

High Strength Cold Forming Hot-rolled Steel

工程机械用
高强度热连轧结构钢

www.baosteel.com



BS系列高强钢简介 Brief Introduction

开发历史

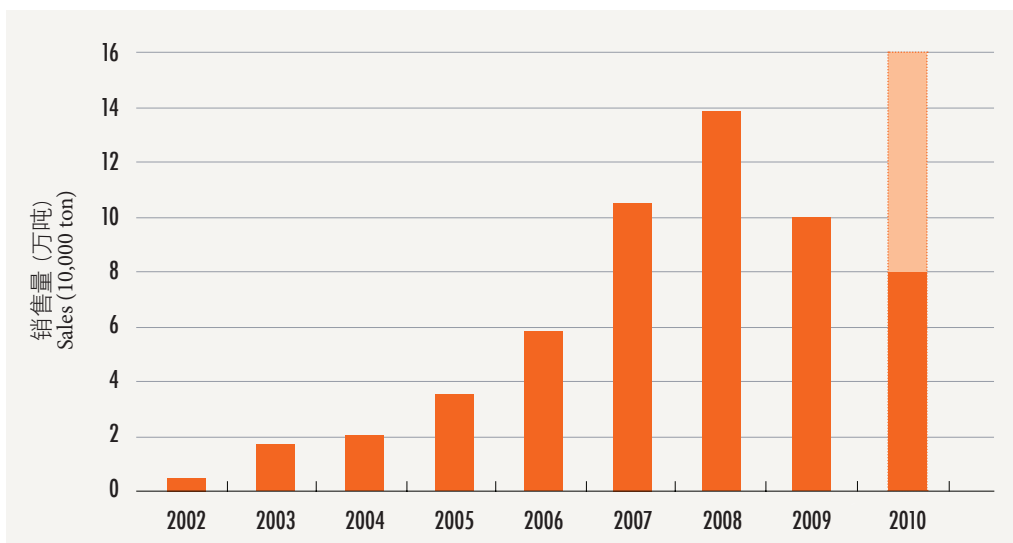
工程机械用系列高强、超高强结构钢是宝钢于2000年在国内率先开发成功的一类热轧新产品，牌号大多采用“BS”开头，如第一代高强钢BS600MC和BS700MC已大量应用于工程机械、集装箱制造等行业。2005年宝钢开发成功具有优良低温韧性的第二代高强钢，牌号为BS700MCK2、BS600MCK4、BS550MCK4等等。BS系列高强钢为低碳低合金结构钢，具有良好的可焊接性和冷成形性，可广泛应用于工程机械、车辆结构、集装箱等制造行业。

BS系列高强结构钢采用宝钢股份先进的冶炼技术、铌钛微合金化处理以及精确的控制轧制和控制冷却技术，获得的金相显微组织为贝氏体加少量铁素体。制造工艺和金相组织保证了合格稳定的力学性能、加工性能和可靠的质量。自从2000年开发成功以后，深受用户青睐，产销量逐年增长。

The Development of BS Series Steels

High strength steel (HSS) and Ultra-high strength steel (UHSS) for construction machinery were first developed in China by Baosteel in 2000. These high strength cold forming hot-rolled steels (BS series steels), mostly initialed by “BS”, such as Type I BS steels, BS600MC and BS700MC, have been used in large amount in construction machinery and marine container industries. In 2005, Baosteel developed the Type II BS steels, which have good toughness at low temperature, such as BS700MCK2, BS600MCK4 and BS550MCK4. The BS series steels are low carbon low alloy structural steels with good welding performance and cold formability. They could be widely used in construction machinery, vehicle structure and marine container industries.

The BS series steels get a microstructure of Bainite with Ferrite by the adoption of Baosteel's advanced metallurgy process, Nb-Ti micro alloying treatment, and accurate control of rolling and cooling. The manufacture process and microstructure ensure stable and qualified mechanical properties, formability and reliable quality. After the development in 2000, BS series steels are welcomed by our users and the annual sales are increasing year by year.



选用高强度代替传统产品可显著减小钢板的设计厚度, 进而减轻结构的自重。除此之外, BS系列高强度还具有如下特点:

- 优良的成形性, 不同强度级别钢板均能够冷加工成形;
- 良好的焊接性, 钢板具有低焊接裂纹敏感性, 焊接接头的性能优良;
- 良好的低温冲击韧性。

The designed thickness of the plates in a structure can be reduced without loss of load-bearing capability by switching from conventional steels to high strength steels, thus the tare weight of the structure can be reduced. This is one of the major benefits of using BS series steels. Furthermore, the BS series steels are featured with:

- Good formability. All grades of BS steel can be cold formed.
- Excellent welding performance. The steels have low welding crack sensitivity and the properties of welding joint are good.
- Good toughness at low temperature.

制造工艺及交货状态

生产工艺流程:

BS系列高强度采用氧气转炉冶炼镇静钢, 经过二次精炼后进行连续铸造, 连铸坯送热轧厂再加热并采用控轧控冷工艺轧制成卷, 精整检验后可以钢卷状态交货, 也可以矫直切板后以钢板状态交货。

交货状态:

BS系列高强度采用轧态 (TMCP) 交货。

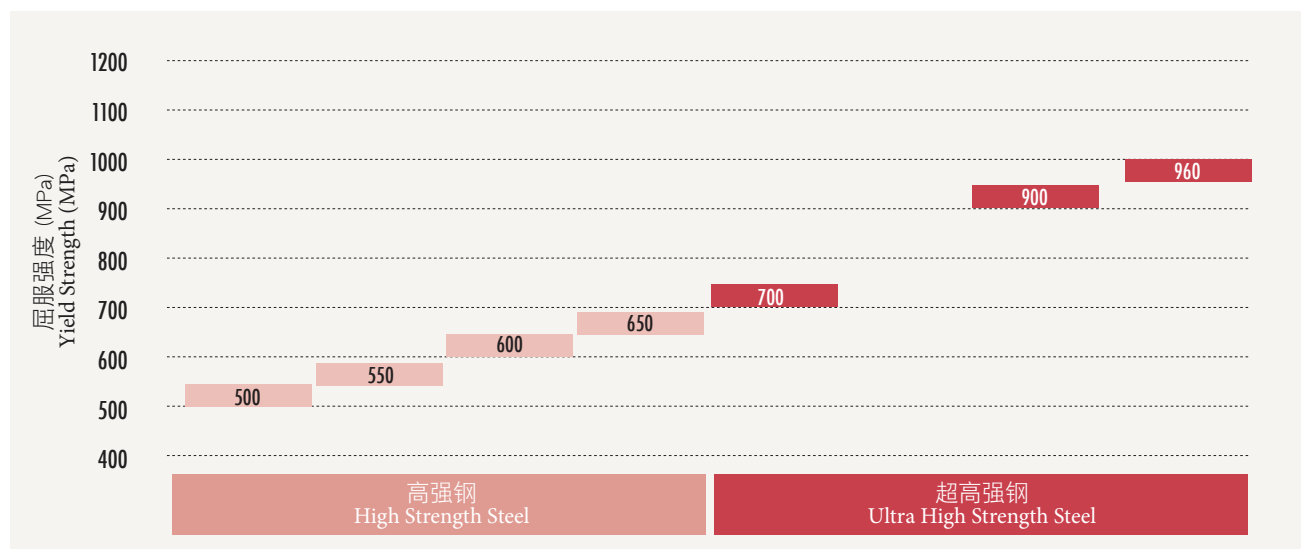
Manufacture Process and Delivery Condition

Manufacture process:

The BS series steels are killed in oxygen converter. After secondary refining and continuous casting, the slabs are reheated and rolled into coil in TMCP rolling process. After inspection, the BS series steels may be delivered in coil, or in sheets with further leveling and cutting process.

Delivery condition:

The BS series steels are delivered in TMCP condition.

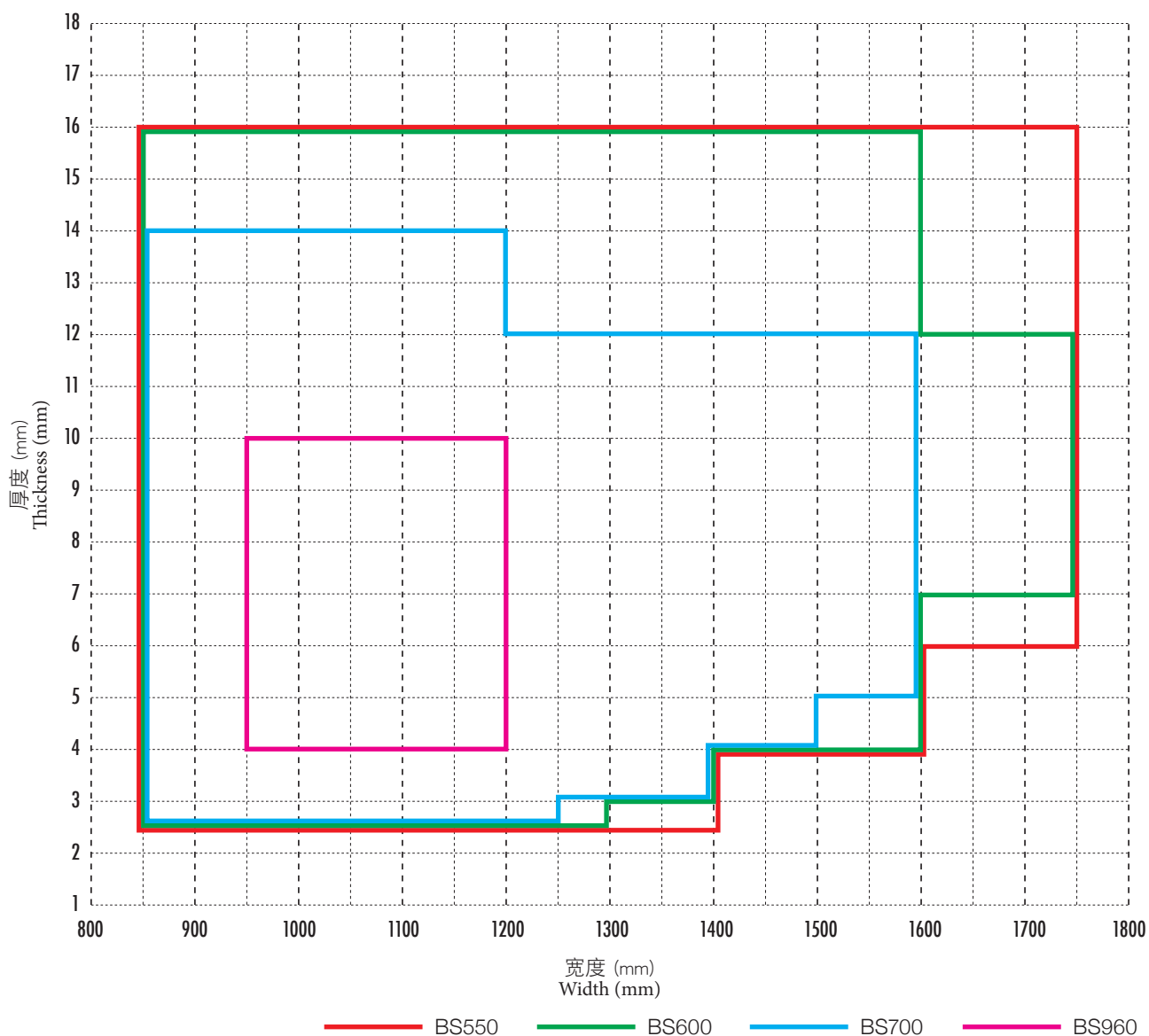


牌号及可供规格范围 Product Range of Dimensions

宝钢BS系列热轧高强钢可供规格如图表所示，超出规格范围可与我们联系。

The available size of BS series steels is as shown in the table below. Contact us if the required size is out of range.

