



ENGINEERED FORMED TUBE SOLUTIONS

产品与液压成形技术图册

PRODUCT & HYDROFORMING TECHNOLOGY CATALOG

异形管件、材料选择、CAE 成形分析与模具开发的工程参考。

An engineering reference for formed tubes, material selection, CAE forming analysis and tooling development.



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按技术基础、材料与分析、应用产品及询盘信息组织。

Organized around process fundamentals, materials and analysis, product applications, and RFQ information.

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液压成形原理

HYDROFORMING FUNDAMENTALS

液压成形以受控液体压力作为成形载荷，使管坯在封闭模腔内贴合型面。轴向补料、内压路径与材料流动需协同设定。

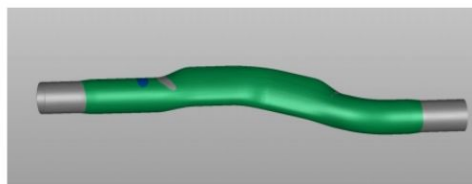
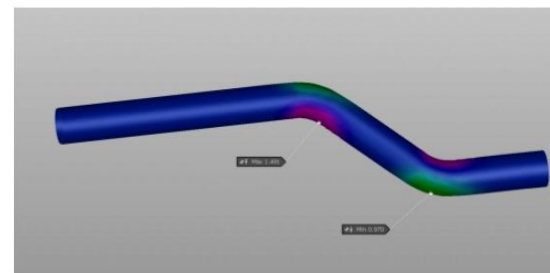
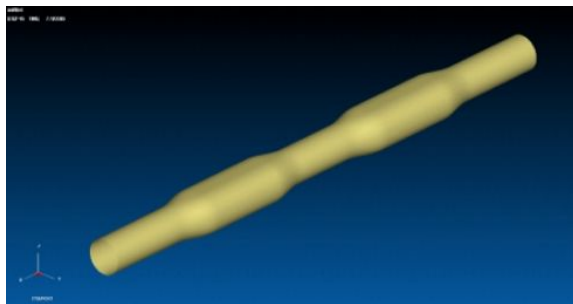
Hydroforming uses controlled fluid pressure to expand a tube blank against a closed die cavity. Axial feed, pressure path and material flow must be set together to achieve the target geometry.

PROCESS PRINCIPLES

01 封闭模腔定义外形
Closed die defines the outer form

02 内压推动管坯胀形
Internal pressure expands the blank

03 轴向补料管理局部减薄
Axial feed manages local thinning



管材液压成形流程

TUBE HYDROFORMING PROCESS

典型路线由管坯准备、预成形、合模与密封、加压补料、保压定形及切割检验组成。复杂件可结合充液弯曲和局部胀形。

A typical route covers blank preparation, preforming, die closing and sealing, pressure-and-feed control, calibration, trimming and inspection. Complex parts may combine fluid-assisted bending with local expansion.

01

管坯准备
Blank preparation

02

弯曲或预成形
Bending or preforming

03

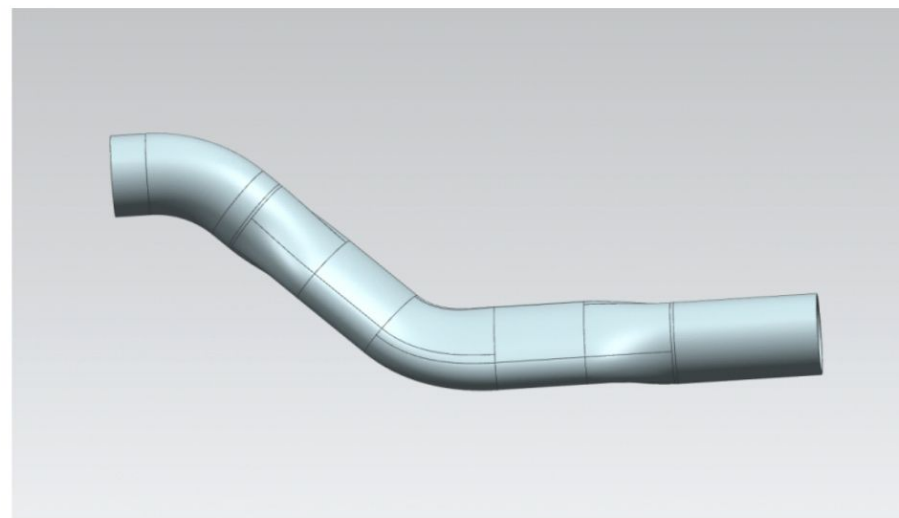
合模与密封
Die closing and sealing

04

加压与轴向补料
Pressurization and axial feed

05

定形、切割与检验
Calibration, trimming and inspection



可选材料：铝合金、不锈钢与钢材

MATERIAL OPTIONS: ALUMINUM, STAINLESS STEEL & STEEL

选材需同时评估延展性、批次稳定性、表面质量、强度与后续工艺兼容性。牌号仅作原资料中的典型选项参考。

Material selection considers ductility, batch stability, surface quality, strength and compatibility with downstream operations. Grades are shown only as typical options identified in the source material.

