诺林异形钢管
NUOLIN SHAPED STEEL PIPE

因为专一所以专业　异形管、方管矩管制造专家

BECAUSE OF THE SINGLE-MINDEDNESS, WE ARE PROFESSIONAL
SPECIAL-SHAPED TUBE, SQUARE TUBE AND RECTANGULAR TUBE MANUFACTURING EXPERT

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聊城诺林钢管有限公司
LIAOCHENG NUOLIN STEEL PIPE CO., LTD

山东鑫诺林智能装备科技有限公司
SHANDONG XINNUOLIN INTELLIGENT EQUIPMENT TECHNOLOGY CO., LTD



Nuo Lin Shaped Steel Pipe

专注 专心 专一 专业

Focused,Concentrated,Dedicated,Professional

以优质的服务，高质量的产品，合理的价格

高尚的人品 服务与社会

With high-quality service, high-quality products, and reasonable prices

Noble character service and society



因为专一所以专业　异形管、方管矩管制造专家

企业简介
Brief Introduction

聊城诺林钢管有限公司/山东鑫诺林智能装备科技有限公司成立于2010年公司坐落于山东省聊城市凤凰工业园经三路38号，交通十分便利，有着良好的生产经营环境。

公司成立近十五来，一直“专注”于异型管、方管矩管、冷拔管的使用、发展与研发，并"专心”为方管矩管、异形钢管的使用创造平台和推广，公司自成立之初就为异型管、方管矩管做出了"专一"的选择，使公司在同行业内具有更高更强的经营团队和知名度，有了前面的“三专”终于给方管矩管、异型管的规格、尺寸、材质等面延伸提供了"专业”知识。公司秉承“因为专一，所以专业”的经营理念，力争把诺林打造成全国规格品种最全的异形管、方矩管基地，真正实现“购异型管方管不用东奔西走，诺林应有尽有”的一站式购齐的经营目标。

本公司三条生产线所生产异型管、方管矩管的规格具备了全尺寸:20×20-760x760的异型管方管、圆管，20x30-600x800的矩管，厚度为1.5mm-35mm,规格达2800多种；材质为20#.、Q345、Q460、Q550、Q700、等不锈钢、无缝管、合金钢等，并能生产菱形、三角形、五边形、六边形、扇形、燕尾形等特殊规格尺寸，也可按照客户提供图纸、尺寸量身定做。

我们所生产的大口径、厚壁方矩管、异形管填补了国内外部分空白，产品广泛用于大型工程机械、农业机械、造船、桥梁、建筑业、冶金工业、汽车工业、铁路、公路、航空、集装箱、家具、装饰装修等众多行业。公司视产品质量为企业的生存命脉，用人品打造产品，层层严把产品质量关。

本公司已通过ISo9001:2008质量管理体系认证，公司凭借"多品种、大库存、高品质、低价格、交货期短、完善的售后服务"等诸多竞争优势，已成为多家大型企业的指定供应商，客户遍及全国二十多个省市地区并远销美国、加拿大、俄罗斯、印度、马来西亚、欧洲等国家和地区。

公司总经理冯其朝，衷心感谢各界朋友多年来将对诺林的信任和大力支持，诺林全体员工将一如既往的为广大用户竭诚服务，与您共同发展、合作共赢、诚信共铸、再创辉煌！

Liaocheng Nuolin Steel Pipe Co., Ltd./Shandong Xinnuolin Intelligent Equipment Technology Co., Ltd. was established in 2010. The company is located at 38 Jingsan Road, Fenghuang Industrial Park, Liaocheng City, Shandong Province, with convenient transportation and a good production and operation environment.

Since its establishment nearly fifteen years ago, the company has been dedicated to the use, development, and research and development of special-shaped tubes, square tube rectangular tubes, and cold drawn tubes, and has been dedicated to creating platforms and promoting the use of square tube rectangular tubes and special-shaped steel pipes. Since its establishment, the company has made a "specialized" choice for special-shaped tubes and square tube rectangular tubes, which has enabled the company to have a higher and stronger management team and reputation in the same industry. With the previous "three specialties", the company has finally provided "professional" knowledge for the specifications, dimensions, materials, and other aspects of square tube rectangular tubes and special-shaped tubes. The company adheres to the business philosophy of "professionalism because of specialization" and strives to build Norlin into the most comprehensive base of special-shaped pipes and square rectangular pipes in the country, truly achieving the one-stop business goal of "purchasing special-shaped pipes and square pipes without running around, Norlin has everything".

Our company's three production lines produce special-shaped tubes, square tubes, and rectangular tubes with full sizes of 20 × 20-760x760 square tubes and round tubes, as well as 20x30-600x800 rectangular tubes, with a thickness of 1.5mm-35mm and over 2800 specifications; The material is 20 # Q345, Q460, Q550, Q700, and other stainless steel, seamless pipes, alloy steel, etc. can also produce special specifications and sizes such as diamond, triangle, pentagon, hexagonal, fan-shaped, and dovetail, and can also be customized according to customer provided drawings and dimensions.

Our large-diameter, thick walled rectangular pipes and special-shaped pipes have filled some gaps both domestically and internationally. Our products are widely used in many industries such as large-scale engineering machinery, agricultural machinery, shipbuilding, bridges, construction, metallurgy, automotive industry, railways, highways, aviation, containers, furniture, decoration, etc. The company regards product quality as the lifeblood of the enterprise's survival, uses character to create products, and strictly controls product quality layer by layer.

Our company has passed the ISo9001:2008 quality management system certification. With many competitive advantages such as "multiple varieties, large inventory, high quality, low price, short delivery time, and comprehensive after-sales service", we have become the designated supplier for many large enterprises. Our customers are located in more than 20 provinces and cities across the country and are exported to countries and regions such as the United States, Canada, Russia, India, Malaysia, and Europe.

Feng Qichao, the General Manager of the company, sincerely thanks friends from all walks of life for their trust and strong support in Norin over the years. All employees of Norin will continue to serve our customers wholeheartedly, and work together with you for development, win-win cooperation, integrity, and creating new brilliance!

企业资质
Enterprise Qualification











厂容厂貌
Factory Photos











产品展示
Products Display

冷拔异型管
Cold drawn shaped pipe



冷拔方矩管
Cold drawn rectangular tube



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可生产方矩管材质对照表
Material Comparison Table



本公司可生产一下材质方矩管
Our Company is Specialized in Producing Square and Rectangular Steel Pipes as Follows

执行标准 Executive standard	GB/T912-1989 GB/T3274-1988 中国	EN10025-1993 欧洲	DIN17100-80 德国	ASTM A106/A500 美国	JIS G3466 日本
钢级 Steel grade	Q195 Q215A Q215B	S185	St33		SS330
	Q235B	S235JR	St37-2	Gr.A	SS400
	Q235C	S235J0	St37-3		
	Q345B	S355JRH	St52-2	Gr.B	STK 490
	Q345C Q390B Q390C	S355JOH	St52-3	Gr.C	
	Q345D	S355J2H		Gr.D (热处理状态货)	
	Q345E				
	20#			Gr.B	
	45#,20Mn2,27SiMn				
外径范围 OD range	20mmX20mm-600mmX600mm				
	20mmX30mm-600mmX800mm				
壁厚 Wall thickness	1.5mm-35.0mm				

产品执行标准
Implementation of Standards

企业执行标准及国内外执行标准参考
Enterprise execution standards and reference to domestic and foreign execution standards

	QB/XJY01企业标准	GB/T6728-2002(中国)	GB/T3094-2000(中国)
边长 Outside dimensions A、Bmm	100以下±0.4（±0.2） 100以上±0.6%（±0.3%）	50以下±0.5 300±2.4 100±0.8 350±2.8 150±1.2 400±3.2 200±1.6 500±4.0 250±2.0 600±4.0	30以下±0.3（普通） ±0.2（高级） 30-50±0.4 ±0.3 50-75±0.8% ±0.7% 75以上±1.0% ±0.8%
平面度mm Convexity or concavity	100以下±0.5（±0.3）以下 100以上0.4%（0.3%）以下	60以下 ±0.4 60以上 0.6%	30以下 ±0.2 ±0.1 30-50 ±0.3 ±0.15 50-75 ±0.8% ±0.5% 75以上 ±0.9% ±0.6%
直角度 Squareness of side	±1.0°(±0.5°)	±1.5°	±1.5°
弯曲度 Bending degree	特殊精度1m内0.2mm	每米不大于2mm 全场不大于0.2%	每米≤4.0mm，全长≤0.4% 每米≤2.0mm，全场≤0.2%
R角 Radius of Corners	Rs=1.0-3.0t	碳素钢 Rs=1.0-3.5t 低合金钢 Rs=1.5-4.0t	
扭曲 Twist	1m内1mm 特殊精度1m内0.2mm	扭曲度V=2+LX0.5/1000	
壁厚 Wall thickness	使用材料的相应标准公差范围内，或根据协议	10.0mm一下，±10% 10.0mm以上，±8%	1mm以下 ±0.18（普通）±0.12（高级） 1-3mm +15% -10% +15% -10% 3mm以上 +12.5%-11% +10%
长度 length	-0mm +10mm	普通级别 4m-12m-0mm +70mm 精确级别 4m-6m-0mm +5mm >6m-12m-0mm+10mm	-0mm +15mm

企业执行标准及国内外执行标准参考
Enterprise execution standards and reference to domestic and foreign execution standards

	ASTM A500	JISG3466(日本)	AS 1163(澳大利亚)	EN 10210-2:2006
边长 Outside dimensions A、Bmm	≤63.5 ±0.51 63.5-88.9 ±0.64 88.9-139.7 ±0.76 >139.7 ±1%	100以下 ±1.5 100以上 ±1.5%	±1.0% 最小±0.5mm	±1% 最小±0.5mm
平面度mm Convexity or concavity	65以下 ±0.5 65-90 ±0.6 90-140 ±0.8 140以上 ±1.0%	100以下 0.5以下 100以上 边长±0.5%	最大0.8%或者 0.5mm（选最大值）	1%
直角度 Squareness of side	±2°	±1.5°	±1°	±1°
弯曲度 Bending degree	0.20%	全场0.3%以下	全场0.15%	总长度的0.2%，局部范围内3mm/m
R角 Radius of Corners	Rs=3.0t以下	Rs=3.0t以下	50以下 Rs=1.5-3.0t 50以上 Rs=1.8-3.0t	每个角部最大为壁厚的3倍
扭曲 Twist	40以下 ≤1.3mm/m 40-65 ≤1.6mm/m 65-100 ≤1.9mm/m 100-150 ≤2.2mm/m 150-200 ≤2.5mm/m 200以上 ≤2.8mm/m	不能有明显扭曲	2+0.5mm/m	2mm，长度每增加1m，增加0.5mm
壁厚 Wall thickness	±10%	焊接 3mm以下 ±0.3mm 3mm以上 ±0% 无缝 4mm以下 ±0.6mm 6mm以上 ±15%	±10%	焊接 -10% +0% 无缝 -10% +12.5%
长度 Length	≤6.7m-6.4mm+12.7mm >6.7m-6.4mm+19mm	-0mm +根据协议	≤14m -0mm +6mm	2mm-6mm -0mm +10mm >6mm -0mm +15mm