牌号 Steel grade	可供厚度 Thickness (mm)	可供宽度 Width (mm)	可供长度 Length (mm)
BS550-	2.5-16	850-1750	2000-12000
BS600-	2.5-16	850-1750	2000-12000
BS700-	2.5-14	850-1600	2000-12000
BS960-	4-10	950-1200	2000-12000



供货技术条件及产品性能实绩

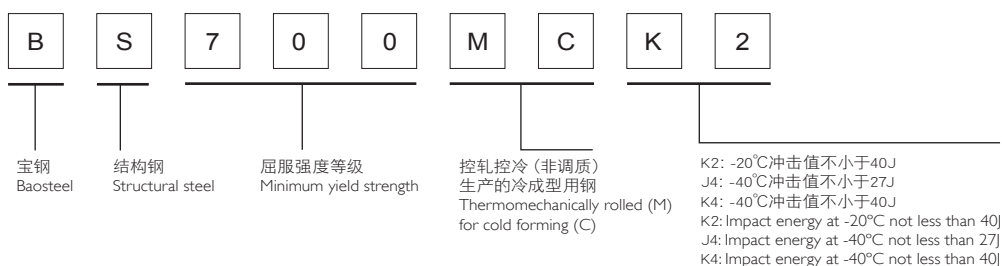
Technical Delivery Conditions and Typical Properties

第一代BS高强钢按照宝钢企业标准Q/BQB311或按照供货技术协议BXYZ2008-018执行, 第二代BS高强钢按照宝钢新产品试制协议书BKJ系列执行。两代之间的差别在于, 第一代产品不提供冲击性能保证, 第二代产品提供低温冲击性能保证, 以K2、J4等后缀作为区分, 详见供货技术条件力学性能表格。

Type I BS series steels are delivered according to Q/BQB 311 or BXYZ2008-018 while Type II according to BKJ technical specifications. The difference between Type I and Type II is that Type I steels do not guarantee the impact energy while Type II steels guarantee a low temperature toughness, which is shown with suffix K2, J4, etc.

BS700MCK2牌号含义:

The designation of BS700MCK2:



现行交货标准及近似国外产品

Technical Delivery Conditions and Corresponding Steel

	牌 号 Steel grade	宝钢标准 Specification	相近产品 Corresponding steels	
			EN10149-2	SSAB
第二代 Type II	BS550MCK4	BKJ07-063	S550MC	Domex550MCE
	BS600MCJ4	BKJ04-013	S600MC	Domex600MCE
	BS600MCK4	BKJ10-049	S600MC	Domex600MCE
	BS700MCK2	BKJ05-006	S700MC	Domex700MCD
	BS960MCJ4	BKJ08-024	-	Domex960
第一代 Type I	S550MC	Q/BQB311-2007	S550MC	Domex550MC
	S600MC (BS600MC)	Q/BQB311-2007 (BXYZ2008-018)	S600MC	Domex600MC
	S650MC	Q/BQB311-2007	S650MC	Domex650MC
	S700MC (BS700MC)	Q/BQB311-2007 (BXYZ2008-018)	S700MC	Domex700MC

力学性能交货标准 Delivery Conditions of Mechanical Properties

牌 号 Steel grade	厚 度 Thickness (mm)	拉伸试验 ⁽²⁾ Tensile test				冲击试验 ⁽³⁾ CVN Impact test			180° 弯曲试验 Bending test	
		方向 ⁽¹⁾	屈服强度 Re (MPa)	抗拉强度 Rm (MPa)	伸长率 A5 (%)	方向 ⁽¹⁾	温度 Temp. (°C)	冲击值 IE (J)	方向 ⁽¹⁾	弯心直径 Diameter
BS550MCK4	≤16	T	≥550	≥600	≥18	L	-20	≥40	T	d = 2a
BS600MCJ4	<10	T	≥600	≥680	≥15	L	-40	≥27	T	d = 2a
	10-16		≥580	≥680	≥15					
BS600MCK4	≤16	T	≥600	≥680	≥15	L	-40	≥40	T	d = 2a
BS700MCK2	3-8	T	≥700	750-950	≥15	L	-20	≥40	T	d = 2a
	>8		≥680	750-950	≥15					
BS900MCJ4	3-10	L	≥900	≥950	≥10	L	-40	≥27	T	d = 3a
BS960MCJ4	3-10	L	≥960	≥980	≥10	L	-40	≥27	T	d = 3a
S550MC	≤16	L	≥550	600-760	≥14	-	-	-	T	d = 1.5a
S600MC (BS600MC)	≤16	L	≥600	650-820	≥13	-	-	-	T	d = 2a
S650MC	≤16	L	≥650	700-880	≥12	-	-	-	T	d = 2a
S700MC (BS700MC)	≤6	L	≥700	750-950	≥12	-	-	-	T	d = 2a

注:

- (1) T=Transverse, 试样方向垂直于轧制方向; L=Longitude, 试样方向平行于轧制方向。
- (2) 拉伸试样采用短比例标距。标距 $L_0=5.65\sqrt{S_0}$,屈服强度采用上屈服强度,屈服现象不明显时,采用Rp0.2。
- (3) 冲击试样采用夏比V型缺口试样,表中冲击值为一组三个试样的平均值,表中冲击值适用于10×10×55标准尺寸试样,当板厚<12mm采用5mm或7.5mm厚度冲击试样时,表中冲击值等比例减小。

Remarks:

- (1) T=Transverse, specimen direction is perpendicular to the rolling direction; L=Longitude, specimen direction is parallel to the rolling direction.
- (2) A short gauge length specimen ($L_0=5.65\sqrt{S_0}$) is adopted in the tensile test. For the specified yield strength, the upper yield strength shall be taken. If the yield phenomenon is not present, the 0.2% proof strength (Rp0.2) shall be taken.
- (3) Charpy V-notch specimen shall be adopted in the impact test. The minimum impact values given in the table above apply for the mean of 3 full size test pieces. Subsidiary test pieces shall be adopted when the thickness of plate is less than 12mm, the minimum impact values given in the table above shall be reduced in proportion to the cross-sectional area of the test piece.