铝合金 Aluminum alloys

3003 / 5052 / 6061 / 6063 / 6082

汽车结构件、自行车车架、运动器材与家具结构件
Automotive structures, bicycle frames, sports equipment and furniture structures

奥氏体不锈钢 Austenitic stainless steel

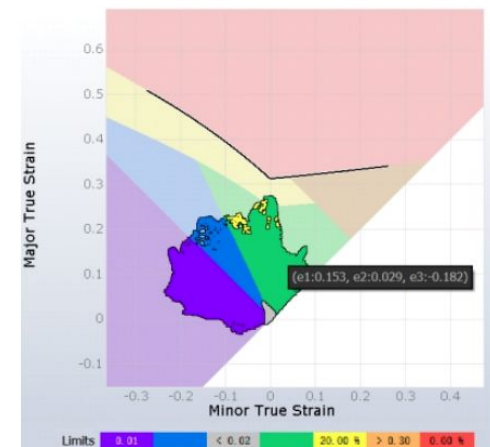
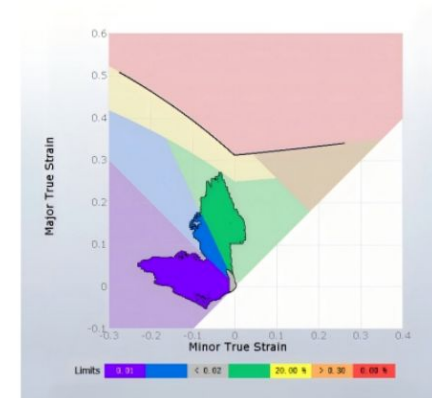
304 / 304L / 316 / 316L

排气与消音管件、卫浴五金、管接头与壳体
Exhaust and silencer tubes, sanitary hardware, fittings and housings

低碳钢与高强钢 Low-carbon and high-strength steels

Q235 / SPCC / SPCD / SPCE / SAE 1008 / 1010 / 1020

底盘、悬架及一般结构件，耐蚀需求由材料与表面处理共同满足
Chassis, suspension and general structures, with corrosion requirements addressed through material and surface treatment



可选材料：钛合金与铜合金

MATERIAL OPTIONS: TITANIUM & COPPER ALLOYS

钛材可用于需兼顾质量和耐蚀性的异形管；铜及铜合金具有良好的导热、导电和成形特性。厚度、材料状态与胀形比需结合零件几何验证。

Titanium may suit formed tubes where mass and corrosion resistance are important. Copper and copper alloys combine useful thermal, electrical and forming properties. Thickness, temper and expansion ratio require validation against part geometry.

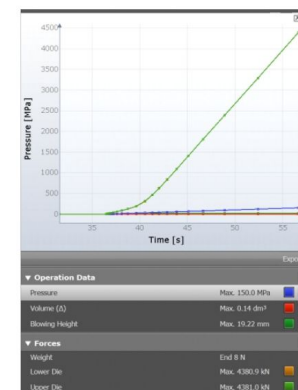
纯钛与钛合金

Commercially pure titanium and titanium alloys

TA1 listed in source material

摩托车排气管及图纸指定的耐蚀异形管

Motorcycle exhaust tubes and corrosion-resistant formed tubes specified by drawing



铜及铜合金

Copper and copper alloys

T2 / H62 / H65 / H68 / QSn6.5-0.1

换热管件、电气连接件、卫浴五金与装饰件

Heat-exchanger fittings, electrical connectors, sanitary hardware and decorative parts



CAE 成形分析

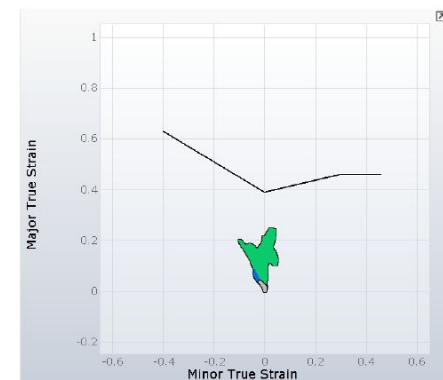
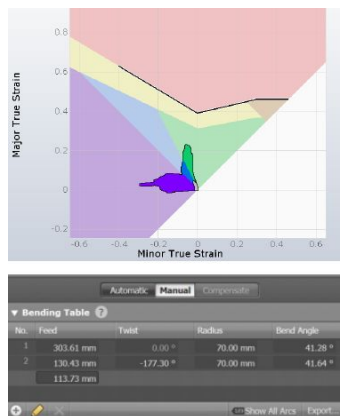
CAE FORMING ANALYSIS

成形仿真用于对比管坯形状、压力路径、补料条件和模具几何。极限成形、壁厚分布与应变趋势可帮助识别开裂和起皱风险。

Forming simulation compares blank geometry, pressure path, feed conditions and die geometry. Forming limits, thickness distribution and strain trends help identify potential splitting and wrinkling before tooling trials.

