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HKISC is a non-profit making organization with its members coming from universities, consultants, developers, contractors and laboratories in Hong Kong. HKISC serves the construction industry in Hong Kong and the neighbouring region and carries the following specific objectives.

OBJECTIVES

- Channeling of technology transfer between academics and industry for improved quality in design, analysis and construction;
- Making university research more practical and useful for practitioners;
- Informing and sharing of new technology worldwide among members ;
- Organizing seminars for local and overseas experts for dissemination of their technological know-how;
- Developing and fostering friendship among members for exchange of opinions on complex problems ;
- Sponsoring international conferences on steel structures in order to allow sharing of expertise between local and overseas researchers and engineers and
- Publication of bulletin for news and new technology developed by local or overseas universities

A FEW WORDS FROM THE ISSUE EDITOR, Ir. S.M. PANG

This issue of bulletin serves to conclude a very eventful year in 2002 for the Hong Kong Institute of Steel Construction, the second full year since its establishment. It is of great encouragement to board members of the Institute to see the good support to its activities from members, and non-members alike. As would be expected, our members coming from diversed sections of the local construction industry would have a great diversity of interest and concern in technology development. Therefore, in this issue of bulletin, we shift our focus to some constructions with metal other than steel, viz. stainless steel and aluminium. In the Research and Technology Forum, Dr. Ben Young of the Hong Kong University of Science and Technology presents his research on the design of tubular structural members and joints using stainless steel cold-rolled sections. In the Industrial Forum, Mr. Clement Ng, an aluminium extrusion and finishes consultant from Canada gives us a thorough introduction to the industrial practices on the production of aluminium extrusions for application in building construction. With the respective advantages in their individual properties, both metals are expected to play an important role in future design and new construction, and the Institute and its members should keep up with the recent development in these areas. After all, our Industry's future, and indeed that of Hong Kong, relies on how well and how fast we can improve ourselves to deliver better products and service to end-users.

Finally, on behalf of the Hong Kong Institute of Steel Construction, I wish our members a happy and prosperous new year in 2003!

RESEARCH AND TECHNOLOGY FORUM

Opinions expressed in this column do not represent that of the HKISC nor the affiliated organization(s) of the author(s). Further details can be sought directly from the author(s.)

STAINLESS STEEL TUBULAR STRUCTURAL MEMBERS AND JOINTS

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ABSTRACT

Experimental investigation and design of stainless steel tubular structural members and joints are described in this paper. A series of column tests was compressed between fixed ends. The specimens were cold-rolled from stainless steel sheets. The tests were performed over a range of column lengths that involved local buckling and overall flexural buckling. The column test strengths were compared with the design strengths obtained using the American, Australian/New Zealand and European specifications for cold-formed stainless steel structures. Generally, the three specifications conservatively predicted the test strengths of the fixed-ended cold-formed stainless steel square hollow section columns. The design rules in the Australian/New Zealand Standard are slightly more reliable than the design rules in the American and European specifications. Furthermore, stainless steel K-joint tests were also performed. Design rules are proposed for stainless steel K-joints by adopting the rules of the CIDECT recommendations for carbon steel tubular structures and replacing the yield stress in these recommendations by the 0.2% proof stress.

INTRODUCTION

Stainless steel tubular members are being increasingly used for structural applications. This is due to the aesthetic appearance, high corrosion resistance and ease of maintenance as well as ease of construction of stainless steel structural members. Stainless steel tubular members are used as columns in frame structures, roof structures, truss girders and other applications. These structural members are primarily subjected to compressive loads. Design rules are available for cold-formed stainless steel structural members. These include the American Society of Civil Engineers (ASCE) Specification for the Design of Cold-Formed Stainless Steel Structural Members [1], the Australian/New Zealand Standard (Aust/NZS 4673) for Cold-Formed Stainless Steel Structures [2], and the European Code (Eurocode 3) Design of Steel Structures, Part 1.4: Supplementary Rules for Stainless Steels [3].

