FISEND 烟台孚信达双金属股份有限公司
YANTAI FISEND BIMETAL CO.,LTD

连铸轧制铜铝复合排(CCA)
选型加工手册

Selection Guide & Machining Manual for
Copper Clad Aluminum (CCA) Busbar
Manufactured by Continuous-casting and Rolling

版本Version：A/5

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前 言
PREFACE

为了方便客户对产品进行前期选型以及后期加工处理，拟写本文件作为参考之用。本文件对公司现有的铜铝复合排产品选型、规格特性、加工方法和运输贮存都做了明确介绍。本文件适用于正常工作条件下输电、变电、配电、电器设备等领域用的铜铝复合排，对在严重腐蚀环境（如海洋环境、化学电解液环境）、严重污秽的环境、高海拔地区、高寒地区等条件下使用的本标准产品，尚应对裸露表面进行防腐蚀特殊处理，或满足其他相关标准的有关规定。

As reference, this manual is useful when customer select and make subsequent machining for CCA busbar. It makes a definite and clear introduction about CCA busbar including selection,specification,machining,transporting and warehousing. The CCA busbar described in this article can be applied in power transmission & transformation and distribution under the normal working conditions. The surface anti–corrosion treatment should be made if applied in severely corrosive environment (such as the marine, chemical electrolyte), severe polluted environment or in high altitude and frozen area, or met other relevant provisions of the relevant standards.

1 铜铝复合排简介Description of CCA Busbar

1.1铜铝复合排的定义Definition of CCA Busbar

本公司生产的铜铝复合排属于一种新型双金属复合导体材料，其综合体现了铜的高导电性能与铝的低成本优势。产品的基本生产工艺流程为：水平连铸、压力加工、热处理及后续表面处理等。铜铝复合排的铜和铝之间有原子间结合的冶金结合层，保证了铜铝之间高的结合强度。

FISEND CCA busbar is manufactured by horizontal continuous casting, with both advantages of high conductivity of copper and lighter weight of aluminum. The basic process of the product is: horizontal casting, pressure processing, heat treatment and subsequent treatment. There are metallurgical bonding layer between the copper and aluminum which ensure the high binding strength.

1.2铜铝复合排的结构Composition of CCA Busbar

1.2.1材质Material

铜铝复合排的包覆层化学成分符合GB/T 5231中标准阴极铜T2要求，相对应美标ASTM牌号为C11000；

铝芯化学成分符合GB/T 3190中1050、1070牌号或1100牌号铝的成分要求，供需双方也可以根据合同约定，采用其他电工铝牌号的成分要求。

The chemical composition of cladding layer of CCA is in accordance with copper cathode T2 in standard GB/T5231, corresponding to the type C11000 in ASTM;

The chemical composition of aluminum core is accordance with 1050、1070 or 1100 aluminum in standard GB/T 3190, the other electrical aluminum can also be used according to contracts by supplier and purchaser.

1.2.2表面质量Surface Quality

产品表面光滑平整，没有划痕、凹凸、裂纹、露铝及明显锈斑等缺陷，窄边没有飞边、毛刺。

The surface shall be smooth, no defects such as scratch, unevenness, crack, bare Al and rusty spot. no flash and burr in the narrow edge.

1.2.3依据本手册推荐的加工工艺进行锯切、冲孔、弯曲、压铆、安装后，铜、铝不分层。

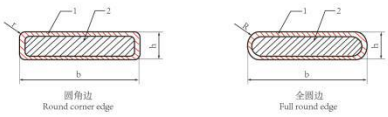
It shall be no delamination of CCA when make subsequent machining such as cutting, punching, bending, riveting and installing if in compliance with the machining manual.