注 Note:

1、QB/XJY01--本企业标准，一般结构用无缝，焊接方矩形管、异型管，适应范围最大边长600mm，整厚tmax-=35.0mm

2、其他特殊精度要求以供需双方所签协议为准。

3、断面的尺寸及角度的测定位置，是指离管端100mm以内的任意点。

4、普碳钢材质:Q195，Q215，Q235，Q275，Q345等;无缝材质:10#，20#，45#等;不锈钢材质:SUS304，316,321，钛合金，纯钛等。

1、QB/XJY01 - the enterprise standard, the general structure is seamless, welded rectangular pipe, special-shaped pipe, the maximum side length of the scope of adaptation is 600mm, and the overall thickness tmax = 35.0mm

2. Other special accuracy requirements are subject to the agreement signed by the supplier and demand.

3. The measurement position of the size and angle of the section refers to any point within 100mm from the end of the pipe.

4. Carbon steel material: Q195, Q215, Q235, Q275, Q345, etc.; Seamless material: 10#, 20#, 45#, etc.; Stainless steel material: SUS304, 316, 321, titanium alloy, pure titanium, etc.

产品执行标准尝试

PRODUCT STANDARDS COMMON SENSE

DIN EN 10210(欧洲)非合金和细晶粒结构钢及热精加工结构空心型材

DIN EN 10210 (Europe) Hot finished structural hollow sections of non-alloy and fine grain steels

DIN EN 10219(欧洲)非合金和细晶粒结构钢及冷弯成型空心型材

DIN EN 10219 (Europe) Cold formed welded structural hollow sections of non-alloy and fine grain steels

ASTMA500(美国)结构用碳素钢冷成型圆截面和异型截面焊接钢管和无缝管

ASTM A500 (American) Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

GB/T 3094-2000(中国)冷拔异型钢管

GB/T 3094-2000 (China) Cold drawm forming steel tube

GB/T 6728-2002(中国)结构用冷弯空心型材GB/T 178-2005(中国)建筑结构用冷弯矩形钢管

GB/T 6728-2002 (China)Cold formed structural hollow sections

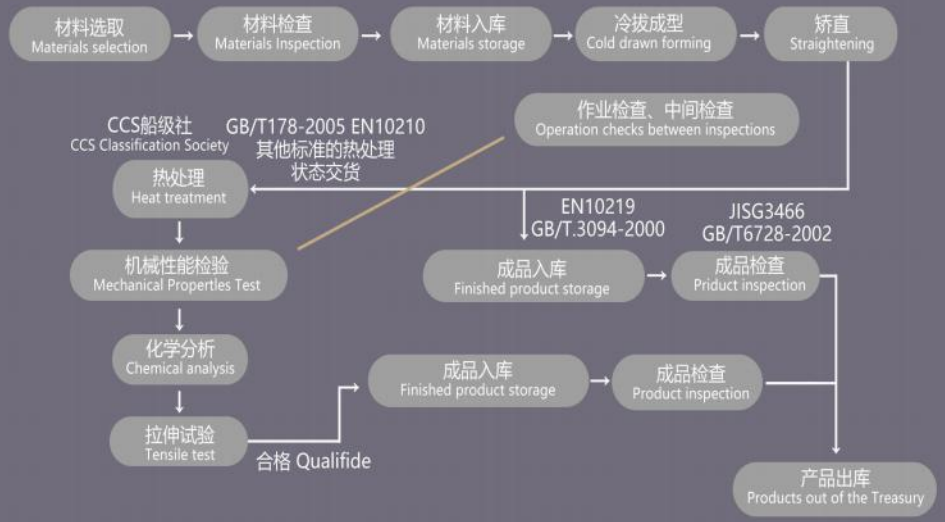
GBT 178-2005 (China) Building strnucture witih cold-formed rectangular steel pipe

JISG 3466(日本)一般结构用碳素方短管

JiSG 3466(Japan)Carbon steel square pipes for general structural purposes

执行标准工艺图

Technical process figure



技术参数

Technical Parameters

制作工艺

MANUFACTURING PROCESS

直接成方:对冷轧或热轧直接进行连续弯角变形，经高频焊接形成矩形钢管的成型方式，也称为方变方成型。
Direcly inlo Square: make conliruous angle delommation af cold-,oled or hokoled slel plale drecy, and then by high frequeny welding form a reclangular steel tube fomingmethod. Also known as square-square method.
先圆后方:对冷轧或热轧直接进行连续弯角变形，经高频焊接形成圆管，通过整形最终形成矩形钢管的成型方式，也称为圆变方成型。
Round lo square: make coninuous ange delommalon of cold.oled or hotroled stel plale drecly, and then by high frequeny welding fom a round stleltube foming mehodhrough the reshaping finally form a rectangular steel tube forming method. Also known as round to square method.
本公司制作工艺为渐行内外模具冷拔成型:采用多道次逐渐连续变形，有效的减少了R角的内部应力及损伤，对外形尺寸的精确控制和R角的特殊要求，及产品的扭曲和弯曲达到了同行业及国际领先水平
Our company's production process is gradual internal and external mold cold drawing forming: using multiple passes of gradual continuous deformation, effectively reducing the internal stress and damage of the R angle, precise control of the external dimensions and special requirements for the R angle, and the twisting and bending of the product reaching the leading level in the same industry and internationally

技术要求

TECHNICAL REQUIREMENTS

钢号

Steel Grade

产品屈服强度等级 Yield Strength Grade	对应国内原料牌号 Domestic Rawmaterial Grade
235	0235B、Q235C、Q235D、Q235qC、Q235qD
345	Q345A、Q345B、Q3450、0345D、Q345gC、0345qD、StE355、B480GNQR

碳当量carbon Equtvaient

碳当量(Ceq)计算 ceq(%)=C+Mn/6+Si/24+Ni/40+Cr/5+Mo/4+V/14

I级产品的碳当量 I grade produdt ceq(%)

产品屈服强度等级 Yield Strength Grade	235	345	390
Ceq (%)	≤0.36	≤0.43	≤0.45

注:为改善钢材性能，390可以加入钒.铌.钛.钼.氮等微量元素
Note: In order to improve the performance of steel,390 could add the microelement such as V, Nb, Ti, Mo and N etc.





力学性能
Mechanical Property

产品曲阜 强度等级 Yield Strength Grade	壁厚t/mm	取费强度Rel/MPa	抗拉强度Rm/MPa	断后伸长率A/%
235		≥235	≥370	≥24
345	≤19	≥345	≥470	≥20
390		≥390	≥490	≥17

对于断面尺寸<60mmx60mm(包括等周长尺寸的圆及矩形冷弯型钢)及边厚比≤14的冷弯型钢产品，平板部分断后伸长率应不小于17%。
For cold-formed steel products with cross-sectional dimensions<60mmx60mm (including round and rectangular cold-formed steel with equal perimeter dimensions) and edge thickness ratios ≤ 14, the flat section is broken the elongation after use should not be less than 17%.

表面质量
Surface Quality

1、冷弯型钢的表面不得有气泡、裂纹、结疤、折叠、夹杂和端面分层，允许有不大于公称厚度10%的轻微凹坑、凸起、压痕、发纹、擦伤和压入的氧化铁皮。
2、冷弯型钢的表面缺陷允许用修磨方法清理，但清理后的冷弯型钢厚度不得小于最小允许厚度
3、对表面质量有特殊要求的冷弯型钢由供需双方协商确定

1. Cold bending section steel surface can not have bubbles, cracks, inclusions and transverse stratification, wrinkle, buckle and so onAllow slight pit,convex, indentation, scratch and pressure into the iron oxide, but is not greater than 10% of nominal wallthickness.
2.Surface defects allowed use grinding method to clear up, but after cleaning the thickness should be no less than minimum allowable2thickness.
3. If have special requirements on surface quality of cold bending section steel, determined by supply and demand.

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焊缝质量
Welding Quality

1、冷拔焊接空心型钢焊缝处不得有开焊、搭焊、烧穿及严重错位。
2、焊缝处的缺陷允许补焊、打磨，但补焊修磨后应达到国标所规定的要求，
3、焊缝处的外毛刺应予以清除。焊缝处的内毛刺一般不清除，如有特殊要求，由供需双方协商确定。

1. There shall be no open welding, overlap welding, burning through, or severe misalignment at the weld seam of cold drawn hollow steel.
2. Defects at the weld seam can be repaired by welding or grinding, but the repaired welding and grinding should meet the requirements specified in the national standard,
3. The external burrs at the weld seam should be removed. The internal burrs at the weld seam are generally not removed. If there are special requirements, they shall be determined through negotiation between the supply and demand parties.

交货重量的计算方法及允许偏差
Weight Calculation and Allowable Deviation

1、理论计重 Theoretical calculation formula
方管理论重量计算公式(1):边长x4x壁厚x7.85
Square fube theoretical caiculation fomula (1): side length x 4 x wall thickness x 7.85
方管理论重量计算公式(2):4x壁厚x(边长-壁厚)x7.85
Square tube theoretical calculation fomula (2) wall thicknessx 4 x (side length - wall thickness) x 7.85
其中:边长和壁厚都以毫米为单位，得出即每米长度方管的重量，以克为单位。
Nole : side length and wallthickness in miimeter, calculated that the weight of per meter length of the square tube, in grams per unit.

2、过磅计重 weighing weight
成品打包成件，按实际过磅数量计重。
Finished product packed into bundies, according to the actual weighing weight
冷弯矩型钢管实际重量与理论重量允许偏差为:+10%~-6%。
Cold bending recdangular sleel tube allows the deviation between the actual weight and the theory weight:.+10% to -6%.