开裂风险 Split risk

检查局部主应变与成形极限
Review local major strain against forming limits



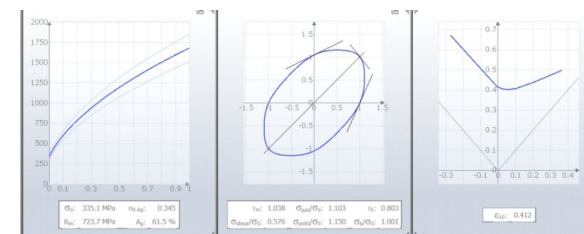
起皱风险 Wrinkle risk

识别过量补料或局部压缩区
Identify excess feed or local compression zones



壁厚分布 Thickness distribution

核对减薄和增厚趋势
Evaluate thinning and thickening trends



缺陷控制与模具开发

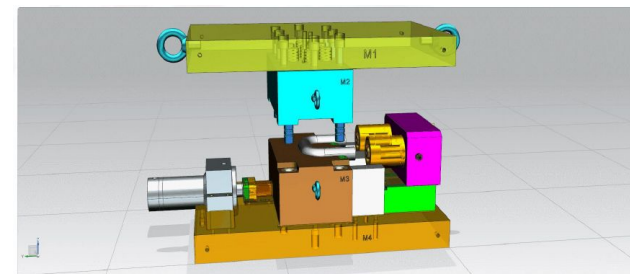
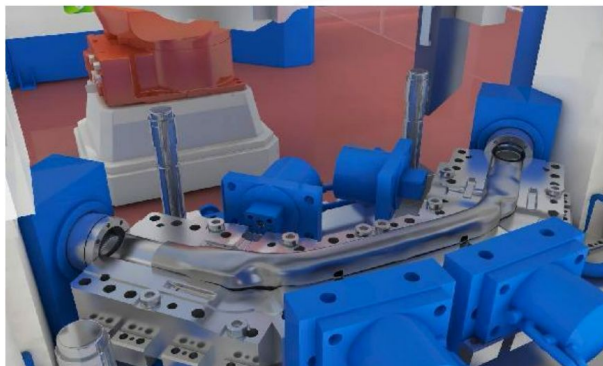
DEFECT CONTROL & TOOLING DEVELOPMENT

工艺窗口需在密封、补料、内压和摩擦条件之间取得平衡。模具开发从零件数据和分模策略出发，经 CAE 验证后进入加工、试模与修正。

The process window balances sealing, axial feed, internal pressure and friction. Tooling development starts with part data and parting strategy, then moves through CAE review, machining, tryout and correction.

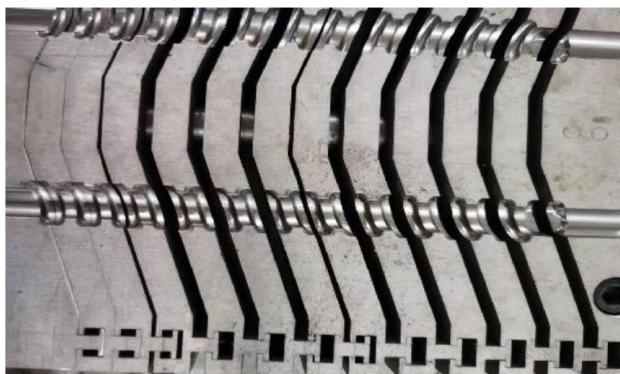
管端泄压 End leakage

核对密封结构与管端尺寸
Review seal design and tube-end dimensions



局部开裂 Local splitting

调整压力与补料路径，复核材料状态
Adjust pressure/feed path and review material temper



起皱与叠料 Wrinkling or folding

调整预成形、摩擦与轴向进给
Tune preform, friction and axial feed

液压成形的工艺价值

ENGINEERING VALUE OF HYDROFORMING

对适合的零件，液压成形可将复杂弯曲、变截面或局部加强特征集成在单一管件中。具体收益取决于几何、材料、批量和后续工艺。

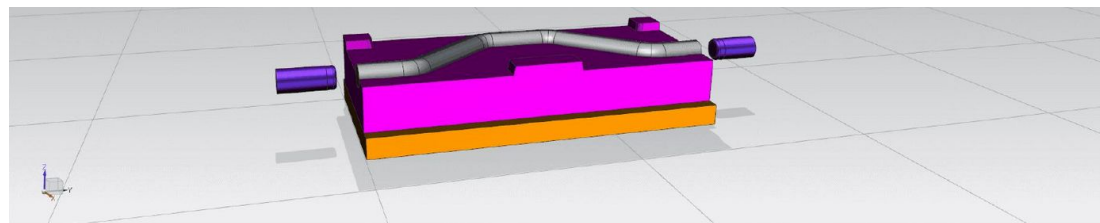
For suitable parts, hydroforming can integrate complex bends, variable sections or local reinforcement into one tubular component. Actual benefits depend on geometry, material, volume and downstream operations.

零件集成 Part integration

可减少多段管料拼接位置
May reduce joints between multiple tube segments

截面自由度 Section flexibility

可形成圆形、椭圆、扁平及其他异形截面
Supports round, oval, flattened and other shaped sections

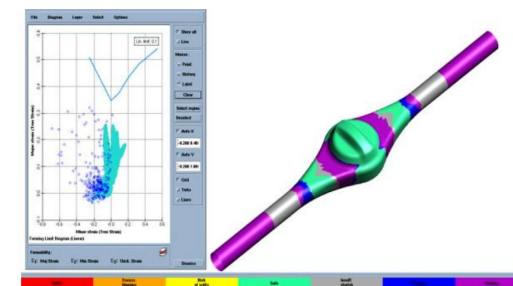
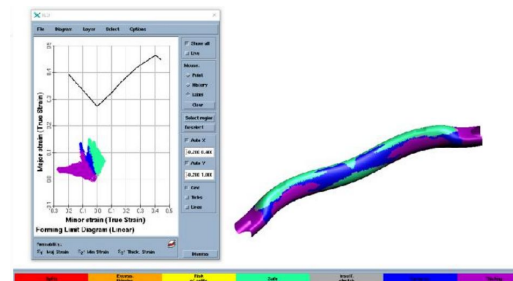


尺寸一致性 Dimensional consistency

模腔定形有利于管理外形与装配面
Die calibration helps manage outer geometry and interfaces

后续工艺简化 Downstream simplification

可在可行时减少焊接、修整和组装工序
May reduce welding, correction and assembly where feasible



液压成形与传统拼焊工艺

HYDROFORMING VS. WELDED FABRICATION

两类工艺应根据零件几何、年需求、材料可成形性、焊缝要求与模具投入综合比较。液压成形并非对所有零件都更优。

The two routes should be compared against geometry, annual demand, material formability, weld requirements and tooling investment. Hydroforming is not automatically the better route for every component.