2 规格及系列Specification and Series

2.1 产品分类Product Classification

公司主要生产截面形状为圆角边及全圆边截面形状的铜铝复合排产品，依据选型优先原则，本文优先推荐圆角边（直边）产品，因为其有均匀过度的圆角，既避免了直角所带来的潜在的尖端放电效应现象，又使铜铝复合排有效截面积增大（较全圆边），与全圆边截面相比增加了有效搭接面积。截面形状，见下图。

Fisend mainly produces CCA busbar with the section of round corner edges and full round edge, we are prefer to suggest the rounded edge section which has a transitional round corner, avoiding the potential tip discharge effect comparing to the right angle, increasing the effective overlap area comparing to the full round edge. See figure .



截面形状
Cross section shape

说明：Illustration
1——铜包覆层（以下简称“铜层”）；
1——Copper clad layer(refer to “copper layer”);
2——铝芯;
2——Aluminum core;
h——产品厚度;
h——Thickness of product;
b——产品宽度;
b——Width of product;
r——圆角半径，r=1.0mm～2.0mm;
r——Radius of round corner, r=1.0mm～2.0mm;
R——全圆边半径，R＝h/2.
R——Radius of full round edge, R＝h/2.

2.2 尺寸及偏差Dimension and Deviation

a.标称尺寸Nominal size

铜铝复合排常用的标称尺寸h和b见下表

Nominal sizes of CCA busbar are shown in table.

铜铝复合排的常用规格
Commonly used specifications of CCA busbar

h(厚度Thickness) / b(宽度Width)	4	5	6	8	10	12
20	○	○	○	○	○	
30	○	○	○	○	○	
40	○	○	○	○	○	
50		○	○	○	○	
60		○	○	○	○	
80			○	○	○	
100			○	○	○	○
120			○	○	○	○

备注：标注“○”为常用规格。Note: Mark "○" is the common sizes.

b.铜铝复合排尺寸偏差Size deviation of CCA busbar

参考标准：

DL/T247–2012输变电设备用铜包铝母线

GB/T30586–2014连铸轧制铜包铝扁棒、扁线

The reference standards: DL/T247–2012 CCA busbar for equipment of transmission and commutation

GB/T30586–2014 Copper clad aluminum flat bars and wires manufactured by continuous–casting and rolling

铜铝复合排产品厚度、宽度偏差
The thickness and width deviation of CCA busbar

宽度With（b）	宽度偏差 Width Deviation	厚度Thickness（h）	厚度偏差 Thickness Deviation
≤30	±0.5	>3–6	±0.1
>30–100	±0.8	>6–10	±0.15
>100	±1.2	>10	±0.2

备注：圆角半径允许偏差：±0.5 mm.Note: Allowable deviation of the round corner radius: ±0.5 mm.

2.3 包覆层厚度Thickness of the Cladding Layer

允许产品横断面宽边和窄边铜层厚度存在不均匀分布，侧边铜层厚度大于平面铜层厚度，厚度在6mm以上的铜铝复合排任意位置的最小铜层厚度不小于0.4mm，厚度不大于6mm的铜铝复合排任意位置的最小铜层厚度不小于0.2mm。

The unevenness in thickness of Cu cladding layer in the cross section is permitted, but the minimum thickness of Cu cladding layer in any position is no less than 0.4mm when thickness of CCA busbar is more than 6mm, the minimum thickness of Cu cladding layer in any position is no less than 0.2mm when thickness of CCA busbar is less than 0.2mm.

3 基本性能参数Basic Parameters

3.1铜铝复合排与铜排的基本性能对比Comparison of Properties between CCA & Cu Busbar（Annealed）

项目比较 Comparison / 产品名称 Product name	密度 Density g/cm³	抗拉强度 Tensile strength Mpa	伸长率 Elongation %	20℃直流电阻率 DC electrical resistivity at 20℃ Ω mm²/m	20℃导电率 Electric conductivity at 20℃ %IACS	界面结合强度 Interface bonding strength Mpa	状态 State
CCA Busbar(30%)	4.56	≥130	≥30	≤0.02424	≥71.1	≥40	退火态
CCA Busbar(25%)	4.25	≥128	≥28	≤0.02498	≥69	≥40	退火态
CCA Busbar(20%)	3.94	≥125	≥25	≤0.02550	≥67.6	≥40	退火态
CCA Busbar(30%)	4.56	≥180	≥3.8	≤0.02477	≥69.6	≥40	硬态
CCA Busbar(25%)	4.25	≥170	≥3.5	≤0.02548	≥67.7	≥40	硬态
CCA Busbar(20%)	3.94	≥160	≥3	≤0.02596	≥66.4	≥40	硬态
CCA Busbar	8.89	≥206	≥35	0.01724	100	–	退火态