规格型号
Specifications



正方形20x20-700x700x1.5-35.0mm
Figure 1 Square

规格 / 壁厚	大口径规格								中口径规格										小口径规格							
	600X600	500X500	400X400	350X350	300X300	280X280	260X260	250X250	240X240	220X220	200X200	180X180	160X160	150X150	140X140	135X135	120X120	115X115	110X110	100X100	90X90	80X80	70X70	60X60	50X50	40X40	30X30	20X20
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35.0																												

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长方形 20x30-600x800x1.5-35.0mm
Figure 2 Rectangular

规格 / 壁厚	大口径规格																											
	600X600	800X400	700X500	700X400	700X200	600X200	500X300	450X250	450X150	420X350	400X300	400X200	400X150	360X200	360X350	360X310	360X240	360X200	350X300	350X250	350X150	350X100	320X200	304X254	300X250	300X200	300X170	300X100
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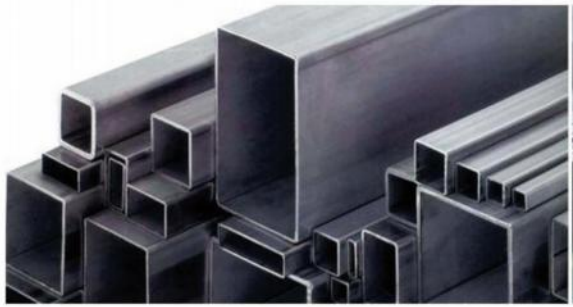

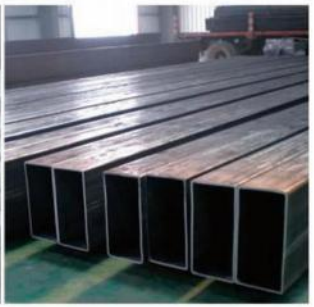

长方形 20x30-400x800x1.5-35.0mm Figure 3 Rectangular

规格 / 壁厚	大口径规格																											
	280 X 240	280 X 120	260 X 175	260 X 90	250 X 225	250 X 200	250 X 150	250 X 100	220 X 200	220 X 160	220 X 140	220 X 120	200 X 160	200 X 150	200 X 120	200 X 100	200 X 80	180 X 150	180 X 100	180 X 80	175 X 150	175 X 100	160 X 130	160 X 100	160 X 80	150 X 100	150 X 80
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长方形 20x30-400x800x1.5-35.0mm Figure 4 Rectangular

规格 / 壁厚	大口径规格																											
	140 X 80	130 X 120	125 X 100	125 X 90	120 X 100	120 X 80	120 X 60	110 X 75	110 X 60	100 X 80	100 X 50	100 X 40	100 X 30	100 X 20	90 X 50	80 X 40	75 X 45	75 X 50	70 X 40	70 X 30	70 X 20	60 X 40	60 X 30	60 X 20	50 X 30	50 X 25	50 X 20	45 X 20	40 X 20
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产品应用
Products Application

机械制造： 工程机械、农用机械、纺织机械、造纸机械、
食品机械、电工设备、环卫设备、矿山设备

道路桥梁： 铁路、航空、高速公路、立交桥、道路护栏、交通标识

建筑工程： 钢结构施工、体育场馆、立体车库

装修装饰： 铁艺门窗、户外广告、亭台楼榭、玻璃幕墙

交通运输： 汽车制造、轮船制造、集装箱、三轮车、塔吊

Mechanical manufacturing:
construction machinery, agricultural machinery, textile machinery, papermaking machinery
Food machinery, electrical equipment, sanitation equipment, mining equipment

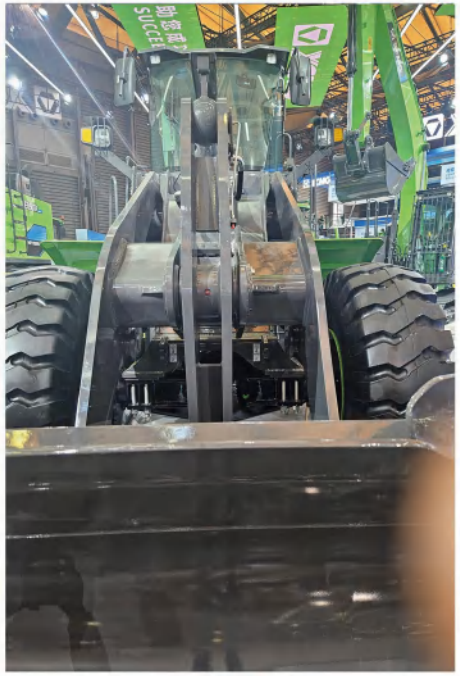
Road bridges:
railways, aviation, highways, overpasses, road guardrails, traffic signs

Construction engineering:
steel structure construction, sports venues, three-dimensional parking lots

Decoration:
Iron doors and windows, outdoor advertising, pavilions and pavilions, glass curtain walls

Transportation:
automobile manufacturing, ship manufacturing, containers, tricycles, tower cranes











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技术交流
Technical Communication

热轧钢管的产品特性
HOT ROLLING STEEL PIPE' S PRODUCT CHARACTERISTIC

热轧产品与冷弯产品的硬度与残余应力的分析
ANALYSIS OF HARDNESS AND RESIDUAL STRESS OF HOT-ROLLED AND COLD-FORMED PRODUCTS

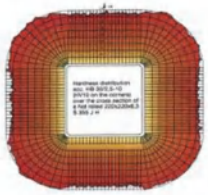
空心型钢整个横截面上的张力性能
THE TENSILE PERFORMANCE OF HOLLOW SECTION STEEL ON THE ENTIRE CROSS-SECTION

硬度分布
HARDNESS DISTRIBUTION

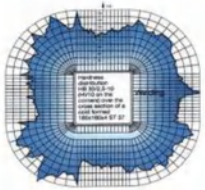
横截面上的硬度分配体现了热轧和冷弯型钢最显著的区别。(参看下图)
THE HARDNESS DISTRIBUTION ON THE CROSS-SECTION REFLECTS THE MOST SIGNIFICANT DIFFERENCE BETWEEN HOT-ROLLED AND COLD-FORMED STEEL SECTIONS. (REFER TO THE FIGURE BELOW)

热轧空心型钢显示了横截面上硬度均匀分布，而冷弯型材在拐角处硬度分布最多。这表明张力性能在这些地方成多样性。另外，在纵向焊接处硬度也分布最多，由此我们可以猜想接处没有进行热处理。

HOT ROLLED HOLLOW STEEL SHOWS A UNIFORM DISTRIBUTION OF HARDNESS ON THE CROSS-SECTION, WHILE COLD-FORMED PROFILES HAVE THE HIGHEST HARDNESS DISTRIBUTION AT THE CORNERS. THIS INDICATES THAT THE TENSION PERFORMANCE BECOMES DIVERSE IN THESE AREAS. IN ADDITION, THE HARDNESS DISTRIBUTION IS ALSO HIGHEST AT THE LONGITUDINAL WELDING POINT, SO WE CAN SPECULATE THAT THE JOINT HAS NOT UNDERGONE HEAT TREATMENT.



热轧硬度分布
HARDNESS DISTRIBUTIONHOT ROLLED
依据HB 30/2.5-10(拐角处H Y10)，热轧钢管220*220*6.3 S355 JH 横截面上的硬度分布



冷弯硬度分布
HARDNESS DISTRIBUTIONCOLD ROLLED
依据HB30/2.5-10(拐角处HV10)，冷弯钢管160*160*4ST 37 横截面上的硬度分布

残余应力
RESIDUAL STRESSES
残余应力的分布和硬度分布大致相同。正如在图中所见，热轧MSH型钢显示出截面上均匀、低水平的残余应力而冷弯型钢体现出的是高力度的参与抗张强度。在一些过程中(如焊接、热浸镀)，这些残余应力可以释放出来并有可能导致不可控制的型钢或整个结构的扭曲。接下来相关的费用会很多。

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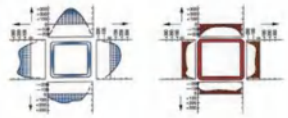
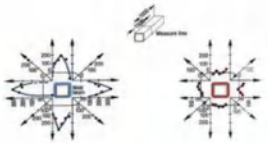
The residual stress distribution offers apicture similar to that of the hardness-distribution. As can be seen very clear-lyfrom adjacent diagrams, hot roiled MSHsection exhibit exceedingly uni-form, lowlevel residual stresses over the entirecross section,whereas cold formed hollowsection are characterized by high residualtensile stresses. During processing(E.G.weiding,Hot-dip galva-nizing), theseresidual stressed may be released andmay cause uncontrollable distortion of thehollow section or of the completestructure. The subsequent costs involvedcould be quite consider-able.



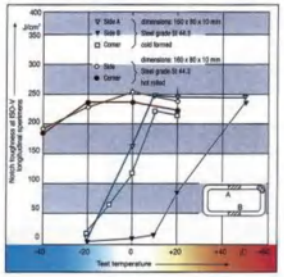
St37中冷弯和热轧空心型钢横截面上的残余拉张应力分布(N/mm)
(a)冷弯(16041605mm)(b)热轧(160=18046.3mm)Residual tensile stress distribution in Nmm over the crossection of cold formed and hot rolled ho low section in St37 Cold formed(160*160*5mm) Hot rolled(160*18063mm)



冷弯(a)和热轧()空心型钢横截面上的残余横向应力分布(N/mm2)(60*60*4mm)
Residual transversal stress distribution in N/mm over theaoss section of cold formed (a) and hot rolled (b)hollowsecton(6o*60*4mm)

