up an processing and distribution system: there are 35 slitting lines processing 780Mpa and above with a total capacity around 1.42 million tons/y, there are 7 lines processing 980Mpa and above with total capacity of 425 thousand tons/y, there are 10 cutting and blanking lines processing 980Mpa and above with total capacity of 500 thousand tons/y.

Among the first UHSS processing unit, Shanghai HSS Distribution Co., Itd started business in 2010 and run a slitting and a CTL line both capable of processing steel up to 1470Mpa. It has planned to improve capabilities up to 1800Mpa within 2018. The capacity in Shanghai will also be lifted to 450 thousand tons/y, since other regional steel service centers can cover processing demand up to 1180Mpa, those higher than 1180Mpa will be covered by shanghai facility.





| | Parameter | rs of S3 | |
|---|-----------------------|----------------|-----|
| | Slitting Strength Max | 1800MPa | |
| | Yield Strenth Max | 1800MPa | |
| | Coil Weight Max | 30MT | 0 |
| | Entrance Width | 300-1650mm | |
| 7 | Exit Width | 30-1650mm | |
| | OD Max | 2100mm | |
| | OD Min | 900mm | |
| | ID | Ø508 and 610mm | |
| | Coil Thickness | 0.5-6.0mm | |
| | Design Capacity | 150000MT | 10: |
| Y | j | (4) | |

| Parameters of L4 | |
|---------------------|----------------|
| Cutting Strength | 1470MPa |
| Yield Strength Max | 1470MPa |
| Coil Weight Max | 30MT |
| Entrance Width | 300-1650mm |
| Cutting Length | 300-6000mm |
| OD Max | 2100mm |
| OD Min | 900mm |
| ID | Ø508 and 610mm |
| Coil Thickness | 0.5-4.0mm |
| Stacking Height Max | 750mm |
| Stacking Weight Max | 5MT |
| Design Capacity | 150000MT |
| | |



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