3.2载流量（参考值）Carrying Capacity (Reference Table)

环境温度Environment temperature：25℃

电源频率Power frequency：50Hz

温升 Temperature rising：50K 65K 75K

规格 Specification (b×h) mm×mm	载流量Carrying Capacity								
	VPCu=20%			VPCu=25%			VPCu=30%		
	50K	65K	75K	50K	65K	75K	50K	65K	75K
15.0×4.0	193	213	222	196	210	225	200	213	229
20.0×4.0	250	276	288	254	273	293	259	277	298
25.0×4.0	310	341	355	314	339	363	321	345	370
30.0×4.0	326	361	375	336	362	387	347	372	399
30.0×5.0	425	453	476	438	453	489	450	466	503
30.0×6.0	486	538	562	499	539	579	514	554	595
30.0×8.0	579	648	678	596	644	697	613	662	717
30.0×10.0	638	711	724	658	712	745	676	733	767
40.0×4.0	453	498	517	465	500	532	479	513	547
40.0×5.0	538	604	633	554	605	652	570	622	670
40.0×6.0	612	677	708	630	679	728	649	698	750
40.0×8.0	725	805	847	746	806	873	767	829	897
40.0×10.0	790	894	949	814	896	977	837	921	1005
50.0×5.0	665	735	765	684	736	788	703	758	810
50.0×6.0	755	836	872	777	836	898	799	861	923
50.0×8.0	891	989	1042	918	990	1072	944	1019	1103
50.0×10.0	969	1061	1107	998	1061	1139	1026	1092	1172
60.0×5.0	759	856	892	781	858	918	804	882	945
60.0×6.0	861	952	885	886	953	1025	911	980	1053
60.0×8.0	1011	1123	1182	1041	1124	1216	1070	1156	1252
60.0×10.0	1093	1215	1279	1125	1218	1318	1157	1253	1355
80.0×6.0	1081	1197	1250	1113	1198	1287	1145	1232	1323
80.0×8.0	1265	1405	1479	1302	1407	1523	1340	1448	1566
80.0×10.0	1362	1505	1583	1402	1507	1629	1442	1550	1676
100.0×6.0	1283	1419	1483	1320	1422	1527	1358	1462	1571
100.0×8.0	1504	1669	1758	1548	1672	1811	1593	1719	1862
100.0×10.0	1620	1790	1883	1668	1793	1938	1716	1844	1993
120.0×8.0	1740	1932	2035	1791	1935	2095	1842	1990	2154
120.0×10.0	1890	2090	2197	1946	2094	2261	2002	2153	2326

备注：数据是对垂直样品进行测试，如果是水平的，数据应是0.95倍（宽度≤60.00mm）和0.92倍（宽度＞60.00mm）。

Notes: the data is tested on standing sample, if in horizontal, the data multiply by 0.95 for width ≤60.00m and multiply by 0.92 for width >60.00mm.