WELDED ROUTE



HYDROFORMED ROUTE



FORMED BEND

比较维度 CRITERION	液压成形 HYDROFORMING	传统拼焊 WELDED FABRICATION
零件结构 Part architecture	适合整体管形、变截面与局部特征 Suited to integrated tubes, variable sections and local features	适合由标准管段组合或需频繁变更的结构 Suited to standard tube segments or frequently changing structures
连接方式 Joining	可减少部分拼接与焊缝 Can reduce selected joints and welds	通过切割、定位和焊接构建几何 Builds geometry through cutting, fixturing and welding
工装特点 Tooling	需专用模具、密封和压力路径开发 Requires dedicated die, sealing and pressure-path development	通常需切割、弯曲和焊接工装 Typically uses cutting, bending and welding fixtures
适用判断 Route decision	以成形可行性和集成价值为重点 Driven by forming feasibility and integration value	以标准化管段、柔性 with 低工装门槛为重点 Driven by standard sections, flexibility and lower tooling threshold

产品应用总览

PRODUCT APPLICATION OVERVIEW

图册覆盖汽车、摩托车、骑行、换热、卫浴装饰及其他异形管场景。图示用于展示典型结构和工艺方向，不代表特定客户项目。

The catalog covers automotive, motorcycle, cycling, heat-exchange, sanitary/decorative and other formed-tube applications. Images illustrate typical structures and manufacturing approaches, not named customer programs.



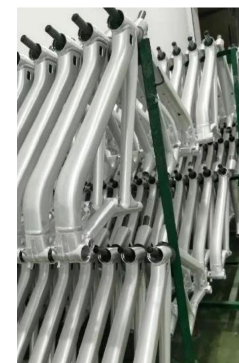
汽车
Automotive

12-18



摩托车
Motorcycle

19-21



骑行
Cycling

22-24



换热管
Heat-exchanger tubes

25



卫浴与装饰
Sanitary & decorative

26



其他异形管
Other formed tubes

27-29

汽车底盘承载件

AUTOMOTIVE CHASSIS LOAD-BEARING COMPONENTS

横梁、扭力梁与纵梁类管件兼顾结构刚度、连接界面与布置空间。高强钢方案需根据延展性和回弹行为验证。

Crossmembers, torsion beams and rails balance structural stiffness, interfaces and packaging space. High-strength steel routes require validation of ductility and springback behavior.

高强钢



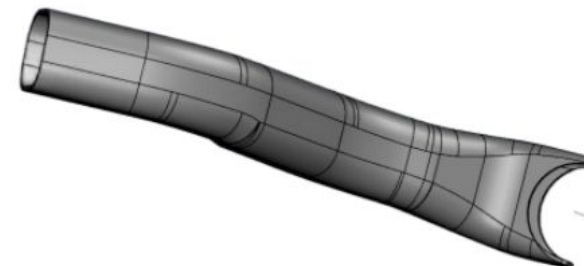
底盘横梁
Chassis crossmember

高强钢



扭力梁
Torsion beam

高强钢



车架纵梁件
Frame rail component

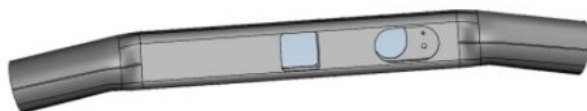
悬架连接与横向加强件

SUSPENSION LINKS & CROSSMEMBERS

控制臂和前后横梁承担连接、定位与载荷传递任务。成形方案需结合接口公差、孔位及焊接或紧固方案复核。

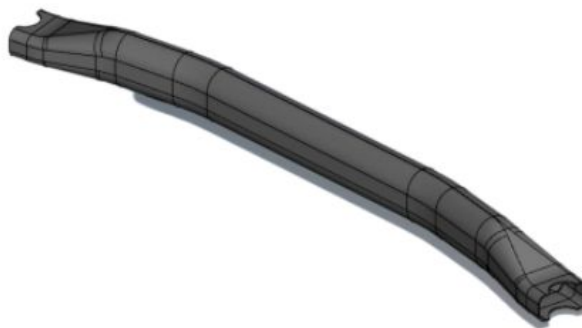
Control arms and front/rear crossmembers provide attachment points, locate suspension geometry and transfer loads. The forming route must be reviewed with interface tolerances, hole locations and joining strategy.