冲击韧性
NOTCH TOUGHNESS

不管是在结构钢工作还是在机械建筑工作中，设计工程师所面临的最危险的现象之一是脆性破裂。这种低塑性破裂表明了严重的危险性，因为发生时没有任何迹象，有时甚至在远远低于允许力度时就发生，因材料韧度而增加的脆性破裂的灵敏度可以被视为脆性破裂趋势的重要参数,正是因为它受冷弯的影响:每1%的冷变形，从塑性到脆性破裂的转换温度在约3-5摄氏度间更换。因为冷加工量在于20-33%的范围(在一些案例中，甚至是43%)所以转换温度的更换是相当重要的。图中显示的冲击韧性标示热轧和冷弯空心型钢。正如所料，热轧MSH型钢表面和拐角处的冲击韧性几乎相同，而冷弯型钢在这方面的冲击韧性的值相差很大，在-40摄氏度，热轧空心型材仍然保持高韧性，相反，冷弯型钢表面及拐角处的韧性值已经在0摄氏度的转换区域了。
ONE OF THE MOST DANGEROUS PHENOMENA FACED BY DESIGN ENGINEERS, WHETHER IN STRUCTURAL STEEL WORK OR MECHANICAL CONSTRUCTION WORK, IS BRITTLE FRACTURE. THIS LOW PLASTIC FRACTURE INDICATES SERIOUS DANGER, AS IT OCCURS WITHOUT ANY SIGNS AND SOMETIMES EVEN FAR BELOW THE ALLOWABLE STRENGTH. THE INCREASED SENSITIVITY OF BRITTLE FRACTURE DUE TO MATERIAL TOUGHNESS CAN BE REGARDED AS AN IMPORTANT PARAMETER OF BRITTLE FRACTURE TREND, PRECISELY BECAUSE IT IS AFFECTED BY COLD BENDING: THE TRANSITION TEMPERATURE FROM PLASTIC TO BRITTLE FRACTURE CHANGES BETWEEN ABOUT 3-5 DEGREES CELSIUS FOR EVERY 1% OF COLD DEFORMATION. BECAUSE THE AMOUNT OF COLD WORK RANGES FROM 20% TO 33% (IN SOME CASES, EVEN 43%), CHANGING THE CONVERSION TEMPERATURE IS QUITE IMPORTANT. THE IMPACT TOUGHNESS SHOWN IN THE FIGURE INDICATES HOT-ROLLED AND COLD-FORMED HOLLOW STEEL SECTIONS. AS EXPECTED, THE IMPACT TOUGHNESS ON THE SURFACE AND CORNERS OF HOT-ROLLED MSH STEEL IS ALMOST THE SAME, WHILE THE IMPACT TOUGHNESS VALUES OF COLD-FORMED STEEL IN THIS REGARD DIFFER GREATLY. AT -40 DEGREES CELSIUS, HOT-ROLLED HOLLOW PROFILES STILL MAINTAIN HIGH TOUGHNESS. ON THE CONTRARY, THE TOUGHNESS VALUES ON THE SURFACE AND CORNERS OF COLD-FORMED STEEL HAVE ALREADY GONE THROUGH THE TRANSITION ZONE OF 0 DEGREES CELSIUS.



针对与冷弯空心型钢的美国标准ASTM A500 在脚注明确指出这些型材不适用于暴露在低温下承受很大应力的结构。
THE AMERICAN STANDARD ASTM A500 SPECIFICALLY STATES IN THE FOOTNOTE THAT THESE PROFILES ARE NOT SUITABLE FOR STRUCTURES EXPOSED TO HIGH STRESS AT LOW TEMPERATURES, IN RELATION TO COLD-FORMED HOLLOW STEEL.

摘自ASTM AS00 EXTRACT FROM ASTM AS00
"注1一按此规格生产的产品不适用于焊接结构中要承受很大力度的元件(焊接结构中低温冲击韧性性能尤为重要)。
NOTE 1: PRODUCTS PRODUCED ACCORDING TO THIS SPECIFICATION ARE NOT SUITABLE FOR COMPONENTS IN WELDED STRUCTURES THAT NEED TO WITHSTAND SIGNIFICANT FORCES (LOW-TEMPERATURE IMPACT TOUGHNESS PERFORMANCE IS PARTICULARLY IMPORTANT IN WELDED STRUCTURES).

技术交流
Technical Communication

残余应力产生及消除方法
GENERATION OF RESIDUAL STRESS AND ELIMINATION METHOD

残余应力产生
Generation of Residual Stress

工件经机械加工后，其表面层都存在残余应力。残余压应力可提高工件表面的耐磨性和受拉应力时的疲劳强度，残余拉应力的作用正好相反。若拉应力值超过工件材料的疲劳强度极限时，则使工件表面产生裂纹，加速工件的损坏。引起残余应力的原因有以下三个方面:

After mechanical processing, there are residual stresses on the surface layer of the workpiece. Residual compressive stress can improve the wear resistance of the workpiece surface and the fatigue strength under tensile stress, while the effect of residual tensile stress is exactly the opposite. If the tensile stress value exceeds the fatigue strength limit of the workpiece material, it will cause cracks on the surface of the workpiece and accelerate its damage. There are three reasons that can cause residual stress:

（一）冷塑性变形引起的残余应力 Cold plastic deformation caused residual stress

在切削力作用下,已加工表面受到强烈的冷塑性变形,其中以刀具后刀面对已加工表面的挤压和摩擦产生的塑性变形最为突出,此时基体金属受到影响而处于弹性变形状态,切削力除去后,基体金属趋向恢复,但受到已产生塑性变形的表面层的限制,恢复不到原状,因而在表面层产生残余压应

Under the action of cutting force, the processed surface undergoes strong cold plastic deformation, among which the plastic deformation caused by the extrusion and friction of the tool back face on the processed surface is the most prominent. At this time, the base metal is affected and in an elastic deformation state. After the cutting force is removed, the base metal tends to recover, but is limited by the surface layer that has already undergone plastic deformation and cannot return to its original state, resulting in residual compressive stress in the surface layer

（二）热塑性变形引起的残余应力 Thermoplastic deformation caused tesidual stress

工件加工表面在切削热作用下产生热膨胀,此时基体金属温度较低,因此表层金属产生热压应力,当切削过程结束时,表面温度下降较快,故收缩变形大于里层,由于表层变形受到基体金属的限制,故而产生残余拉应力。切削温度越高,热塑性变形越大,残余拉应力也越大,有时甚至产生裂纹。磨削时产生的热塑性变形比较明显。
The surface of the workpiece undergoes thermal expansion under the action of cutting heat. At this time, the temperature of the base metal is relatively low, resulting in thermal compression stress on the surface metal. When the cutting process is completed, the surface temperature drops rapidly, resulting in greater shrinkage deformation than the inner layer. Due to the limitation of the base metal on the surface deformation, residual tensile stress is generated. The higher the cutting temperature, the greater the thermoplastic deformation, the greater the residual tensile stress, and sometimes even cracks. The thermoplastic deformation generated during grinding is relatively significant.

（三）金相组织变化引起的残余应力 Metallographic structure changes caused residual stress

切削时产生的高温会引起表面层的金相组织变化。不同的金相组织有不同的密度,表面层金相组织变化的结果造成了体积的变化。表面层体积膨胀时,因为受到基体的限制,产生了压应力;反之,则产生拉应力。

The high temperature generated during cutting can cause changes in the metallographic structure of the surface layer. Different metallographic structures have different densities, and the change in surface layer metallographic structure results in a change in volume. When the volume of the surface layer expands, compressive stress is generated due to the limitation of the matrix; On the contrary, tensile stress is generated.

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总之,残余应力即消雄外力成不均匀的温度场等作用后仍面在物体内的自相平衡的内应力,机械加工和强化工艺都引起残余应力,如冷拉、弯曲、切加工,滚压、喷丸铸造、最压,接和金黑热处理等,不均匀里性变形或相变都可能引起残余应力,残余应力一校是有害的,如零件在不适当的处理、焊接成切削加工后,残余应力会引起零件发生曲成曲变形甚至开裂经火或磨雨后表置会出现纹,残余应力的存在有时不会立见表现为缺,当零件在工作中因工作应力与余应力的费加,而使总应力超过强度极阳时,便出现纹和断,零件的残余应力大部分都可通过适当的热处理消,残余应力也有有盐的方面,它可以被控制用来提高零件的疲劳强度和耐性能
In short, residual stress refers to the self equilibrium internal stress that remains in the object after the uneven temperature field caused by external forces is dissipated. Mechanical processing and strengthening processes can cause residual stress, such as cold drawing, bending, cutting, rolling, shot peening casting, maximum pressure, welding, and hot metal treatment. Uneven internal deformation or phase transformation can cause residual stress, and residual stress correction is harmful. For example, after improper treatment, welding, and cutting, residual stress can cause parts to undergo bending deformation or even cracking. After fire or grinding, wrinkles may appear on the surface, and the presence of residual stress sometimes does not appear immediately. When parts are not properly treated or welded, residual stress correction is harmful. When the total stress exceeds the strength limit due to the increase in work stress and residual stress, wrinkles and fractures appear. Most of the residual stress in the parts can be dissipated through appropriate heat treatment, Residual stress also has a salt aspect, which can be controlled to improve the fatigue strength and resistance of parts

消除方法
Elimination Method

一、自然时效 Natural aging

自然时效是通过把零件暴于室外,经过几个月甚至几年的时间,使其尺寸精度达到稳定的一种方法,这种时效方法早已被替润采用,大量的试验研究和生产实践证明,自然时效具有稳定铸件尺寸精度的良好效果

Natural aging is a method of stabilizing the dimensional accuracy of castings by exposing parts to the outdoors for several months or even years. This aging method has long been adopted by lubrication, and extensive experimental research and production practice have proven that natural aging has a good effect on stabilizing the dimensional accuracy of castings

二、热时效 Thermal aging

1用的工艺方法就是进行消除应力的退火,这种方法的特点就是能够大幅度的降低构件的残余应力,尺寸精度稳定,构件加热到400700°c时,技术构件即具有相当的单行,同时具有明显的塑性,这个温度范围称为弹性转变温度。

The process method used is annealing to eliminate stress. The characteristic of this method is that it can significantly reduce the residual stress of the component, with stable dimensional accuracy. When the component is heated to 400700 ° C, the technical component has a considerable single line and obvious plasticity. This temperature range is called the elastic transition temperature.

a.热时效中,退火温度是影响消除残余应力效果的最重要因素
b.热时效保温时间
c.热时效升温速度
d.热时效降泪速度
e.热时效炉的温差
f.工件在炉中的放置与支撑

a. In thermal aging, annealing temperature is the most important factor affecting the effect of eliminating residual stress
b. Thermal aging and insulation time
c. Heat aging and heating rate
d. Heat aging and tear reduction speed
e. Temperature difference of thermal aging furnace
f. Placement and support of workpieces in the furnace

三、振动时效法 Vibratory stress telief

振动时效的实质是以共振的形式给工件施加附加动应力,当附加动应力与残余应力叠加后,达到或超过材料的屈服极限时,工件发生微观或宏观塑性变形,从而降低和均化工件内部的残余应力,并使其尺寸精度达到稳定。

The essence of vibration aging is to apply additional dynamic stress to the workpiece in the form of resonance. When the additional dynamic stress is superimposed with residual stress and reaches or exceeds the yield limit of the material, the workpiece undergoes microscopic or macroscopic plastic deformation, thereby reducing and homogenizing the residual stress inside the workpiece, and achieving stable dimensional accuracy.