3.3铜铝复合排与铜排的体积重量对比
Volume & Weight Comparison Table between CCA & Cu Busbar

规格 Specification (b×h) mm×mm	铜铝复合排CCA Busbar				铜排Copper Busbar		
	包覆层体积比 Volume Ratio of Cladding Layer %	圆角边Round Corner Edge			圆角边Round Corner Edge		
		截面积（S）Sectional Area mm²	每米重量 Weight Per Meter kg/m	每千克长度 Length Per Kilogram m/kg	截面积（S）Sectional Area mm²	每米重量 Weight Per Meter kg/m	每千克长度 Length Per Kilogram m/kg
15.0×4.0	20	58.07	0.23	4.35	58.07	0.52	1.94
20.0×4.0		78.07	0.31	3.23	78.07	0.69	1.44
25.0×4.0		98.07	0.39	2.56	98.07	0.87	1.15
30.0×4.0		118.07	0.47	2.13	118.07	1.05	0.95
30.0×5.0		148.07	0.58	1.72	148.07	1.32	0.76
30.0×6.0		178.07	0.70	1.43	178.07	1.58	0.63
30.0×8.0		238.07	0.94	1.06	238.07	2.12	0.47
30.0×10.0		298.07	1.17	0.85	298.07	2.65	0.38
40.0×4.0		156.57	0.62	1.61	156.57	1.39	0.72
40.0×5.0		196.57	0.77	1.30	196.57	1.75	0.57
40.0×6.0		236.57	0.93	1.08	236.57	2.10	0.48
40.0×8.0		316.57	1.26	0.80	316.57	2.81	0.36
40.0×10.0		396.57	1.56	0.64	396.57	3.53	0.28
50.0×5.0		246.57	0.97	1.03	246.57	2.19	0.46
50.0×6.0		296.57	1.17	0.85	296.57	2.64	0.38
50.0×8.0		396.57	1.56	0.64	396.57	3.53	0.28
50.0×10.0		496.57	1.96	0.51	496.57	4.41	0.23
60.0×5.0		296.57	1.17	0.85	296.57	2.64	0.38
60.0×6.0		356.57	1.40	0.71	356.57	3.17	0.32
60.0×8.0		476.57	1.88	0.53	476.57	4.24	0.24
60.0×10.0		596.57	2.35	0.43	596.57	5.30	0.19
80.0×6.0		476.57	1.88	0.53	476.57	4.24	0.24
80.0×8.0		636.57	2.51	0.40	636.57	5.66	0.18
80.0×10.0		796.57	3.14	0.32	796.57	7.08	0.14
100.0×6.0		596.57	2.35	0.43	596.57	5.30	0.19

规格 Specification (b×h) mm×mm	铜铝复合排CCA Busbar				铜排Copper Busbar		
	包覆层体积比 Volume Ratio of Cladding Layer %	圆角边Round Corner Edge			圆角边Round Corner Edge		
		截面积（S）Sectional Area mm²	每米重量 Weight Per Meter kg/m	每千克长度 Length Per Kilogram m/kg	截面积（S）Sectional Area mm²	每米重量 Weight Per Meter kg/m	每千克长度 Length Per Kilogram m/kg
100.0×8.0	20	796.57	3.14	0.32	796.57	7.08	0.14
100.0×10.0		996.57	3.93	0.25	996.57	8.86	0.11
120.0×8.0		956.57	3.77	0.27	956.57	8.50	0.12
120.0×10.0		1196.57	4.71	0.21	1196.57	10.64	0.09
50.0×5.0	25	246.57	1.05	0.95	246.57	2.19	0.46
50.0×6.0		296.57	1.26	0.79	296.57	2.64	0.38
50.0×8.0		396.57	1.69	0.59	396.57	3.53	0.28
50.0×10.0		496.57	2.11	0.47	496.57	4.41	0.23
60.0×5.0		296.57	1.26	0.79	296.57	2.64	0.38
60.0×6.0		396.57	1.52	0.66	396.57	3.17	0.32
60.0×8.0		476.57	2.03	0.49	476.57	4.24	0.24
60.0×10.0		596.57	2.54	0.40	596.57	5.30	0.19
80.0×6.0		476.57	2.03	0.50	476.57	4.24	0.24
80.0×8.0		636.57	2.71	0.40	636.57	5.66	0.18
80.0×10.0		796.57	3.39	0.30	796.57	7.08	0.14
100.0×6.0		596.57	2.54	0.40	596.57	5.30	0.19
100.0×8.0		796.57	3.39	0.30	796.57	7.08	0.14
100.0×10.0		996.57	4.24	0.24	996.57	8.86	0.11
120.0×8.0		956.57	4.07	0.25	956.57	8.50	0.12
120.0×10.0		1196.57	5.09	0.20	1196.57	10.64	0.10
30.0×4.0	30	118.07	0.54	1.85	118.07	1.05	0.95
30.0×5.0		148.07	0.68	1.47	148.07	1.32	0.76
30.0×6.0		178.07	0.81	1.24	178.07	1.58	0.63
30.0×8.0		238.07	1.09	0.92	238.07	2.12	0.47
30.0×10.0		298.07	1.36	0.74	298.07	2.65	0.38
40.0×4.0		156.57	0.71	1.41	156.57	1.39	0.72
40.0×5.0		196.57	0.9	1.11	196.57	1.75	0.57
40.0×6.0		236.57	1.08	0.93	236.57	2.1	0.48
40.0×8.0		316.57	1.44	0.69	316.57	2.81	0.36
40.0×10.0		396.57	1.81	0.55	396.57	3.53	0.28