高强度



控制臂类成形件
Formed control-arm component

高强度



前横梁
Front crossmember

高强度



后横梁
Rear crossmember

后桥、副车架承梁与异形弯头

REAR AXLE, SUBFRAME BEAM & FORMED BEND

后桥和副车架承梁需围绕承载、连接与布置条件定义截面。异形弯头则更关注流路转向、接口和壁厚分布。

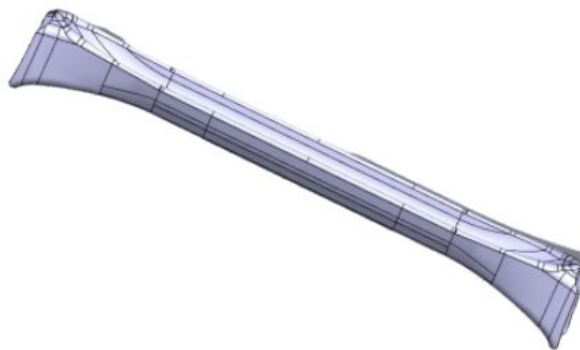
Rear-axle and subframe-beam sections must be developed around load paths, connections and packaging constraints. Formed bends place greater emphasis on flow routing, interfaces and thickness distribution.

Q235、铸钢或图纸指定钢材



后桥壳体
Rear axle housing

高强钢



副车架承梁
Subframe bearing beam

304 或 409 不锈钢



汽车异形弯头
Automotive formed bend

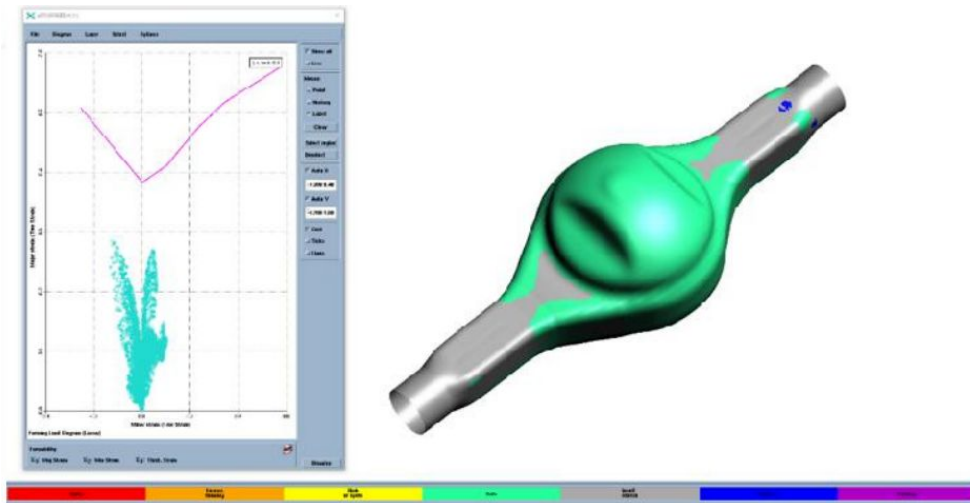
汽车桥壳成形分析

AUTOMOTIVE AXLE-HOUSING FORMING ANALYSIS

桥壳类零件可通过成形分析检查局部填充、壁厚变化和加载路径。工艺可行性需与结构载荷、材料数据和后续接口要求一并评审。

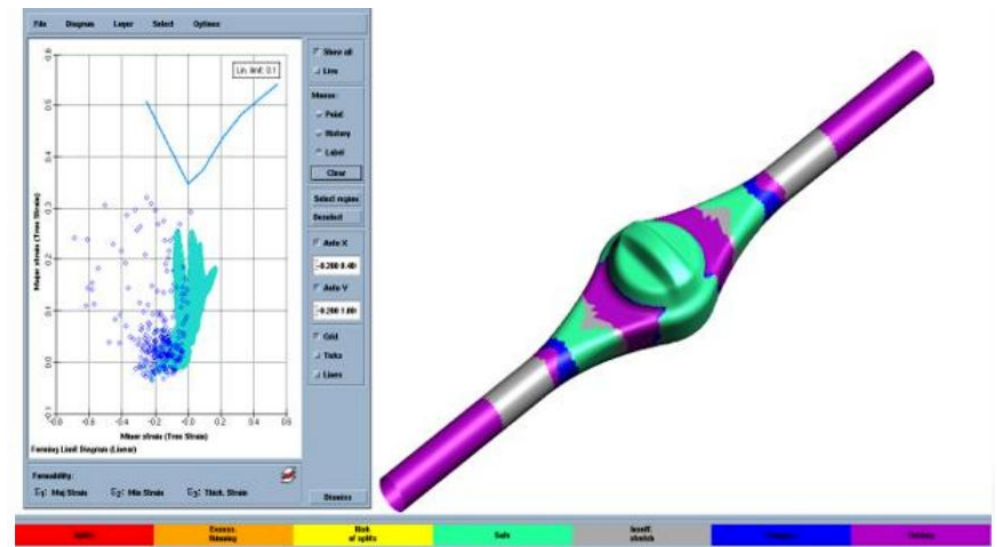
Axle-housing analysis examines local filling, thickness change and loading path. Process feasibility should be reviewed in conjunction with structural loads, material data and downstream interface requirements.

图纸指定的可成形钢材



管式桥壳
Tubular axle housing

图纸指定的可成形钢材



管式桥壳
Tubular axle housing

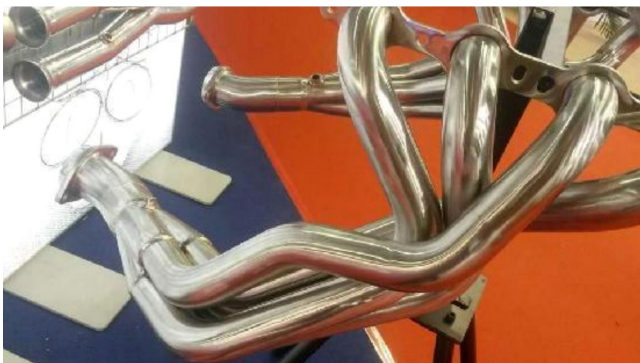
进排气系统异形管

FORMED TUBES FOR INTAKE & EXHAUST SYSTEMS

进排气管件常包含紧凑弯曲、非圆截面和多个接口。成形路线可与切割、管端成形及焊接路线组合评估。

Intake and exhaust tubes often combine tight bends, non-round sections and multiple interfaces. Route development should cover trimming, tube-end forming and the selected joining operations.