其特点有:

1. 投资少
2.生产周期短
3.使用方便
4.适应性强
5.节约能源，降低成本
6.机械性能显著提高
7.符合环保要求
8.操作简单，易于实现机械自动化。

Its characteristics include:

1. Low investment
2. Short production cycle
3. Easy to use
4. Strong adaptability
5. Energy saving and cost reduction
6. Significant improvement in mechanical performance
7. Meets environmental protection requirements
8. Easy to operate and achieve mechanical automation.

可避免金属零件在热时效过程中产生的翘曲变形、氧化、脱碳及硬度降低等缺陷。

It can avoid defects such as warping deformation, oxidation, decarburization, and decreased hardness of metal parts during the thermal aging process.

四、静态过载法 Static overload method

是以静力或静力矩的形式,暂时加载于构件上,并在这种载荷下保持一段时间,从而使零件尺寸精度获得稳定的时效方法。

It is a time effective method of temporarily loading a component in the form of static force or static moment, and maintaining it for a period of time under this load, in order to achieve stable dimensional accuracy of the component.

用于焊接件时需要将载荷加大到使原来应力与附加应力之和接近于材料的屈服极限,才能消除残余应力。

When used for welding components, the load needs to be increased to make the sum of the original stress and the additional stress close to the yield limit of the material in order to eliminate residual stress.

静态过载法的精度稳定性效果,取决于附加应力的大小及应力下保持时间特别指出,静态过载法处理后构件中仍然保持着相当大的残余应力。

The accuracy and stability of the static overload method depend on the magnitude of the additional stress and the holding time under stress. It is particularly pointed out that after being processed by the static overload method, there is still a considerable residual stress in the component.

五、热冲击时效法 Thermal shock method

1970年前后出现的一种新颖的稳定工件尺寸精度的时效工艺法。其实质就是将工件进行快速加热,使加热过程中造成的热应力正好与残余应力叠加,超过材料的屈服极限引起塑性变形,从而使原始残余应力很快松弛并稳定化。

A novel aging process method for stabilizing the dimensional accuracy of workpieces that emerged around 1970. Its essence is to rapidly heat the workpiece, so that the thermal stress caused by the heating process coincides with the residual stress, exceeding the yield limit of the material and causing plastic deformation, thereby quickly relaxing and stabilizing the original residual stress

六、声波时效法 Sonic the statuet of limitations

超声波时效法首先在前苏联诞生,并在发达国家得到推广,该方法起先主要应用于船舶、核潜艇、航空航天等对消除应力非常严格的军事领域。但是由于超声波法只能解决构件表层一定深度内的应力问题,所以相对应用环境较窄,且成本颇高。

The ultrasonic aging method was first born in the former Soviet Union and promoted in developed countries. Initially, this method was mainly applied in military fields such as ships, nuclear submarines, aerospace, etc., where stress relief is very strict. However, due to the fact that the ultrasonic method can only solve the stress problem within a certain depth of the surface layer of the component, the application environment is relatively narrow and the cost is quite high.

诺林钢管 NUOLIN STEEL PIPE
因为专一所以专业 异形管、方管矩管制造专家

辊完成型异形管角部硬度变形规律的研究

THE RESEARCH ON CORNER HARDNESS DEFORMATION LAW OF ROLL FORMING SECTION TUBE

摘要：通过对冷弯成型异型管角部的研究,分析总结出其变形规律。在生产异型管时,避免产生不利因素

Abstract: Through the study of the corners of cold-formed special-shaped pipes, the deformation laws were analyzed and summarized. Avoiding adverse factors during the production of special-shaped pipes

主题词：冷拔成型异型管加工硬化应力分析

Keyword: Analysis of Work Hardening Stress in Roll Bending Shaped Pipes

序言：由圆管加工成异形管、方矩形管的冷拔成型的主要变形方式为内外模具横向弯曲变形,而弯曲最大的部位是方矩异形管的角部。为此,我公司对无缝管20#成型的各种规格方矩型管、异形管进行许多试验,利用硬度仪对现有的方矩形管产品的内外角进行硬度分析。从对方矩形管的成型进行受力分析可知,角部主要变形为弯曲变形,另外附加变形有纵向拉伸变形、扭曲变形等。

Preface: The main deformation mode of cold drawing formed by processing circular tubes into special-shaped tubes and square rectangular tubes is the transverse bending deformation of the inner and outer molds, and the largest bending part is the corner of the square rectangular special-shaped tube. For this purpose, our company conducted many tests on various specifications of square and irregular tubes formed by seamless tube 20 #, and used a hardness tester to analyze the hardness of the inner and outer corners of existing square and rectangular tube products. From the force analysis of the forming of the rectangular tube on the other side, it can be seen that the main deformation at the corners is bending deformation, and additional deformation includes longitudinal tensile deformation, twisting deformation, etc.

试验条件:试验中所用设备,采用试样材质为20#

Test conditions: The equipment used in the experiment is made of a sample material of 20#



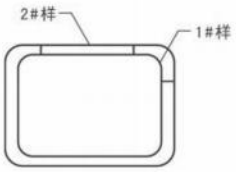
成型方式 Forming Method	冷拔成型 Cold Bending Formed
材质Steel Grade	Q235
长度Length	6m
成型速度Forming Speed	12m/min

试验目的:采用同一钢种、不同批次、不同外径尺寸的材料制成不相同成品的方、矩形及异型管的形状,尺寸和角部成型后的硬度进行测试比较,表1为试验条件。

Test purpose: To compare the shape, size, and hardness of square, rectangular, and irregular pipes made from materials of the same steel grade, different batches, and different outer diameter sizes. Table 1 shows the test conditions.

试验结果和考察:加工后不同位置的硬度比较:取一矩形管为样,分别在角部、平直段取样(如图2所示)做硬度测量,其结果如下表2、3和图3、4、5所示。

Experimental results and investigation: Comparison of hardness at different positions after processing: A rectangular tube was taken as a sample, and hardness measurements were taken at the corners and straight sections (as shown in Figure 2). The results are shown in Tables 2, 3, and Figures 3, 4, and 5.



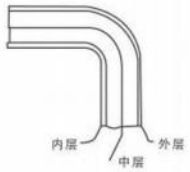


表2 取样位置

表21#、2#样周向硬度分布

1#样	外层	235	238	231	227	234	244	253	237	276	261	244	253	258	265
	中层	209	209	229	218	212	209	203	200	229	209	208	224	222	205
	内层	286	315	305	317	320	335	323	377	361	389	359	343	389	368
2#样	外层	194	201	208	229	220	208	220	217	213	226	211	211	220	238
	中层	186	189	185	181	188	173	184	177	190	179	180	178	178	185
	内层	189	196	203	203	199	193	193	201	198	186	194	190	195	208

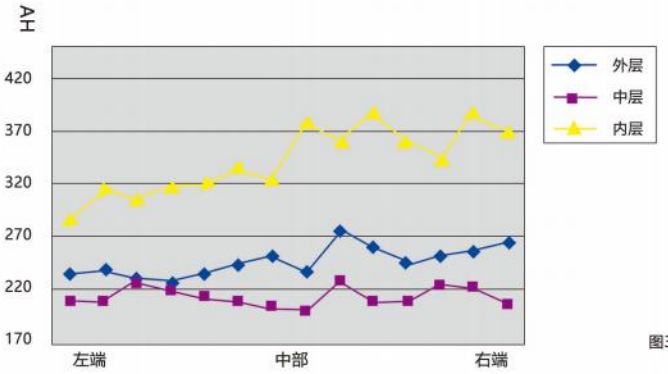


图3 角部1#样件周向硬度分布图

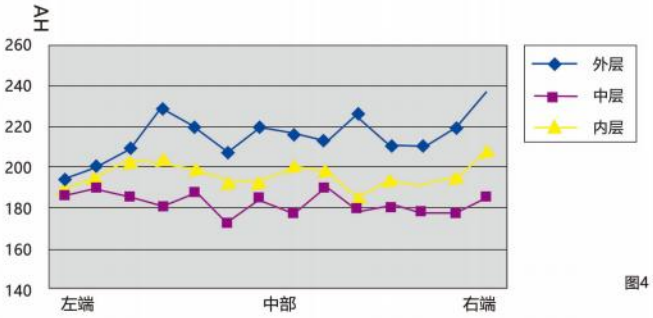


图4 平直段2#样件周向硬度分布图

原料焊接圆管外部的硬度分布如下：

外层	173	175	170	173	172	170	161	180	173	169	170	167	170	180	180	171
中层	168	173	173	171	172	169	169	169	181	176	164	169	173	174	186	172
内层	179	158	179	177	179	172	180	176	169	171	183	166	181	175	176	166

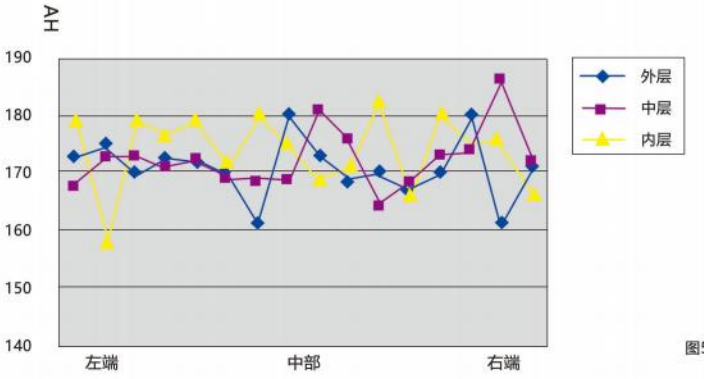


图5 圆管焊接外部周向硬度分布

通过以上的图表数据可以分析出如下结果:比较1#、2#试样的硬度,1#试样的硬度值高于2#试样,主要是因为1#试样在变形过程中有弯曲部分,变形量较2#试样大,由于加工硬化作用使Hv1#>Hv2#,且在1#、2#试样中,Hv内>Hv外>Hv中;就1#、2#试样相比,2#的硬度分布均匀,1#硬度外层起伏较大,这主要是因为1#是角部,变形量大,内外表层表面应力状态不同。外表面为拉应力,内表面为压应力。内层二向压应力使微观晶粒组织变的细小致密,由于晶粒细化作用则内层硬度最高;在外层受两向拉应力,使之微观结构变得细长,内应力增加,硬度也较高;而中部由于是冷弯生产,只有最外层轧辊施力使之变形,因此弯曲变形作用一般渗透不到中层,故硬度较低,使之从断面上看,内、中、外变形不均,硬度呈现内高,外次之,中心层最小的现象。就成品与原料相比,原料硬度分布均匀,成品分布不均匀且硬度值较高,同样还是由于加工硬化,金属流动不均性造成的。其平均的硬度差值如下:

Based on the above chart data, the following results can be analyzed: Comparing the hardness values of samples 1 # and 2 #, the hardness value of sample 1 # is higher than that of sample 2 #, mainly because sample 1 # has a bending part during the deformation process, and the deformation amount is larger than that of sample 2 #. Due to work hardening, Hv1 #>Hv2 #, and in samples 1 # and 2 #, Hv inside>Hv outside>Hv inside; Compared to the 1 # and 2 # samples, the hardness distribution of 2 # is uniform, and the outer layer of 1 # hardness fluctuates greatly. This is mainly because 1 # is a corner, with a large amount of deformation, and the surface stress state of the inner and outer layers is different. The outer surface is subjected to tensile stress, while the inner surface is subjected to compressive stress. The two-dimensional compressive stress in the inner layer causes the microstructure to become finer and denser, and due to the grain refinement effect, the hardness of the inner layer is the highest; Subjected to biaxial tensile stress in the outer layer, the microstructure becomes slender, the internal stress increases, and the hardness is also higher; Due to the cold bending production in the middle, only the outermost roller exerts force to deform it. Therefore, the bending deformation effect generally does not penetrate the middle layer, resulting in lower hardness. From the perspective of the cross-section, the internal, middle, and external deformations are uneven, and the hardness shows a phenomenon of high internal, secondary external, and minimum central layer. Compared with raw materials, the hardness distribution of raw materials is uniform, and the distribution of finished products is uneven with higher hardness values. This is also due to work hardening and uneven metal flow. The average hardness difference is as follows:

内表层：Av方矩型管—Av圆管=158

外表层：Av方矩型管Av圆管=90

中心层：Av方矩型管—Av圆管=52

对于复杂截面的异型管(如图6所示)

角部硬度分布情况见下图7、8、9、10和表3、4

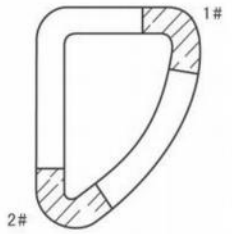


图5 异型管试样

周向 径向	1	2	3	4	5	6	7	8	9	10	11	12	13
1	169.8	176.5	188.3	177.2	190.6	183.7	190.6	186.9	177.9	166.9	154.7	152.4	153
2	184.5	191.3	193	216.8	181.5	177.1	173.7	188.3	186	165.4	160	144.3	149.4
3	172	181.5	174.7	198	154.7	177.2	157	168.9	170.3	153.1	157	154.2	146.9
4	183.7	180	193.8	197.1	160.7	154.2	147.5	153	150.8	149.1	158.9	148.6	147
5	179.7	188.3	183.8	210.7	153	145.3	141.2	143.8	132.1	144.3	157.4	150.8	144.8
6	177	180	177.2	203.1	143.8	134	145.3	127.2	139.2	139.2	161.3	153.6	146.4
7	180.8	175.8	186.7	182.2	145.9	146	153.6	144.8	160	150.2	155.9	134.7	145.3
8	189.4	186.7	197.9	186.4	155.3	163.8	163.8	163.8	153	157	158.3	141.2	142.2

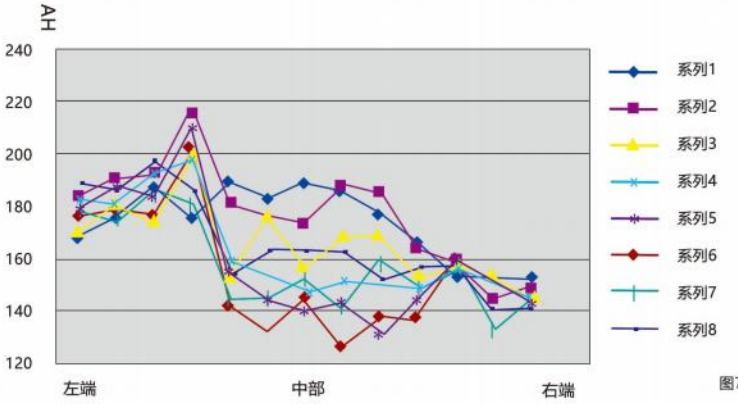


图7 1#件周向硬度分布图

周向 径向	1	2	3	4	5	6	7	8	9	10	11	12	13
1	157.7	145.9	162.2	186	198.4	204.8	195.9	195.9	167.6	152.4	151.6	152.4	153
2	147	153.9	168.9	190.6	208.9	191.8	204.8	204.8	158	153.6	142.2	144.3	149.4
3	149.4	152.7	162.5	189	199.6	175	189.9	189.9	167	150.2	151.3	154.2	146.9
4	150.2	158.9	165.1	177.2	206.6	163.8	205.3	205.3	171.3	157.3	145.9	148.6	147
5	151.6	162.2	164.7	183	180.4	148	183	183	170.3	152.7	150.2	150.8	144.8
6	151.3	161.9	166.7	168.3	169	148.3	162.2	162.2	155	144	146	153.6	146.4
7	150.8	154.4	160.3	178.2	151.9	161.3	156.2	156.2	157.7	146.4	146.9	134.7	145.3
8	153.6	158.3	165	165	157.1	180	165.1	165.1	153	150.8	142.7	141.2	142.2

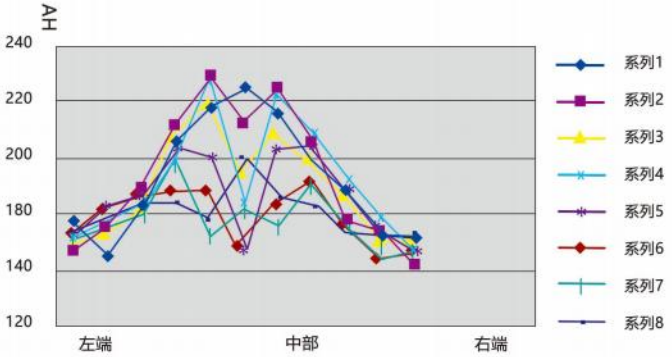


图8 2#件周硬度分布图

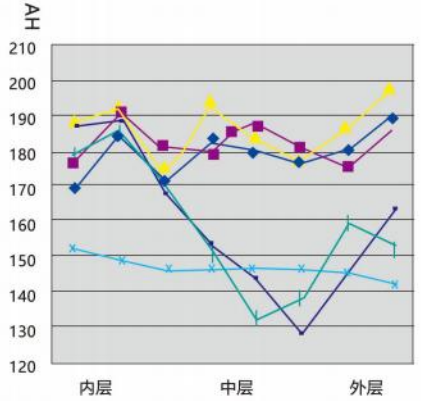


图9 1#件径向硬度分布



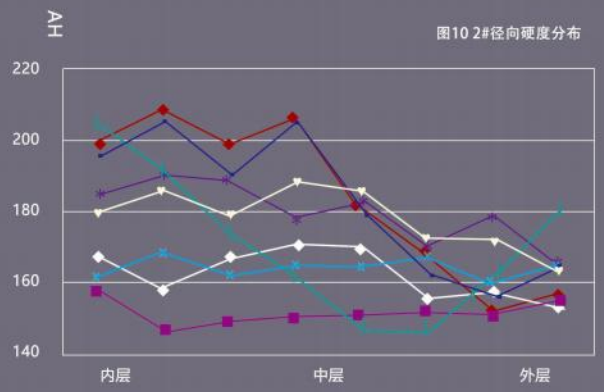


图10 2#径向硬度分布

由以上图表可见大变形的异型管较普通的方矩型管硬度分布规律性不明显。1#样件其角部近90度变形量较2#样件小,其规律较明显,周向硬度排布为:内层硬度>外层硬度>中心层硬度,而变形量较大的2#样件它的周向硬度分布较杂乱,总的趋势为:内层硬度>外层硬度>中心层硬度。其间各层间硬度大小有交叉现象,主要是因为变形量过大,金属流动不均匀。

From the above chart, it can be seen that the hardness distribution pattern of large deformed irregular pipes is not obvious compared to ordinary rectangular pipes. The deformation of the corner of sample 1 # at nearly 90 degrees is smaller than that of sample 2 #, and the pattern is more obvious. The circumferential hardness distribution is: inner layer hardness>outer layer hardness>center layer hardness, while the circumferential hardness distribution of sample 2 # with larger deformation is more disorderly, and the overall trend is: inner layer hardness>outer layer hardness>center layer hardness. There is a cross phenomenon in the hardness values between the layers, mainly due to excessive deformation and uneven metal flow.

从图中曲线可看出,在每一条曲线上都有内、中、外层的点,曲线的起伏也就可见三层硬度大小的不同。该曲线图反映的规律同周向硬度分布情况一样:一般为内层硬度最高,外层次之,中心层最小。

From the curve in the graph, it can be seen that there are inner, middle, and outer points on each curve, and the fluctuation of the curve also shows the different hardness sizes of the three layers. The curve reflects the same pattern as the circumferential hardness distribution: generally, the inner layer has the highest hardness, the outer layer has the lowest, and the central layer has the smallest.

1#样件反映的该规律较明显,2#样件稍有区别之处即左端一条经向曲线表现得中心层处硬度不是最小的,这主要是2#样件是异型管中小角部,它的变形量最大,因此径向中心层也能渗透到内外层的变形,也有一定的硬化作用,硬度提高。而且变形量次之则反映的规律正常。

The pattern reflected by sample 1 is more obvious, while sample 2 has a slight difference in that a longitudinal curve at the left end shows that the hardness at the center layer is not the smallest. This is mainly because sample 2 is a small corner of an irregular tube, which has the largest deformation. Therefore, the radial center layer can also penetrate the deformation of the inner and outer layers, and has a certain hardening effect, resulting in an increase in hardness. Moreover, the deformation amount followed by it reflects a normal pattern.