3.4热胀冷缩性能Performance in Heat Expansion and Cold Contraction

我公司对铜铝复合排进行了–40℃~110℃的热胀冷缩性能循环测试，循环1000次，铜铝之间的界面不分层，铜铝界面结合强度及电性能不发生变化。

The 1000 times cycling test of CCA Busbar have been made from –40℃ ~110℃, the electric performance and the bonding strength of interface between Cu & AL keep stable.

4 机械性能及加工规范Mechanical Property and Specification

4.1未注公差标准No Marked Tolerance Standard

默认未注公差，受折弯或冲压成型影响的尺寸建议按照GB/T 15055–m执行，未注形位公差按照GB/T13916–2013–c执行，孔间距和加工尺寸按照GB/T 1804–m执行。

Affected by bending or stamping molding, default no marked tolerance is according to GB/T15055–m, the no marked position tolerance is based on GB/T 13916–2013–m, the hole spacing and processing tolerance is according to GB/T 1804–c.

4.2裁切加工方式Cutting Method

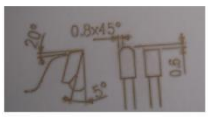
4.2.1锯切Cutting

可参照铝型材切断工艺，圆锯推荐采用梯平齿锯片，以保证断面锯切质量，避免端头粘铝现象。在使用高速锯时，最好使用乳化液或皂化液冷却锯片，因为铝的加工过程中容易出现粘锯现象，影响端面质量。

Technology of cutting process for Al section bar can be as reference. The TCG blade is recommended for circular saw to avoid Al–adhesion at the end. When high–speed saw is applied, the emulsion or saponification liquid shall be used to cool the blade, as the property of Al is sticky , which could make inferior quality on end–face.

推荐梯平齿锯片参数如下：

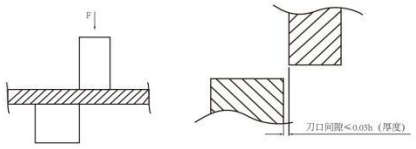
Recommended ladder flat tooth saw blade parameters are as follows:



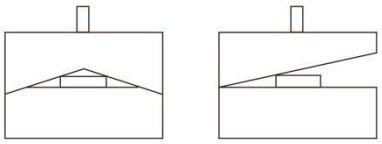
4.2.2冲切Die Cutting

4.2.2.1在冲切加工中要调整好模具间隙，刀刃间隙应不大于0.05h（厚度）mm，刀刃要锋利，否则容易对铜铝结合层造成损伤。间隙配合如下图所示：

Check and adjust the gap of die, its blade clearance should be less than 0.05h (thickness) mm, keep sharp edge, otherwise the bonding layer of Cu and Al could be damaged. Clearance fit showed as below:

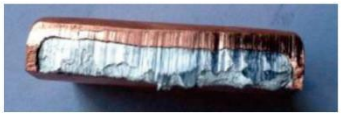


4.2.2.2不允许使用的冲切方式如下Prohibited as Showed



4.2.2.3当冲切加工模具间隙过大或者刀刃钝化，冲切的结果如下图所示：（图示并不是铜铝复合排分层，而是由于冲切模具间隙过大导致的）

When the clearance between die cutting is too large or the blade is passivation, its result is as follow(showed in the picture is not layered between Cu and Al, but due to die cutting clearance is too large).