典型力学性能实绩

Typical Mechanical Properties

宝钢BS系列高强钢于2000年研发成功以来,已批量生产约55万吨,实物性能检验值的80%以上在表列波动范围以内。

More than 550,000 tons BS series steels have been produced after the development in 2000. 80% of the actual properties of the product are within the value given in the table below:

牌号 Steel grade	厚度 Thickness (mm)	屈服强度 Re (MPa)	抗拉强度 Rm (MPa)	伸长率 A5 (%)	冲击值 IE (J)
BS550MCK4	6-12	560-645	645-740	16-26	120-280
BS600MCJ4	2.5-(10)	600-670	680-780	15-23	140-240
	10-16	600-660	700-760	16-21	120-270
BS700MCK2	3-8	700-860	780-920	15-21	40-100
	(8)-12	685-820	790-900	15-21	60-150
BS960MCJ4	4-8	960-1050	1050-1080	11-15	(100-140)
BS600MC	3-14	640-720	700-790	17-26	-
BS700MC	2.5-8	680-810	750-880	14-23	-

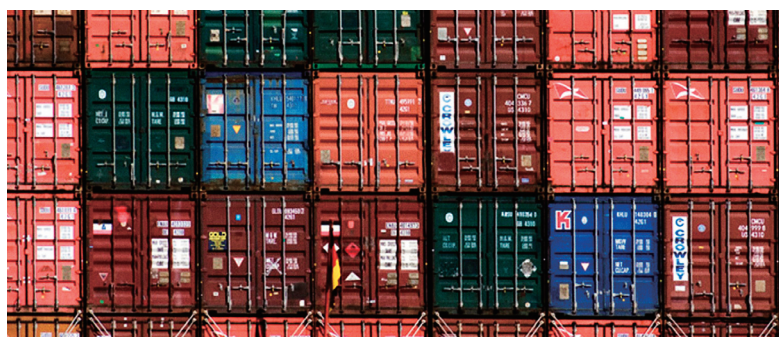
化学成分

Composition wt%

强度级别 Minimum yield strength	牌号 Steel grade	C	Si	Mn	P	S	Alt	B
550	BS550MCK4	≤0.12	≤0.50	≤2.0	≤0.015	≤0.005	≥0.015	-
600	BS600MCJ4	≤0.12	≤0.50	≤2.0	≤0.015	≤0.005	≥0.015	≤0.005
	BS600MCK4	≤0.12	≤0.50	≤2.0	≤0.015	≤0.005	≥0.015	≤0.005
700	BS600MC	≤0.12	≤0.50	≤2.0	≤0.020	≤0.010	≥0.015	≤0.005
	BS700MCK2	≤0.12	≤0.60	≤2.10	≤0.025	≤0.010	≥0.015	≤0.005
	BS700MC	≤0.12	≤0.60	≤2.10	≤0.025	≤0.015	≥0.015	≤0.005
900	BS900MCJ4	≤0.12	≤0.50	≤1.60	≤0.015	≤0.005	≥0.015	≤0.003
960	BS960MCJ4	≤0.12	≤0.50	≤1.60	≤0.015	≤0.005	≥0.015	≤0.003

注: 根据强度要求, 可加入Nb、V、Ti、Cr、Mo等合金元素。

According to the strength, Nb, V, Ti, Cr and Mo may be added.



焊接及加工 Machining and Welding

焊 接

宝钢BS系列热连轧高强钢通过低碳低合金设计降低钢的碳当量和焊接裂纹敏感性指数, 并采用先进的冶炼装备技术结合微合金强化技术, 获得良好的可焊接性。

Welding

BS series steels has low carbon equivalent and low weld crack sensitivity index obtained from low carbon and low alloy designing. The steels show good weldability by the use of advanced smelting technology and micro-alloy enhancement technology.

良好的焊接性

— 碳当量及焊接裂纹敏感性指数

Good Weldability

carbon equivalent (Ceq) and weld crack sensitivity index (Pcm)

牌 号 Steel grade	碳含量实绩 C (%)	碳当量实绩 Ceq	焊接敏感性指数实绩 Pcm
BS550MCK4	≤0.08	≤0.49	≤0.22
BS600MCK4	≤0.08	≤0.45	≤0.20
BS700MCK2	≤0.08	≤0.47	≤0.21
BS960MCJ4	≤0.10	≤0.52	≤0.24
BS600MC	≤0.08	≤0.45	≤0.20
BS700MC	≤0.08	≤0.47	≤0.21

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

$$Pcm=C+Si/30+(Mn+Cu+Cr)/20+Ni/60+Mo/15+V/10+5B$$

— 焊接裂纹敏感性试验

采用搭接接头拘束焊接裂纹试验 (CTS) 测定了BS高强钢焊接裂纹敏感性, 结果表明各项裂纹发生率均为0%。证明BS系列高强钢在0°C以上进行各种焊接加工时, 不易产生焊接裂纹。

— 接头的硬度

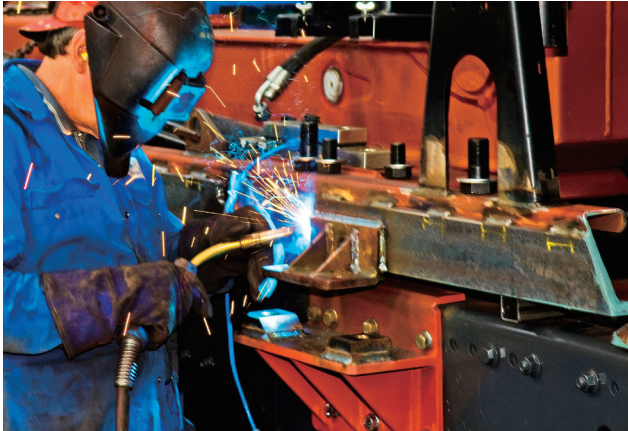
BS高强钢焊接接头的最大硬度小于350HV10。高强钢的焊接热影响区存在一个比较窄的软化区。建议尽可能采用小热输入、快速焊接为宜, 以减小软化区的宽度。

Welding Crack Sensitivity Test

Controlled thermal severity cracking test (CTS) is used to evaluate the welding crack sensitivity of BS series steels. The results show that the frequency of welding crack for these steels is 0%. This means that when the air temperature is higher than 0°C, welding of BS series steels may not generate the cracks.

Hardness of the Joints

The highest hardness of the welded joints of these steels is lower than 350HV10. There is a narrow softened zone in the HAZ of the welded joints. A small heat input and high welding speed is recommended in order to decrease the width of softened zone.