结论:根据以上的结果归纳如下主要变形规律:角部的硬度普遍高于平直部,且试件内层硬度最高,外层次之中心层的硬度最低。但对于异型管有时中心层硬度并不比外层低,这是因为变形量大,金属流动不均匀的缘故。

Conclusion: Based on the above results, the main deformation patterns can be summarized as follows: the hardness of the corners is generally higher than that of the straight parts, and the hardness of the inner layer of the specimen is the highest, while the hardness of the central layer of the outer layer is the lowest. But for irregular pipes, sometimes the hardness of the central layer is not lower than that of the outer layer, because of the large deformation and uneven metal flow.

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钢材知识
Steel Knowledge

各种钢材的理论重量计算公式及示例

THEORETICAL WEIGHT CALCULATION FORMULAS AND EXAMPLES OF VARIOUS KINDS OF STEEL PRODUCTS

计量单位为公斤 The measuring unit is Kilograms: kg

钢的密度为 Density of steel is: 7.85g/cm³

名称 name / 单位 unit	计算公式 computational formula	符号意义 significance of symbol	计算举例 calculation example
圆钢 盘条 (kg/m)	W=0.006165XdXd	d=直径mm	直径100mm的圆钢，求每m重量。每m重量=0.006165X100²=61.65kg
螺纹钢 (kg/m)	W=0.00617XdXd	d=断面直径mm	断面直径为12mm的螺纹钢，求每m重量。每m重量=0.00617X12²=0.89kg
钢管（包括无缝钢管及焊接钢管kg/m)	W=0.02466XS(D-S)	D=外径 S=壁厚	外径为60mm壁厚4mm的无缝钢管，求每m重量。每m重量=0.02466X4X（60-4）=5.52kg
六角钢 (kg/m)	W=0.006798XsXs	s=对边距离mm	对边距离50mm的六角钢，求每m重量。每m重量=0.006798X50²=17kg
八角钢 (kg/m)	W=0.0065XsXs	s=对边距离mm	对边距离80mm的八角钢，求每m重量。每m重量=0.0065X80²=41.62kg
等边角钢 (kg/m)	W=0.00785X[d(2b-d)]+0.215(R²-2r²)]	b=边宽 d=边厚 R=内弧半径 r=端弧半径	求20mmX4mm等边角钢的每m重量。4mmX20mm等边角钢的R为3.5，r为1.2，则每m重量=0.00785X[4x(2x20-4)+0.215x(3.5²-2x1.2²)]=1.15kg
不等边角钢 (kg/m)	W=0.00785X[d(B+b-d)]+0.215(R²-2r²)]	B=长边宽 b=短边宽 d=边厚 R=内弧半径 r=端弧半径	求30mmX20X4mm不等边角钢的每m重量。30X20X4不等边角钢的R为3.5，r为1.2，则每m重量=0.00785X[4x(30+20-4)+0.215x(3.5²-2x1.2²)]=1.46kg

名称 name / 单位 unit	计算公式 computational formula	符号意义 significance of symbol	计算举例 calculation example
槽钢 (kg/m)	W=0.00785X[hd+2t(b-d)+0.349(R²-r²)]	h=高 b=腿长 d=腰厚 t=平均腿厚 R=内弧半径 r=端弧半径	求80mmX43mmX5mm的槽钢的每m重量。该槽钢t为8，R为8，r为4，则每m重量=0.00785X[80X5+2X8X(43-5)+0.349X(8²-4²)]=8.04kg
工字钢 (kg/m)	W=0.00785X[hd+2t(b-d)+0.615(R²-r²)]	h=高 b=腿长 d=腰厚 t=平均腿厚 R=内弧半径 r=端弧半径	求250mmX118mmX10mm的工字钢的每m重量。该工字钢t为13，R为10，r为5，则每m重量=0.00785X[250X10+2X13X(118-10)+0.615X(10²-5²)]=42.03kg
钢板 (kg/m²)	W=7.85Xd	d=厚	厚度4mm的钢板，求每㎡重量。每㎡重量=7.85X4=31.4kg
方管、矩管 (kg/m)	W=0.00785XbX4Xd	b=边长mm d=厚mm	边长20mm，厚3.0mm的方管，求每m重量。每m重量=0.00785X20X4X3=1.88kg

毫米与英寸换算表

Millimeter and Inch Conversion Table

毫米 (mm)	英寸 (in)	毫米 (mm)	英寸 (in)	毫米 (mm)	英寸 (in)	毫米 (mm)	英寸 (in)	毫米 (mm)	英寸 (in)
0.01	0.0004	0.01	0.0039	1	0.0394	10	0.394	100	3.937
0.02	0.0008	0.02	0.0079	2	0.0787	20	0.787	200	7.874
0.03	0.0012	0.03	0.0118	3	0.1181	30	1.181	300	11.811
0.04	0.0016	0.04	0.0158	4	0.1575	40	1.575	400	15.748
0.05	0.0020	0.05	0.0197	5	0.1969	50	1.969	500	19.685
0.06	0.0024	0.06	0.0236	6	0.2362	60	2.362	600	23.622
0.07	0.0028	0.07	0.0276	7	0.2756	70	2.756	700	27.559
0.08	0.0032	0.08	0.0315	8	0.3150	80	3.150	800	31.496
0.09	0.0035	0.09	0.0354	9	0.3543	90	3.543	900	35.433

1英寸=25.4毫米

认识山东

Understanding of Shandong

中华水上古城（聊城古城）

Chinese Water Ancient City (Liaocheng Ancient City)



中华水上古城，即东昌古城，也称聊城古城，面积仅有1平方公里，却被6.3平方公里的湖水包围，其“城中有水、水中有城、城水一体、交相辉映”的水城风貌美仑美奂，天圆地方的城市形态全球独有。古城坐落在聊城市区内东昌湖中间，北宋时期的城垣。城呈正方形，总面积约100万平方米。城墙始建于宋熙宁三年（1070），初为土城。明洪武五年（1372），东昌平山卫指挥佥事陈镛改筑为砖城。城墙周长3.5千米，高11.7米，顶宽6.7米，基厚11.7米。内墙用三合土夯筑，外墙用砖石砌垒。城设4门，上筑门楼，外设瓮城。南、东、西瓮城为扭头门，南门东向似凤头，东、西门南向似凤翅，北门北向似凤尾，故名“凤凰城”。四城门楼皆重檐歇山，四角飞翅，东曰“春熙”，西曰“清远”，南曰“正德”，北曰“宣武”。明万历七年（1579），城墙上又建垛口2700余个、敌楼27座；4城门楼更名，东曰“寅宾”，西曰“纳日”，南曰“南熏”，北曰“锁钥”。各个城门均有水门、吊桥。城东北角、西北角原有“望岳”“绿云”2楼。城高大坚固，易守难攻，大有高屋建瓴、睥睨四邻之势，又有“能陷不失的凤凰城”之说。

The Chinese Water Ancient City, also known as Dongchang Ancient City, also known as Liaocheng Ancient City, has an area of only 1 square kilometer, but is surrounded by a 6.3 square kilometer lake. Its "water in the city, water in the city, and city water in one, complement each other" water city style is magnificent, and the urban form of a round sky and a unique place is unique to the whole world. The ancient city is located in the middle of Dongchang Lake in the urban area of Liaocheng, which was a city wall during the Northern Song Dynasty. The city is square in shape, with a total area of approximately 1 million square meters. The city wall was first built in the third year of the Xining period of the Song Dynasty (1070) and was originally a earthen city. In the fifth year of Ming Hongwu (1372), Chen Yong, the commander of Dongchang Pingshanwei, rebuilt it as a brick city. The perimeter of the city wall is 3.5 kilometers, with a height of 11.7 meters, a top width of 6.7 meters, and a foundation thickness of 11.7 meters. The inner wall is constructed with rammed concrete, and the outer wall is built with bricks and stones. There are four gates in the city, with a gate tower built on top and a walled city on the outside. The South, East, and West Wengcheng are the twisting gates. The South Gate faces east like a phoenix head, the East and West Gates face south like phoenix wings, and the North Gate faces north like a phoenix tail, hence the name "Phoenix City". The four city gates all have double eaves and rest on the mountain, with four corners flying upwards. To the east, they are called "Chunxi", to the west, they are called "Qingyuan", to the south, they are called "Zhengde", and to the north, they are called "Xuanwu". In the seventh year of the Ming Wanli era (1579), more than 2700 battlements and 27 enemy towers were built on the city walls; The four city gate towers were renamed, with "Yinbin" in the east, "Nari" in the west, "Nanxun" in the south, and "Lock Key" in the north. Each city gate has water gates and suspension bridges. The original 2nd floor of "Wangyue" and "Lvyun" were located in the northeast and northwest corners of the city. The city is tall and sturdy, easy to defend but difficult to attack, with a commanding presence that overlooks its neighbors. It is also known as the "Phoenix City that can be captured without losing.".

光岳楼
Guangyue Tower



古城为在明代遗址上的复建建筑，以闻名遐迩的光岳楼为中心，利用十字步行商业街将城区用地分为四块。十字大街为商业步行街，两侧以传统风情的商业为主。城墙始建于宋熙宁三年(1070)，初为土城。明洪武五年(1372)，东昌平山卫指挥佥事陈镛改筑为砖城。内墙用三合土夯筑，外墙用砖石砌垒。城设4门，上筑门楼，外设瓮城。南、东、西瓮城为扭头门，南门东向似凤头，东、西门南向似凤翅，北门北向似凤尾，故名“凤凰城”。城区街道，经纬分明，垂直交叉，形成棋盘方格网状骨架。古城利用十字步行商业街将城区用地分为四块。十字大街为商业步行街古城区共有九街十八巷、七十二胡同。历史的渊源给东昌古城留下了繁多的文化艺术和生活气息。民间剪纸、东昌葫芦、木版年画等民间艺术，还有古城的状元街、考院街、十县胡同、火神庙街、关帝庙街等传统风貌街……提起这些文化见证，古城老居民津津乐道。

The ancient city is a rebuilt building on the site of the Ming Dynasty, with the famous Guangyue Tower as the center, and the urban land is divided into four sections using a cross pedestrian commercial street. Cross Street is a commercial pedestrian street, with traditional commercial elements on both sides. The city wall was first built in the third year of the Xining period of the Song Dynasty (1070) and was originally a earthen city. In the fifth year of Ming Hongwu (1372), Chen Yong, the commander of Dongchang Pingshanwei, rebuilt it as a brick city. The inner wall is constructed with rammed concrete, and the outer wall is built with bricks and stones. There are four gates in the city, with a gate tower built on top and a walled city on the outside. The South, East, and West Wengcheng are the twisting gates. The South Gate faces east like a phoenix head, the East and West Gates face south like phoenix wings, and the North Gate faces north like a phoenix tail, hence the name "Phoenix City". The streets in the urban area have clear latitude and longitude, intersecting vertically, forming a checkerboard grid like skeleton. The ancient city uses a cross pedestrian commercial street to divide the urban land into four sections. Cross Street is a commercial pedestrian street in the ancient city area, with a total of nine streets, eighteen alleys, and seventy-two alleys. The historical origins have left Dongchang Ancient City with a rich cultural, artistic, and living atmosphere. Folk Paper Cuttings, Dongchang gourd, woodcut New Year pictures and other folk arts, as well as the Zhuangyuan Street, Kaoyuan Street, Shixian Hutong, Huoshen Temple Street, Guandi Temple Street and other traditional style streets in the ancient city... When these cultural witnesses are mentioned, the old residents of the ancient city enjoy talking about them.