不锈钢或图纸指定耐热材料



进排气异形管
Intake/exhaust formed tube

不锈钢或图纸指定耐热材料



进排气异形管
Intake/exhaust formed tube

按温度、腐蚀与图纸要求选定



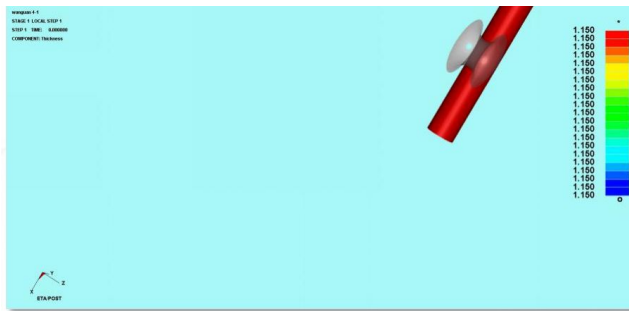
汽车冷热端管件
Automotive hot/cold-end tube

铝合金中冷管与转弯管

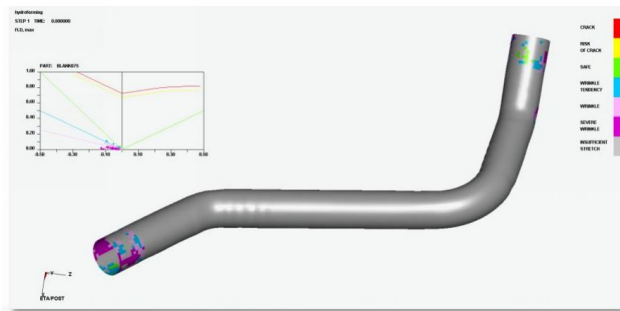
ALUMINUM INTERCOOLER & TURNING TUBES

铝合金中冷管可结合三维弯曲、预成形与液压定形。CAE 用于检查弯曲后的截面畸变、起皱和后续胀形余量。

Aluminum intercooler tubes can combine 3D bending, preforming and hydraulic calibration. CAE is used to review section distortion after bending, wrinkle risk and remaining expansion capacity.



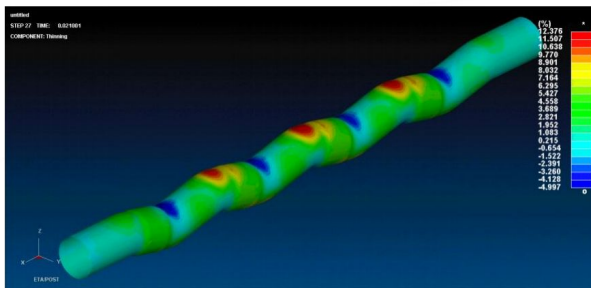
铝合金中冷管
Aluminum intercooler tube



铝合金中冷管
Aluminum intercooler tube



铝合金中冷管
Aluminum intercooler tube



充液弯曲转弯管
Fluid-assisted turning tube



充液弯曲转弯管
Fluid-assisted turning tube

汽车波纹管、净化器壳与综合管件

AUTOMOTIVE BELLOWS, CONVERTER SHELLS & MIXED TUBES

波纹管、净化器壳与异形管组合件的材料和工艺要求存在显著差异。询盘时应分别明确温度、腐蚀、柔性、连接和检验需求。

BelloWS, converter shells and mixed formed-tube assemblies have materially different process requirements. RFQs should state temperature, corrosion, flexibility, joining and inspection needs for each part.



汽车波纹管件
Automotive bellows tube



净化器壳体
Converter shell



汽车综合异形管
Mixed automotive formed tube



汽车综合异形管
Mixed automotive formed tube



汽车综合异形管
Mixed automotive formed tube

不锈钢摩托车排气管件

STAINLESS STEEL MOTORCYCLE EXHAUST TUBES

摩托车排气管件需在紧凑布置下处理弯曲、变截面和接口位置。不锈钢选项需与温度、腐蚀和表面要求匹配。

Motorcycle exhaust tubes must accommodate bends, section changes and interfaces within compact packaging. Stainless steel selection should match temperature, corrosion and finish requirements.

304 不锈钢



摩托车排气管组
Motorcycle exhaust tube set

304 不锈钢



排气壳体
Exhaust shell

304 不锈钢



排气弯头
Exhaust elbow

铝合金后平叉与钛合金排气管

ALUMINUM REAR SWINGARM & TITANIUM EXHAUST TUBE

后平叉与排气管对材料和成形路线的要求不同。铝合金结构件重点检查局部减薄和连接界面；钛材排气管需重点复核弯曲、成形与后续连接条件。

Rear swingarms and exhaust tubes call for different material and forming routes. Aluminum structures emphasize local thinning and interfaces; titanium exhaust tubes require careful review of bending, forming and downstream joining.