焊接工艺参数

环境温度大于0°C时, BS高强钢板不需预热就可直接进行焊接, 不易产生焊接冷裂纹。推荐使用MAG焊接, 推荐焊接保护气体为80%Ar+20%CO₂; 气体流量18~25 l/min。

对于推荐的焊丝适用于全位置焊接, 当垂直位置焊接时, 推荐采用上向焊接方法, 这样可避免焊接缺陷产生。热轧高强钢适用于多种接头型式的焊接, 常用的接头型式有: 对接接头、角接接头和搭接接头; 常用的坡口型式有: I型坡口, V型坡口和双V型坡口型式。在焊接时, 若出现未焊透时, 应检查是否间隙太小, 是否电弧没有垂直钢板表面。

对于打底焊时, 可采用较小焊接参数的熔滴过渡形式, 即小电流, 小电压, 快速焊; 对于特别重要的结构件, 也可考虑采用TIG焊打底。对于定位焊接, 为了防止出现裂纹, 应保证一定的焊接长度, 至少大于50mm长, 焊接参数可选用稍大一些的熔滴过渡形式。对于MAG焊, 以常用焊丝规格 ϕ 1.2mm为例, 典型打底焊的焊接参数为: 100~200A, 12-19V, 2.5~7mm/s; 典型的定位焊接参数为: 200~250A, 20~23V, 4.0~6.5mm/s。

对于填充和盖面焊接, 可以采用稍大一些的熔滴过渡和射流过渡形式的焊接工艺。对于MAG焊, 以常用规格 ϕ 1.2mm为例, 推荐的典型填充和盖面焊接工艺为: 200~250A, 20~23V, 4.0~6.5mm/s (熔滴过渡) 或 270~320A, 27~32V, 4.0~6.0mm/s (射流过渡)。

Welding Parameters

When air temperature is higher than 0°C, no preheating is needed before welding and the welding crack might not be found in the joints. MAG welding is recommended, with shielding gas of 80%Ar+20%CO₂ and gas flow of 18-25l/min.

The recommended filler metal wires can be used in all-position welding. Vertical position welding should utilize the welding direction from the bottom to top, so the welding cracks could be avoided. Common joint forms, such as butt joint, corner joint and lap joint could be used on high strength steels. Normal forms of the grooves include I-groove, V-groove and double V-groove etc. can be used. If incomplete penetration defects occur in the joints, two aspects should be checked. One is whether the welding gap is too small, the other is whether the arc is not vertical to the plate surface.

Backing welding should use the droplet transfer form with small welding parameters, which means low current, small voltage and high welding speed. TIG backing welding may be used for some particularly important structures. The length of tack welding should be guaranteed, for example longer than 50mm, to prevent welding cracks. For the common wires with Φ 1.2mm in MAG welding, the typical backing welding parameters would follow as 100-200A, 12-19V and 2.5-7mm/s; the typical tack welding parameters would be 200-250A, 20-23V and 4.0-6.5mm/s.

Filling welding and cover welding could use the droplet transfer form and spray transfer form with little larger welding parameters. For the common wires with Φ 1.2mm in MAG welding, the typical filling welding and cover welding parameters would be 200-250A, 20-23V, 4.0-6.5mm/s, or 270-320A, 27-32V, 4.0-6.0mm/s.

焊接材料

在接头力学性能满足构件要求的情况下，BS高强钢的配套焊接材料应尽可能选用强度级别稍低的焊接材料，避免高匹配焊接材料的选用。尤其是对于角接接头时，稍低匹配焊接材料选择原则更为重要。

宝钢通过先进的冶炼技术，成功生产出优质MAG焊丝用盘条，包括BH600-II、BH700-II和BH800-II，供应上海大西洋、湖北猴王、武汉铁锚、上海宝焯等国内主要焊接材料生产企业。

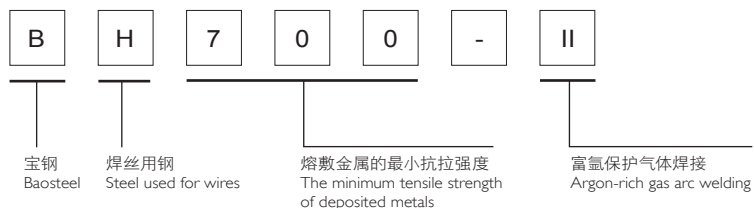
Filler Metals

When the mechanical properties could meet the component requirements, it is better to select lower strength filler metals during welding BS high strength steels. It is especially important to use low-matched welding materials for corner joints.

Baosteel has successfully produced high-quality wire rods for high strength steel through advanced smelting technology, including BH600-II, BH700-II and BH800-II. These rods have been supplied to domestic major welding consumables manufacturers, such as Shanghai Atlantic welding consumables Co.,Ltd., Hubei KMK welding materials Co., Ltd., Wuhan Temo welding consumables Co., Ltd. and Shanghai Baoxuan metal products Co., Ltd.

BH700-II牌号含义说明如下:

Meaning of BH700-II described as following:



宝钢BS系列热连轧高强钢可选用的焊接材料详见下表。

Welding consumables for BS high strength hot-rolled steels could be shown as follows.

牌号 Steel grade	焊丝、盘条牌号 Rod grade	可供焊材企业 Wire manufacturer	焊丝直径 Wire diameter
BS550MCK4	BH600-II	上海大西洋、湖北猴王、武汉铁锚、上海宝焯等国内主要焊接材料生产企业 Shanghai Atlantic welding consumables Co.,Ltd., Hubei KMK welding materials Co., Ltd., Wuhan Temo welding consumables Co., Ltd. and Shanghai Baoxuan metal products Co., Ltd.	Φ1.2-1.6mm
BS600MC	BH700-II		
BS600MCJ4			
BS700MC	BH700-II		
BS700MCK2	BH800-II		
BS960MCJ4	BH800-II		
	BH900-II		

焊接接头的力学性能

Results of mechanical tests of welded joints

牌号 Steel grade (Thickness)	试验用焊丝 Wire	道次 Pass	热输入 Heat input (KJ/cm)	拉伸试验 Tensile test		-20℃冲击试验 CVN Impact test	
				抗拉强度 Rm (MPa)	断裂位置 Fracture position	缺口位置 Position	冲击功 KV2 (J)
BS600MC (12mm)	BH700-II	1 2 3	11 19 21	790	母材 Base metal	焊缝 / Weld metal 热影响区 / HAZ	53 93
BS700MCK2 (8mm)	BH800-II	1 2	12.5 8	841	母材 Base metal	焊缝 / Weld metal 热影响区 / HAZ	96 65
BS960MCJ4 (6mm)	Union X 90	1 2	7.5 9.5	1009	热影响区 HAZ	焊缝 / Weld metal 热影响区 / HAZ	60 70