诺林钢管 NUOLIN STEEL PIPE
因为专一所以专业 异形管、方管矩管制造专家

聊城东昌湖旅游区
Liaocheng Dongchang Lake Tourist Area

东昌湖风景区，为国家AAAA级旅游景区。以水面辽阔、风景秀丽、环绕于中华水上古城区的东昌湖为依托，驰名中外的京杭大运河穿景区而过，集中体现了“水、古、文”的特色，营造出聊城“城中有湖，湖中有城，城湖河一体”的独特风貌。风景区内错落散布着光岳楼，铁塔，山陕会馆，海源阁等名胜古迹，还包含了聊城垂钓基地、东昌湖游乐园、江北水寨、沙滩浴场、湖心岛、荷香岛、腾龙广场、水城明珠大剧场、二十一孔桥、湖滨公园、金凤广场等一大批游览景点和设施。东昌湖始建于宋熙宁三年（公元1070年），在原护城河的基础上经历代开挖而成，现有水域6.6平方公里，为江北地区罕见的大型城内湖泊。东昌湖引黄河水为源，常年水深3 - 5米，湖水清澈，无任何工业污染；景色宜人，令游客流连忘返。东昌湖中心是已有千年历史的1平方公里的正方形聊城古城。古城风貌保存完好，以古城正中的光岳楼为中心，向四面辐射，形成东西南北四条古城区干道，其它大街小巷，也都是经纬分明，垂直交叉，形成棋盘方格网状骨架。古老的京杭运河两岸，街巷布列，各种店铺民居，随坡就势，依河而建。条石铺砌的大小码头，株株苍劲的古槐，以及宋代隆兴寺铁塔，国家重点文物、清代建筑山陕会馆，仍会使人们体味到昔日运河漕运鼎盛时期古聊城的繁荣和辉煌。东昌湖风景名胜区文化的内涵深厚，旅游资源丰富。千年的历史沧桑，层出不穷的杰出人物，造就了东昌湖风景名胜区丰厚的文化背景和底蕴。迷人的自然风光，众多的文化景点，也汇成了东昌湖风景名胜区的丰富旅游资源。

Dongchang Lake Scenic Area is a national AAAA level tourist attraction. Relying on Dongchang Lake, which has a vast water surface, beautiful scenery, and is surrounded by the ancient urban area of China, the famous Beijing Hangzhou Grand Canal passes through the scenic area, reflecting the characteristics of "water, antiquity, and culture", creating a unique style of Liaocheng with "a lake in the city, a city in the lake, and an integrated city, lake, and river". The scenic area is dotted with famous scenic spots and historical sites such as Guangyue Tower, Iron Tower, Shanshan Guild Hall, Haiyuan Pavilion, etc. It also includes a large number of tourist attractions and facilities such as Liaocheng Fishing Base, Dongchang Lake Amusement Park, Jiangbei Water Village, Beach Bathing Beach, Huxin Island, Hexiang Island, Tenglong Square, Shuicheng Mingzhu Grand Theater, Twenty One Arch Bridge, Hubin Park, Jinfeng Square, etc. Dongchang Lake was first built in the third year of the Xining reign of the Song Dynasty (1070 AD), and was excavated through generations on the basis of the original moat. It currently has a water area of 6.6 square kilometers and is a rare large-scale urban lake in the Jiangbei region. Dongchang Lake draws water from the Yellow River as its source, with a perennial depth of 3-5 meters. The lake water is clear and free from any industrial pollution; The scenery is pleasant, making tourists linger and forget to leave. The center of Dongchang Lake is a 1000 year old square kilometer ancient city of Liaocheng. The ancient city's appearance is well preserved, with the Guangyue Tower in the center radiating in all directions, forming four main roads in the ancient city area, east, west, north, south. Other streets and alleys are also clear in longitude and latitude, intersecting vertically, forming a checkerboard grid network skeleton. On both sides of the ancient Beijing Hangzhou Canal, streets and alleys are arranged, with various shops and houses built along the slope and along the river. The large and small wharves paved with stone, the vigorous ancient locusts, the iron tower of Longxing Temple in the Song Dynasty, the national key cultural relics, and the Shanshan Guild Hall built in the Qing Dynasty will still make people appreciate the prosperity and glory of the ancient Liaocheng in the heyday of canal transport. The cultural connotation of Dongchang Lake Scenic Area is profound, and the tourism resources are abundant. The thousands of years of historical vicissitudes and the emergence of outstanding figures have created a rich cultural background and heritage in the Dongchang Lake Scenic Area. The charming natural scenery and numerous cultural attractions have also converged into the rich tourism resources of Dongchang Lake Scenic Area.



景阳冈/狮子楼
Jing yang gang/Lion Tower







景阳冈旅游区，是《水浒传》中描述的武松打虎处，也是龙山文化城遗址所在地，是水浒旅游线上的重点景区。
主要景点有三碗不过冈酒店、乡民告示处、县衙告示处、山神庙、武松打虎处、石碑、虎啸亭、武松庙、湖心岛、钓鱼台、碑林、虎池、猴山、鹿苑、箭场等20余处。

Jingyanggang Tourist Area is the Wusong Tiger Hunting Site described in "Water Margin" and also the location of the Longshan Cultural City ruins. It is a key scenic spot on the Water Margin tourism line.
There are more than 20 main tourist attractions, including the San Wan Dao Gang Hotel, Township Notice Office, County Government Notice Office, Mountain God Temple, Wusong Tiger Fighting Office, Stone Tablets, Tiger Roaring Pavilion, Wusong Temple, Huxin Island, Diaoyutai, Beilin, Tiger Pond, Monkey Mountain, Deer Garden, Arrow Field, etc.

狮子楼坐落在阳谷县城大隅首西南角，始建于宋景祐三年，现为水浒旅游线上重要景点。“水浒”英雄武松为兄报仇在此怒杀西门庆，狮子楼因而名扬四海。此楼为宋式建筑，二层五开间三进深，青砖灰瓦,飞檐斗拱，雕梁画栋，雄伟壮观。楼前列石狮两对；楼内陈列水浒人物塑像，形态逼真，生动传神。

The Lion Tower is located in the southwest corner of Yanggu County. It was first built in the third year of the Jingyou reign of the Song Dynasty and is now an important tourist attraction on the Water Margin tourism line. The hero of the Water Margin, Wu Song, avenged his brother and angrily killed Ximen Qing here, making the Lion Tower famous all over the world. This building is a Song style building, with five bays on the second floor and three entrances deep. It is magnificent with blue bricks and grey tiles, cornices and arch of wooden architecture, and carved beams and painted rafters. Two pairs of stone lions in front of the building; The water Margin figures are displayed in the building, with lifelike and vivid forms.

东阿阿胶城/东阿阿胶
Dong'e ass hide glue City
Dong'e ass hide glue

东阿阿胶城，位于东阿县县城西郊洛神湖公园内，是集阿胶养生、影视剧拍摄、休闲旅游、中医药文化宣传教育于一体的综合性文化旅游地。现为国家AAAA级景区、山东省重点文化产业项目，是“到山东不得不去的100个地方”之一。

阿胶味甘、性平，质润无毒，入肝、肾、肺三经，两千多年来一直被公认为治病圣药，滋补佳品，滋补药用两宜，具有滋阴补血，润燥止血的功能，补血效果显著，李时珍《本草纲目》誉为"补血圣药"，善于治疗血虚引起的各种病症，并能通过补血起到滋润皮肤的作用，有利于皮肤保健，服用阿胶后会使脸色红润，肌肤细嫩，有光泽；并能调经安胎、增强体质、延缓衰老、提高免疫力、改善睡眠、健脑益智、抗疲劳、抗辐射、提高血红蛋白含量、升高白细胞、改善骨密度和促进钙吸收，有助于防治包括癌症在内的多种疾病，男女老少都可以服用。

Dong'e ass hide glue City, located in Luoshen Lake Park in the western suburb of Dong'e County, is a comprehensive cultural tourism destination integrating ass hide glue health care, film and television drama shooting, leisure tourism, and traditional Chinese medicine culture publicity and education. It is currently a national AAAA level scenic spot and a key cultural industry project in Shandong Province, and is one of the 100 places that must be visited in Shandong.

Ass hide glue has a sweet taste, flat nature, moist and non-toxic quality. It enters the three meridians of the liver, kidney and lung. For more than 2000 years, it has been recognized as the holy medicine for curing diseases. It is a good tonic, and it is suitable for medicinal purposes. It has the functions of nourishing yin and blood, moistening dryness and stopping bleeding. It has a remarkable effect of blood tonic. Li Shizhen's Compendium of Materia Medica is known as the "holy medicine for blood tonic". It is good at treating various diseases caused by blood deficiency, and can play a role in nourishing the skin through blood tonic, which is conducive to skin health care. Taking ass hide glue will make the face ruddy, skin tender and shiny; And it can regulate menstruation and prevent miscarriage, enhance physical fitness, delay aging, improve immunity, improve sleep, enhance brain and intelligence, resist fatigue, resist radiation, increase hemoglobin content, increase white blood cells, improve bone density, and promote calcium absorption, which helps prevent and treat various diseases including cancer. It can be taken by men, women, and children of all ages.