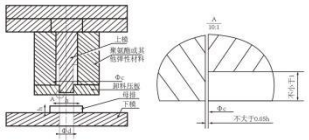


4.3孔加工方式Hole Machining Method

4.3.1冲孔Punching

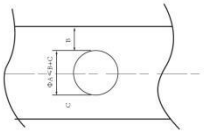
冲孔模具间隙应满足凸模和凹模的单边间隙不大于0.05h（厚度）mm，避免间隙过大对铜铝结合层造成破坏，请参考下图：

The punching die clearance between convex and concave die should be not more than 0.05h mm to avoid damaging the layers between Cu and Al. Picture is as follows:



4.3.1.1冲头直径A选择应满足ΦA≤B+C,冲头要有卸料压板详细如下图所示

Punch diameter should be ΦA ≤ B + C, it must have discharge pressure plate , as shown below in detail:

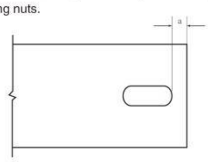


4.3.1.2模具上模必须要有卸料压板，否则脱料时会对上表面结合层造成破坏，如下图：

If there isn’t discharge pressure plate on the punch head, it will damage the surface layer as follow.

4.3.1.3 冲孔位置距离端面太近会造成端面材料凸起，设计时应保证a≥厚度；如果是涨铆螺母底孔，应保证a≥厚度+5mm，否则在涨铆时容易造成已电镀的端面电镀层破裂，请参考下图：

4.3.1.3 Punching postion shouldn’t be close to the head face, otherwise, the material will be raised, when designed, the distance “a” should be more than thickness; if it’s a bottom hole by riveting nut, the distance “a” should be more than thickness+5mm, otherwise, the electroplating layer will be bursted after riveting nuts.



4.3.2钻孔Drilling

铜铝复合排钻孔时，需确保钻头锋利，钻头接近底面铜层时，应适当放慢进给速度，避免挤压力过大，在孔周围形成毛刺甚至破坏铜铝结合层，另需注意下面应装有垫板，避免悬空对铜铝结合层造成破坏。

a)推荐钻头锥度135°～140°；

b)钻孔时开启切削液。

The drill should be kept sharp when drill hole, and when it’s near to the bottom layer of copper the speed of drill head should be kept slowly to avoid higher compressional force which will result in burrs around the hole and even damage the bonding layer of CCA busbar. The other attentional thing is that it should be equiped subplate to avoid damaging the bonding layer of Cu and Al.

Recommended:

a) Bit taper 135°～140°；

b) Cutting fluid should be applied when drilling.

4.4弯曲Bending

4.4.1立弯(厚度方向)折弯半径90°尺寸应参考下表规定。

Bending(thickness direction) radius refer to table when bending angle 90 °

铜铝复合排折弯半径
Bending radius of CCA busbar

标称尺寸 Nomal Dimension/mm	推荐折弯半径 Recommend Bending Radius/mm
h≤5	h
h=6	6、8、10
h=8	8、10、15
h=10	10、12、15
h=12	15、20

4.4.1.1折弯半径不符合标准时容易出现铜层分裂、褶皱等问题，如下图

If bending radius doesn’t conform to standard ,it’s easy to cause copper layer division and fold as follows.

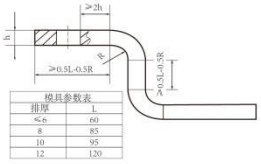
4.4.2平弯（宽度方向）折弯半径R值应2倍以上b值（随b值增大倍数也增大），由于侧弯尺寸公差相对较大(参照GBT15055-m 表中厚度值相应替换为宽度，公差值按相应倍数放大)，由于实际应用极少，不推荐采用，如需采用侧折弯尽量与加工单位协商使用现有模具。

Bending radius R (width direction) should be above two times than b (Multiples increases with the b increases), because of lateral bending dimension tolerance is a little large(reference GB/T15055-m), it’s used very small in actual application and not recommended, if it needs to be used, you could contact with supplier using the existing die.