冷弯加工

BS系列高强结构钢不仅具有高强度,同时还具有良好的塑性,适合冷弯加工成形。对于高强钢来说,折弯半径是冷弯成型工艺的基本参数,应予以关注,建议折弯内径不要小于供货技术条件规定的弯心直径 d 。另外需要注意的是,冷弯结束后高强钢的回弹比普通钢略大,可能导致高强钢构件形状出现偏差。可通过适当的过弯曲来保证获得所需的折弯角度。

辊压成型时,单次辊压变形量不宜太大,通过调整变形量,可避免边部开裂。

矫形

BS高强钢结构如果出现形状偏差而需要矫形时,建议采用冷矫形方式。如特殊情况下需要采用热矫形时,建议热矫形温度不超过 550°C ,超过此温度,可能改变钢板性能。

Cold Forming

With high strength and good formability, BS series steels are suitable for cold forming. Attention shall be paid to the bending radius, which is an important parameter for the cold forming of high strength steel. It is suggested the actual bending diameter not less than the diameter specified in the delivery condition. Also to note, the rebounding of high strength steels is greater than conventional steels and might result in the deviation of the shape. Suitable over-bending could be applied to get the required angle.

During the roll forming, the deformation value of each pass should not be too great. By the adjustment of deformation value, edge cracking may be avoided.

Leveling

Cold leveling is recommended when deviation occurs after the forming of BS series steels. If heat leveling must be used in exceptional situation, the heat leveling temperature is suggested not greater than 550°C in order to avoid changes in properties.



切割

BS高强钢可进行机械剪切加工。剪刀间距是重要的参数，高强钢剪切时应该选择相对较小的剪刀间距，避免剪切断面出现断口分离现象。另一个重要参数是剪刀硬度，例如，剪切700MPa强度钢材时，刀具硬度应当大于58HRC。

BS高强钢采用氧-乙炔火焰切割时，切割速度、气体压力和火焰特性对切割质量有重要影响，其中切割速度的影响最大。随着切割速度增大，其切割面逐渐由平直向倾斜过渡，宏观割面质量逐渐变差；其切割形成了热影响区（HAZ）的宽度随着切割速度的增加而逐渐减小。与中性焰相比，氧化焰的切割质量相对较差，其HAZ宽度也相对更大，故不推荐采用。

火焰切割时，BS系列高强钢采用下述切割参数可获得较好的切割质量。

BS series steels can get a good cutting quality by flame cutting when the parameters in the table below are adopted.

牌号 Steel grade	板厚 Thickness (mm)	切割参数 Cutting parameters		
		氧气压力 Oxygen pressure (MPa)	乙炔压力 Acetylene pressure (MPa)	切割速度 Cutting speed (mm/s)
BS600MC	12	0.35-0.45	0.03-0.05	6-10
BS700MC	6	0.35-0.45	0.03-0.05	10-15

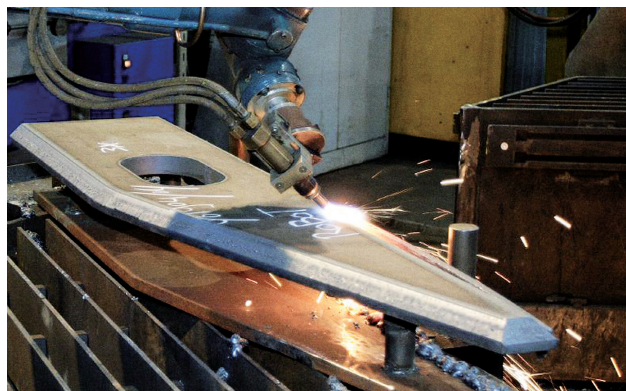
BS高强钢热轧板适用等离子切割和激光切割，其切割热影响区宽度显著小于火焰切割，且切割质量优于火焰切割。

BS series steels are suitable for plasma cutting or laser cutting, by which the width of HAZ will be greatly decreased and cutting surface quality increased than by flaming cutting.

Cutting

BS series steels may be mechanical sheared. Blade clearance is an important parameter. In order to avoid separation in cutting section, a small blade clearance shall be adopted during the cutting of high strength steel. Another important parameter is the hardness of blades. For example, it should be greater than 58HRC to cut the steel with specified minimum yield strength of 700MPa.

When the BS series steels are cut by oxyacetylene flame, the cutting speed, gas pressure and flame character have great influence on the cutting quality, especially the speed. With the increase of speed, the cutting face will transit from straight to tilt and the quality of cutting surface will decrease. The width of HAZ will decrease when the speed increases. Compared with neutral flame, the oxidation flame will undermine the quality of cutting surface and increase the width of HAZ. It is not suggested to use oxidation flame.



订货信息 Delivery Condition

BS系列热连轧高强钢板的尺寸、外形及重量允许偏差执行宝钢企标Q/BQB301-2009《热连轧钢板及钢带的尺寸、外形、重量及允许偏差》。

其中分类和代号约定如下:

按边缘状态分为	切边 (EC)
	不切边 (EM)
按厚度精度分为	普通厚度精度 (PT.A)
	较高厚度精度 (PT.B)
按表面处理方式分为	酸洗表面
	非酸洗表面
按产品类别分为	热轧钢带 (简称: 钢带)
	热轧钢板 (简称: 钢板)
	热轧纵切钢带 (简称: 纵切钢带)

The tolerance on dimension, shape and mass is according to Baosteel's standard Q/BQB 301-2009, Hot-rolled steel sheets and strips - Tolerance on dimension, shape and mass.

The classification and designation are specified as:

Edge Condition	Cut Edge
	Mill Edge
Thickness Tolerance	Normal thickness tolerance (PT.A)
	(PT.B)
Surface treatment	Pickled
	As rolled
Classification	Hot-rolled strip (Strip)
	Hot-rolled plate (Plate)
	Hot-rolled slitting strip (Slitting Strip)

BS系列高强钢的不平度允许值分为四级, 如下表所示:

There are 4 levels of flatness for BS series steels, as listed below:

		下列宽度时的不平度允许值 Deviation in flatness for width (mm)		
		≤1200	>1200—1500	>1500
不平度等级 Flatness level	N级	≤22	≤29	≤35
	S1级	≤15	≤18	≤23
	S2级	≤8	≤11	≤13
	S3级	≤6	≤6	≤8

注:

- 以上不平度允许值仅适用于钢板, 不适用于钢带。
- 如用户对不平度 (平坦度) 有S级要求, 供需双方需协商并在合同中注明。
- 如用户对钢带有平坦度要求, 在用户开卷设备保证质量的前提下, 供需双方可以协商并在合同中注明。
- 不平度允许值是指整张钢板平放在基准台上, 钢板下表面距离台面的最大距离。

Remarks:

- The flatness above is for plates, not for strips.
- If S-level flatness is required, it should be mutually agreed and specified in the order.
- If flatness on strips is required, it should be mutually agreed and specified in the order on the condition that customer's equipment has enough process ability.
- The deviation of flatness is determined by the maximum distance between the steel plate and the reference platform on which the steel plated is placed.