Cold-formed square hollow section is formed by cold-rolled with weld of annealed flat strip into a circular hollow section then further rolled into square hollow section. This process of forming by cold-working produces considerable enhancement to the material properties of the annealed steel. More economic design can be achieved by taking into account of the enhancement of the material properties due to cold-working. Hence, in this paper, the design strengths were calculated based on the material properties obtained from the finished specimens.

The material properties were determined by tensile coupon tests as well as stub column tests.

This paper describes the tests of fixed-ended cold-formed stainless steel tubular columns. Furthermore, tests of cold-formed stainless steel square hollow section K-joints are also describes in this paper. Design rules for stainless steel K-joints are proposed. Comité International pour le Developpement et l'Etude de la Construction Tubulaire (CIDECT) [4] has published the design rules for welded connections of carbon steel tubular sections. The design rules proposed in this paper adopt the CIDECT recommendations and incorporate the material properties specific to stainless steel. The purpose of this paper is to briefly describe the experimental investigation and design of cold-formed stainless steel tubular columns and joints performed by the author. The column test strengths were compared with the design strengths predicted using the American [1], Australian/New Zealand [2] and European [3] specifications for cold-formed stainless steel structures. In addition, design rules of the CIDECT recommendations were used for the design of stainless steel K-joints by replacing the yield stress with the 0.2% proof stress. This paper is extracted from the papers presented by Young [5] and Liu and Young [6]. Further details can be found in these papers.

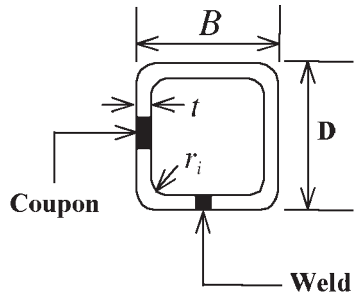

Figure 1 ***Definition of Symbols and Location of Tensile Coupon in Cross-section***

COLUMN DESIGN

Test Specimens

Experimental investigation of cold-formed stainless steel square hollow section (SHS) subjected to pure axial compression is described in Liu and Young [6]. A series of austenitic stainless steel of type 304 were tested between fixed ends for stub and long columns. The test specimens were cold-rolled from annealed flat strips. The specimens were supplied from the manufacturer in uncut lengths of 6000 mm. Each specimen was cut to a specified length ranging from 360 to 3600 mm, and both ends were welded to stainless steel end plates to ensure full contact between specimen and end bearings. The longest specimen lengths produced l_e/r_y ratios of 65 and 69 for Series S1 and S2 respectively, where l_e is the column effective length and r_y is the radius of gyration about the y-axis. Two series of SHS were tested, having nominal dimensions of 70 by 70 mm with thickness of either 2 or 5 mm. The two test series were S1 and S2 of section sizes 70x70x2 and 70x70x5 mm respectively. The cross-section of the SHS is shown in Fig. 1.

Material Properties

The location of the tensile coupon is shown in Fig. 1. The material properties of each series of specimens were determined from tensile coupon tests as well as stub column tests. For tensile coupon tests, longitudinal coupons were taken from the finished specimens belonged to the same batch of specimens as the column tests. The coupon dimensions conformed to the Australian Standard AS 1391 [7] for the tensile testing of metals using 12.5 mm wide coupons of gauge length 50 mm. The coupons were also tested according to AS 1391 in a 300 kN capacity Instron UTM displacement controlled testing machine using friction grips. A calibrated extensometer of 50 mm gauge length was used to measure the longitudinal strain. In addition, two linear strain gauges were attached to each coupon at the center of each face. The strain gauges readings were used to determinate the initial Young's modulus. A data acquisition system was used to record the load and the readings of strain at regular intervals during the tests. The static load was obtained by pausing the applied straining for 1.5 minutes near the 0.2% proof stress and the ultimate tensile strength. This allowed the stress relaxation associated with plastic straining to take place. The measured 0.2% proof stress obtained from the tensile coupon tests are 337 MPa and 444 MPa for Series S1 and S2 respectively.