4.4.3折弯设计注意事项（孔拉伸）Notes for Bending Design (Elongated Hole)

4.4.3.1由于折弯工艺限制，在设计过程中应保证折弯两侧直线段的尺寸≥0.5L-0.5R（特殊情况可协商定做模具），孔边距折弯切线距离应≥2h，避免距离过近产生的孔拉伸问题。（孔拉伤问题可以折弯后再加工孔进行避免，但加工成本会增加，所以应尽量避免。）参见下图：

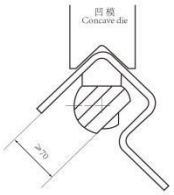
Due to bending processing, the linear distance between two bends should be more than 0.5L–0.5R （ negotiable under special condition ） in design, and the distance between the hole edge and bengding tangent should be more than 2h to avoid causing elongated hole. (the problem could be avoided after bending as an option, but the processing cost will be increased, so we should avoid it.)pictures as follows:



模具参数表	
排厚	L
≤6	60
8	85
10	95
12	120

1)满足常规折弯的加工尺寸以及防止孔的变形。
Meet the conventional bending processing size and prevents deformation of the hole.

4.4.3.2 特殊工件折弯应考虑模具干涉问题。参见下图：
The special workpieces bending should be consider the problem of mold interference.See below:



2)注意模具干涉，特殊情况尺寸限制可根据客户要求定做。
Attention to the problem of mould interference, the size limit can be customized according to customer's requirements under special circumstances.

注：以上干涉参考数据适用于GJCNC–BB–30–2.0机型。
Note:The above interference parameters use to GJCNC–BB–30–2.0 machine type.

4.4.4折弯加工工艺注意事项Bending Processing Matters Needing Attention

1)相同厚度的复合排尽量保证折弯半径相同，凸模半径凹模跨度尺寸不变，否则容易造成折弯系数不稳定，从而导致折弯误差变大；

2)遵循复合排厚度越大凹模跨度越大的折弯规律，折弯半径越大凹模跨度L越大的原则，否则容易造成压痕过大过深；但凹模跨度过大则易造成折弯形状不理想，以及折弯尺寸波动大(参考下表推荐模具)；

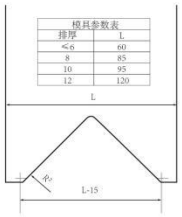
3)推荐采用固定的折弯模具对应固定排厚的折弯，有利于保证折弯尺寸的稳定性。

1)The same thickness of CCA busbar bending processing to ensure that bending radius is the same as far as possible, the convex die radius and die span size remains the same, otherwise, the bending coefficient will not be stable and cause to bending error too big.

2)Follow the bending rules that the more thickness of CCA busbar, the greater of the concave die span, the more bending radius, the greater concave die span L, otherwise, it' s easy to cause indentation deeper; but if the concave die span is too much more, it' s also easy to cause that bending shape is not ideal and the bending size is large fluctuations.(reference die requirements as follow)

3)Recommended to adopt the fixed bending die to bend the same thickness of CCA busbar, to ensure the stability of bending size.

模具参数表	
排厚	L
≤6	60
8	85
10	95
12	120



4.5压铆Riveting

铜铝复合排的铜层厚度完全满足压铆螺母的安装要求，安装后母排表面无变形，孔内无残屑，安装前应去除孔表面毛刺，不允许倒角，以确保压铆强度（压铆螺母的安装强度判定标准：以用螺栓反复拆装10次，压铆螺母无松动、母排外观无变化为合格，具体检测力矩参照下表）。

The copper layer thickness of CCA busbar can fully meet the installing requirements of pressure riveting nut, it should be no surface distortion and no aluminum powder residue inside, pre–treatment of deburring is necessary before installation, but chamfering is not allowed, to guarantee the riveting intensity (Installation strength criteria of riveting nut: disassemble and assemble repeatedly 10 times with bolt, no loose rivet nuts ,no surface changes in busbar , riveting torque see table).