用户如对尺寸公差、不平度等有附加要求, 特别是对切割后钢板的不平度有附加要求, 请在定货时提出, 供需双方协商确认, 并在合同中注明。

Any additional requirement on dimension tolerance or flatness, especially the flatness after cutting, shall be supplied at the time of ordering. Mutually agreed, the requirement shall be specified in the order.

典型应用案例

Typical Applications

典型用户 Users	典型钢种 Steel grades	用途 Usage
徐工集团 XCMG	BS700MCK2 BS960MCJ4 BS600MC BS700MC	工程机械 Construction machines
中联重科 Zoomlion	BS600MC BS700MC	工程机械 Construction machines
三一重工 Sany Heavy Industry Co., Ltd.	BS700MCK2 BS600MC	工程机械 Construction machines
安徽柳工起重机有限公司 Anhui Liugong Crane Co., Ltd.	BS700MCK2	工程机械 Construction machines
山推工程机械股份有限公司 Shantui Construction Machinery Co., Ltd.	BS700MCK2	工程机械 Construction machines
四川长江工程起重机有限责任公司 Sichuan Changjiang Engineering Crane Co., Ltd.	BS600MCJ4 BS700MCK2	工程机械 Construction machines
马尼托瓦克东岳重工有限公司 Manitowoc Dongyue Heavy Industries Co., Ltd.	BS600MC	工程机械 Construction machines
沈阳北方交通重工集团 Shenyang North Traffic Heavy Industry Group	BS600MC	工程机械 Construction machines
中集集团 CIMC	BS700MC	集装箱 Marine container
张家港海星集装箱制造有限公司 Zhangjiagang Marine Star Marine Container Co., Ltd.	BS700MCK2	集装箱 Marine container
青岛四方庞巴迪铁路运输设备有限公司 Bombardier Sifang (Qingdao) Transportation Ltd.	BS700MCK2	铁道车辆 Rail cars
深圳中集专用车有限公司 Shenzhen CIMC Special Vehicle Co., Ltd.	BS550MCK4	特种车辆 Special vehicles

结束语

Our Vision

宝钢一贯秉持“要善于学习，更要善于创新”的创业精神，在热轧高强钢的开发征程上勇于开拓进取，产品不断升级换代，技术不断突破创新，我们愿以更好的产品和服务全心全意地致力于国内外工程机械制造行业的进步发展。

Following the creed, “Good at learning and good at innovation”, Baosteel is pioneering in the development of high strength hot-rolled steel, continuing the upgrade of products and breakthrough of technology. With high quality products and full-hearted service, Baosteel will contribute to the development of domestic and foreign construction machinery industry.

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BAOSHAN IRON & STEEL CO., LTD.
http://www.baosteel.com

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传真: 021-26645419

产品发展部

Product Development Department

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邮编: 201900
电话: 021-26647078
传真: 021-26645299

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宝钢在线

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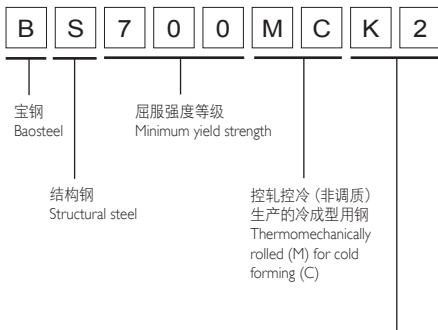
TEL: 0055-21-25311363

FAX: 0055-21-25310298

工程机械用 高强度热连轧结构钢

产品简介

工程机械用系列高强、超高强结构钢是宝钢于2000年在国内率先开发成功的一类热轧新产品，牌号大多采用“BS”开头。宝钢的BS系列工程机械用钢分为两代，第一代高强钢强度高，性能稳定，如BS600MC和BS700MC。第二代高强钢在第一代的基础上还具有良好的低温冲击性能，如BS700MCK2、BS600MCJ4等，带有表征冲击性的后缀K2、J4。牌号含义如下：



K2: -20°C冲击值不小于40J
 J4: -40°C冲击值不小于27J
 K4: -40°C冲击值不小于40J
 K2: Impact energy at -20°C not less than 40J
 J4: Impact energy at -40°C not less than 27J
 K4: Impact energy at -40°C not less than 40J

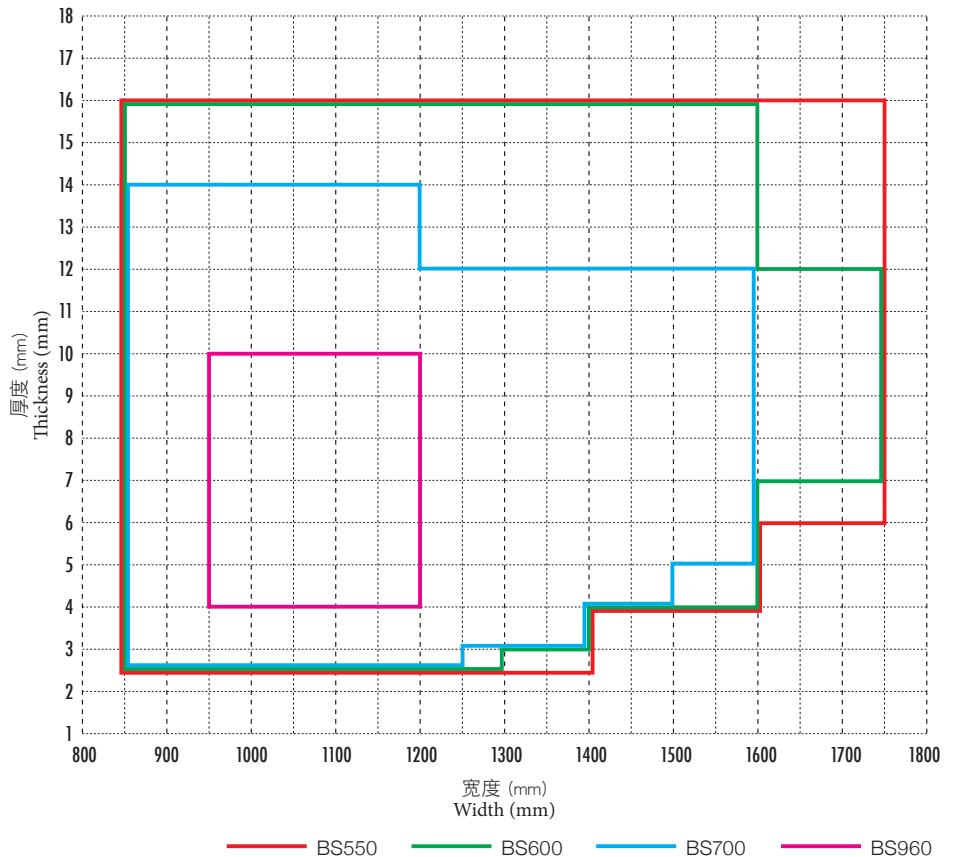
BS系列高强钢为低碳低合金结构钢，控冷控轧轧制(TMCP)。宝钢在生产过程中精心设计调整成分，精确控制轧制工艺，产品具有良好的可焊接性和冷成形性能，可广泛应用于工程机械、车辆结构、集装箱等制造行业。