6061 铝合金



摩托车铝合金后平叉
Aluminum motorcycle rear swingarm

钛合金



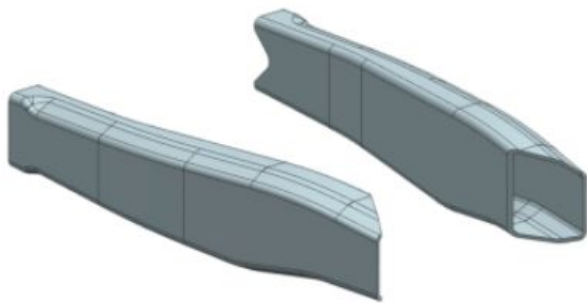
摩托车钛合金排气管
Titanium motorcycle exhaust tube

摩托车排气、消音与进气管件

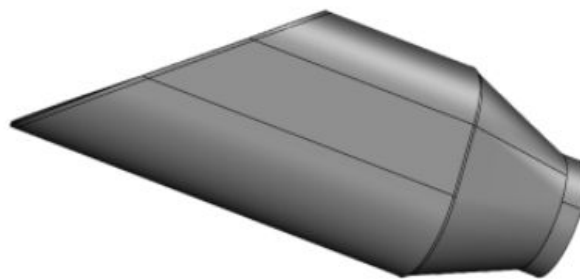
MOTORCYCLE EXHAUST, SILENCER & INTAKE TUBES

同一车型的进排气系统可包含后叉、外壳、弯头、尾喉、消音管和进气管等不同结构。每个零件应独立定义材料、接口和检验要求。

Motorcycle systems can include exhaust shells, elbows, tips, silencer tubes, intake tubes and separate formed structural members. Each part needs its own material, interface and inspection definition.



摩托车铝合金后叉
Aluminum motorcycle rear fork



摩托车排气外壳
Motorcycle exhaust shell



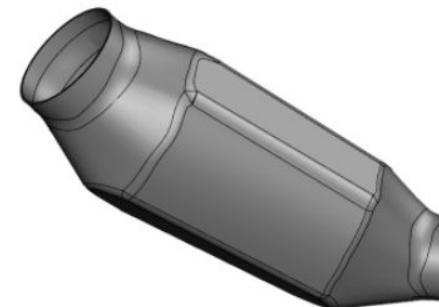
摩托车排气弯头
Motorcycle exhaust elbow



摩托车尾喉
Motorcycle exhaust tip



摩托车消音管
Motorcycle silencer tube



摩托车进气管
Motorcycle intake tube

自行车车架液压成形管

HYDROFORMED BICYCLE FRAME TUBES

自行车车架管可通过变截面与局部形面适配几何、焊接接口和空间布置。铝合金方案需核对材料状态、弯曲压扁和成形后壁厚。

Bicycle frame tubes can use variable sections and local surfaces to suit geometry, welded interfaces and packaging. Aluminum routes require review of temper, bend flattening and post-forming wall thickness.

铝合金



自行车车架异形管
Bicycle frame formed tube

铝合金



骑行后叉成形管
Cycling rear-fork formed tube

铝合金前叉与电池管

ALUMINUM FRONT FORKS & BATTERY TUBES

前叉和电池管分别关注结构连接、安装空间与壳体截面。成形件应根据焊接、孔位、端部与表面处理要求完成评估。

Front forks and battery tubes focus on structural connections, packaging space and enclosure sections. The part review should cover weld interfaces, hole locations, tube ends and finishing requirements.

铝合金



铝合金自行车前叉
Aluminum bicycle front fork

铝合金



电动自行车电池管
E-bike battery tube

电动骑行车架与成形管组

E-BIKE FRAMES & FORMED TUBE SETS

电动骑行车架需协调电池、线束、驱动与车架连接空间。管形设计可在概念阶段结合 CAE 和样件验证迭代。

E-bike frame design must accommodate the battery, wiring, drive system and structural interfaces. Tube geometry can be refined during concept development through CAE and sample validation.

铝合金



电动骑行车架管组
E-bike frame tube set

铝合金或图纸指定材料



定制骑行异形管
Custom cycling formed tube

铝合金或图纸指定材料



定制骑行异形管
Custom cycling formed tube

换热器螺纹管

HEAT-EXCHANGER THREADED TUBES

冷热交换用螺纹管通过受控成形的管壁轮廓服务于换热应用。螺纹形状、管径、壁厚、材料、接口与试验条件应在图纸中明确，并结合使用工况验证。

Threaded tubes use controlled wall profiles for heat-exchange applications. Thread geometry, diameter, wall thickness, material, interfaces and test conditions should be specified on the drawing and validated against the service conditions.

铜、铜合金或图纸指定材料



冷热交换器螺纹管
Heat-exchanger threaded tube

铜、铜合金或图纸指定材料



冷热交换器螺纹管
Heat-exchanger threaded tube

铜、铜合金或图纸指定材料



冷热交换器螺纹管
Heat-exchanger threaded tube

铜、铜合金或图纸指定材料



冷热交换器螺纹管
Heat-exchanger threaded tube

卫浴及装饰弯管

SANITARY & DECORATIVE FORMED TUBES

装饰弯头和水龙头弯管同时关注截面精度、弯曲外观、接口和表面处理。不锈钢方案可按拉丝、抛光或其他饰面需求预留后续工艺余量。

Decorative elbows and faucet bends combine section accuracy, bend appearance, interfaces and surface finish. Stainless steel routes can reserve process allowance for brushed, polished or other finishes.