铜铝复合排压铆螺母检测力矩值
Riveting nut test torque value of CCA busbar

压铆螺母规格 Pressure riveting nut	紧固力矩 Tightening torque/N·m
S–M5–2–ZI	3
S–M6–2–ZI	8
S–M8–2–ZI	18
S–M10–2–ZI	30
S–M12–2–ZI	50

4.6表面处理Surface Treatment

表面处理方式包括镀锡、镀镍、镀银等，工艺安排要求在机械加工完成后的铜铝复合排表面沉锌预镀铜，然后要求材质进行电镀，镀层厚度应满足图纸要求，并无起皮脱落现象，目测表面不能出现反酸发黑等问题。

Surface treatment contains tin–plate、nickel–plate、silver–plate and so on. The procedure of pre–coating of copper should be done after machining, and then electroplating according to requirements,the thickness of coating layer shall meet the requirements of drawing, it should be no peeling off, keep acid–free on surface by visual inspection.

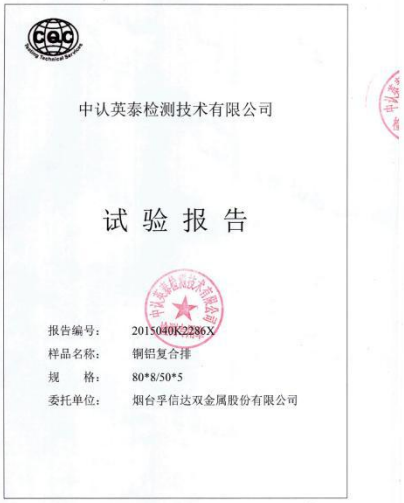
5 运输和贮存Transportation and Warehousing

为了减少运输和贮存环节对产品质量带来的影响，产品的运输和贮存应符合GB/T 3199的相关规定。

Transportation and warehousing should be according to the standard GB/T 3199 to avoid damaging to the quality of products.

附：铜铝复合排冷热循环螺栓连接实验报告

Attachment: The psychro–thermal cycles experiment report of CCA busbar for bolt connection



中认英泰检测技术有限公司

试 验 报 告

报告编号： 2015040K2286X
样品名称： 铜铝复合排
规　　格： 80*8/50*5
委托单位： 烟台孚信达双金属股份有限公司

2.5 试验结果

2.5.1 对连接 2 片样品 1 的螺栓螺母扭力测试

将扭力扳手调到扭矩为 20N·m（参考 CPS FAI 要求为 200kgf.cm 即 19.6N·m），用扭力扳手扭动时没有发现松动现象。如图 1：

图 1 螺栓螺母扭力测试

2.6 结论

1.试验后目视检查样品，螺丝上有大量红色锈迹生产，分析原因可能是高低温循环产生铜氧化物所致，不影响铜铝复合排使用性能；
2.环境试验后，连接 2 片样品 1 的螺栓螺母在 20N·m 扭矩下没有松动现象，达到 CPS FAI 提供标准要求，判定合格；
3.环境试验后，压铆件推力及扭矩力测试、压铆螺钉推力测试达到铝排 PEM 标准要求，判定合格；
4.环境试验后，攻丝破坏力测试达到 CPS FAI 提供标准要求，判定合格；
5.环境试验后，铜铝复合排界面剪切强度均达到 GB/T30586-2014 标准要求，判定合格；
6.环境试验后，对样品再次机加工，样件冲孔、折弯、攻丝、压铆螺母扭力及推力、压铆螺钉推力、攻丝破坏力、界面剪切强度都分别达到 CPS FAI 要求、铝排 PEM 标准以及 GB/T30586-2014 标准，均判定合格；

综上所述：经环境试验后，铜铝复合排的性能满足所有要求。