可供规格

BS系列高强钢一般以板状交货，板状交货时，钢板最短长度为2米，最长长度为12米。对于700MPa以下品种，也可以选择卷状交货。

下图为不同强度级BS高强钢的可供范围。



化学成分

牌 号	C% Max	Si% Max	Mn% Max	P% Max	S% Max	Alt% Min	B% Max
BS550MCK4	0.12	0.50	2.0	0.015	0.005	0.015	-
BS600MCJ4 BS600MCK4	0.12	0.50	2.0	0.015	0.005	0.015	0.005
BS600MC	0.12	0.50	2.0	0.020	0.010	0.015	0.005
BS700MCK2	0.12	0.60	2.10	0.025	0.010	0.015	0.005
BS700MC	0.12	0.60	2.10	0.025	0.015	0.015	0.005
BS900MCJ4	0.12	0.50	1.60	0.015	0.005	0.015	0.003
BS960MCJ4	0.12	0.50	1.60	0.015	0.005	0.015	0.003

注：根据强度需要，可以加入Nb、V、Ti、Cr、Mo等合金元素。

力学性能交货标准

牌 号	厚 度 mm	拉伸试验 ($L_0=5.65\sqrt{S_0}$)				横向弯曲 试验
		方 向	屈 服 (MPa)	抗 拉 (MPa)	延 伸 率 (%)	
BS550MCK4	≤16	T	≥550	≥600	≥18	2a
BS600MCJ4	<10	T	≥600	≥680	≥15	2a
	10~16		≥580	≥680	≥15	
BS600MCK4	≤16	T	≥600	≥680	≥15	2a
BS700MCK2	3~8	T	≥700	750~950	≥15	2a
	>8		≥680	750~950	≥15	
BS900MCJ4	3~10	L	≥900	≥950	≥10	3a
BS960MCJ4	3~10	L	≥960	≥980	≥10	3a
BS600MC	≤16	L	≥600	650~820	≥13	2a
BS700MC	≤6	L	≥700	750~950	≥12	2a

注：方向中，T代表横向，L代表纵向。

力学性能典型值

牌 号	厚 度	屈服MPa	抗拉MPa	伸长率%	冲击值J
BS550MCK4	6-12	560-645	645-740	16-26	120-280
BS600MCJ4	2.5-(10)	600-670	680-780	15-23	140-240
	10-16	600-660	700-760	16-21	120-270
BS700MCK2	3-8	700-860	780-920	15-21	40-100
	(8)-12	685-820	790-900	15-21	60-150
BS960MCJ4	4-8	960-1050	1050-1080	11-15	(100-140)
BS600MC	3-14	640-720	700-790	17-26	-
BS700MC	2.5-8	680-810	750-880	14-23	-

注：宝钢BS系列高强度性能稳定，实物检测值显示80%以上产品的性能在上表所示范围内。

不平度

不平度等级	下列宽度时的不平度允许值		
	≤1200	>1200—1500	>1500
N级	≤22	≤29	≤35
S1级	≤15	≤18	≤23
S2级	≤8	≤11	≤13
S3级	≤6	≤6	≤8

注：如有S类不平度要求，请告知宝钢并在合同中注明。

焊接工艺

BS高强度采用低碳低合金设计，具有较低的碳当量和焊接裂纹敏感指数，如BS700MCK2，碳当量≤0.47，焊接裂纹敏感指数≤0.21。

高强度焊接时热影响区内存在一个比较窄的软化区。建议采用小热输入、快速焊接工艺以减小软化区的宽度。

当环境温度大于0℃时，BS高强度板不需预热就可直接进行焊接，不易产生焊接冷裂纹。推荐使用MAG焊接，保护气体为80%Ar+20%CO₂，气体流量18~25l/min。

在接头力学性能保证的情况下，BS高强度焊接时尽可能使用强度稍低的焊材，避免等强焊接。宝钢已经开发了相应的焊接材料，牌号为BH600-II、BH700-II、BH800-II、BH900-II。

冷弯加工

BS高强度具有良好的塑性，适合冷弯加工。折弯时，弯曲直径应小于技术条件中的规定值。高强度板的回弹较大，成形时应通过适当的过弯曲来保证获得所需的折弯角度。

辊压成型时，单次辊压变形量不宜太大，通过调整变形量，可避免边部开裂。

矫 形

BS高强度需要矫形时，建议采用冷矫形方式。如特殊情况下需要采用热矫形时，建议热矫形温度不超过550℃。

切 割

BS高强度可进行机械剪切加工。高强度剪切时应该选择相对较小的剪刀间距，避免剪切断面出现断口分离现象。同时剪切刀具也应当有足够的硬度。

BS高强度也可进行火焰切割。

我们推荐使用等离子或者激光进行BS系列高强度钢的切割。

技术支持

如您在选择高强度、使用高强度中存在疑问或需要帮助，请洽：

021-26647078

021-26647336

400-820-8590