楼梯扶手装饰弯头
Decorative handrail elbow



楼梯扶手装饰弯头
Decorative handrail elbow



楼梯扶手装饰弯头
Decorative handrail elbow



不锈钢水龙头 U 形弯管
Stainless steel faucet U-bend



不锈钢水龙头 U 形弯管
Stainless steel faucet U-bend

通用异形管与弯管

GENERAL FORMED & BENT TUBES

通用异形管可包含直管局部胀形、多弯管路和端部定形。工艺评估以三维轴线、截面变化、最小弯曲半径、壁厚和公差为基础。

General formed tubes may combine local expansion on straight tubes, multi-bend routing and tube-end calibration. Process review starts from the 3D centerline, section changes, minimum bend radius, wall thickness and tolerances.

按图纸指定的可成形管材



局部胀形直管
Locally expanded straight tube

按图纸与工况选定



多弯异形管
Multi-bend formed tube

异形截面与成形样件

SHAPED SECTIONS & FORMED SAMPLES

异形管样件展示了弯曲、胀形、压扁、局部缩径与管端形成的多种组合。是否可行需以完整零件数据、材料性能和模具分型方案验证。

The sample set illustrates combinations of bending, expansion, flattening, local reduction and tube-end forming. Feasibility depends on complete part data, material properties and the tooling parting strategy.

不锈钢、铝合金、钢材或图纸指定材料



异形截面管件
Shaped-section tube

零件材料按图纸；模具材料按工况选定



液压成形模具与样件
Hydroforming die and sample

零件材料按图纸；模具材料按工况选定



液压成形模具与样件
Hydroforming die and sample

高强钢汽车轮辋

HIGH-STRENGTH STEEL AUTOMOTIVE WHEEL RIMS

高强钢汽车轮辋可在概念阶段协同评估材料、主截面与加强筋特征。CAE 用于检查特征填充、局部减薄和工艺窗口，不替代结构验证。

For high-strength steel automotive wheel rims, material selection, main-section geometry and reinforcement ribs should be reviewed as an integrated forming concept. CAE can be used to review feature filling, local thinning and the forming window; it does not replace structural validation.

高强钢



高强钢汽车轮辋
High-strength steel automotive wheel rim

材料与应用索引

MATERIAL & APPLICATION INDEX

下表用于快速定位图册中的典型材料与应用方向。实际选材应结合强度、耐蚀、温度、成形极限、表面与成本要求。

This index maps typical materials to the application areas presented in the catalog. Final selection should consider strength, corrosion, temperature, forming limits, finish and cost requirements.

材料 MATERIAL	典型应用 TYPICAL APPLICATIONS	页码 PAGES
铝合金 Aluminum alloys	中冷管、自行车车架、前叉、后平叉、电池管 Intercooler tubes, bicycle frames, front forks, rear swingarms and battery tubes	17, 20, 22-24
不锈钢 Stainless steel	进排气管、消音管、尾喉、卫浴与装饰弯管 Intake/exhaust tubes, silencer tubes, exhaust tips, sanitary and decorative bends	16, 18-21, 26
低碳钢与高强度钢 Low-carbon and high-strength steels	底盘横梁、扭力梁、纵梁、控制臂、桥壳与加强特征件 Chassis crossmembers, torsion beams, rails, control arms, axle housings and reinforced parts	12-15, 29
钛合金 Titanium alloys	摩托车排气管与图纸指定的耐蚀异形管 Motorcycle exhaust tubes and drawing-specified corrosion-resistant formed tubes	6, 20
铜及铜合金 Copper and copper alloys	换热器管件、电气连接件、卫浴与装饰件 Heat-exchanger fittings, electrical connectors, sanitary and decorative parts	6, 25

定制询盘所需信息

CUSTOM RFQ CHECKLIST

完整的零件数据有助于快速判断材料、工艺路线、模具边界与检验方案。数据不完整时，可先提供现有图纸和关键功能要求进行初步评估。

Complete part data supports an efficient review of material, process route, tooling scope and inspection plan. If the data set is incomplete, available drawings and critical functional requirements can be submitted for an initial review.

2D/3D 图纸 2D/3D drawings

建议提供带尺寸和公差 PDF，以及 STEP 或其他三维数据
Dimensioned and toleranced PDF plus STEP or other 3D data where available

材料与状态 Material and temper

牌号、标准、供货状态、管径与壁厚
Grade, standard, supply condition, tube diameter and wall thickness

功能与工况 Function and service conditions

载荷、温度、压力、腐蚀、疲劳、密封或外观要求
Load, temperature, pressure, corrosion, fatigue, sealing or appearance requirements

接口与后续工艺 Interfaces and downstream operations

孔位、管端、焊接、切割、热处理与表面处理
Holes, tube ends, welding, trimming, heat treatment and surface finishing

数量与阶段 Quantity and project stage

样件、小批或批量需求，以及目标时间和版本状态
Prototype, pilot or production demand, target timing and revision status

质量与检验 Quality and inspection

关键尺寸、检测方法、样件批准和文件要求
Critical dimensions, inspection methods, sample approval and documentation needs



联系 Jayu Contact Jayu

发送图纸、材料要求和应用工况，用于开展异形管件与液压成形工艺的初步评估。
Send drawings, material requirements and service conditions for an initial review of formed-tube and hydroforming requirements.

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