For stub column tests, the material properties of the complete cross-section in the cold-worked state were obtained from the stub column tests. The shortest specimen lengths complied with the Structural Stability Research Council guidelines [8] for stub column lengths. Four displacement transducers were connected to the bottom end plate of the specimens, and the transducers measured the shortening of the specimens from the top end plate of the specimens. Similar to tensile coupon tests, the static load was obtained by pausing the applied straining for 1.5 minutes. The measured 0.2% proof stress obtained from the stub column tests are 381 MPa and 497 MPa for Series S1 and S2 respectively. The measured stress-strain curves obtained from the tensile coupon tests and the stub column tests were used to determine the parameter n using the Ramberg-Osgood expression [9]. The parameter n is to describe the shape of the curve, which obtained from the measured 0.01% (σ0.01) and 0.2% (σ0.2). proof stresses. The value of n obtained from the tensile coupon tests are 4 and 5 for Series S1 and S2 respectively, whereas the value of n obtained from the stub column tests is 3 for both Series S1 and S2.

Test Rig

The test rig and the test set-up of a typical column test are shown in Figure 2. A servo-controlled hydraulic testing machine was used to apply compressive axial force to the specimen. The columns were tested between fixed-ended bearings. The fixed-ended bearings restrained both minor and major axes rotations as well as twist rotations and warping. Displacement control was used to drive the hydraulic actuator at a constant speed of 0.7 mm/min. The use of displacement control allowed the tests to be continued into the post-ultimate range. A data acquisition system was used to record the applied load and the readings of displacement transducers at regular intervals during the tests. The test rig and the test procedure are detailed in Liu and Young [6].

Column Imperfections

The initial overall geometric imperfections of the test specimens were measured prior to testing. Geometric imperfections were measured for both x and y axes of the specimens. Two theodolites were used to obtain readings at mid-length and near both ends of the specimens. The maximum overall geometric imperfections at mid-length was 1/950 of the specimen length for both Series S1 and S2.

Figure 2 Test Rig and Test Setup

Design Rules

The ASCE Specification adopts the Euler column strength while the Aust/NZS Standard allows the use of Euler column strength (identical to those in the ASCE Specification) or the Perry curve. The latter has been used for the purpose of comparison. The Eurocode 3 adopts the Perry curve. For the ASCE Specification, the tangent modulus (E_t) was determined using Equation (B-2) in Appendix B of the Specification. For the Aust/NZS Standard, the values of the required parameters α, β, λ_o and λ_1 were obtained from Table 3.4.2 of the Standard, which depend on the type of stainless steel and these parameters are given as $\alpha = 1.59$, $\beta = 0.28$, $\lambda_o = 0.55$ and l1 = 0.20 for type 304. For the Eurocode 3, the values of imperfection factor and limiting slenderness were taken as 0.49 and 0.4 respectively, which were obtained from Table 5.2 of the Code. The three specifications require the determination of effective cross-section area (A_e) of the column. In the three specifications, the effective area was found to be equal to the gross area of cross-section (fully effective) for Series S2, whereas the effective area was found to be less than the gross area of cross-section at short column lengths for Series S1.

Reliability Analysis

The reliability index (β_o) is a relative measure of the safety of the design. Reliability analysis is detailed in the ASCE Specification [1], and a target reliability index of 3.0 for structural members as a lower limit is recommended. A resistance factor (ϕ) of 0.85 for concentrically loaded compression members is given by the American and Australian/New Zealand specifications, while a f factor of 1/1.1 is given by the Eurocode 3, and these factors are used in the reliability analysis. The load combinations of 1.2DL + 1.6LL, 1.25DL + 1.5LL and 1.35DL + 1.5LL are used in the analysis for American, Australian/New Zealand and European specifications respectively, where DL is the dead load and LL is the live load. The statistical parameters were obtained from Clause 6 of the ASCE Specification for structural members. The reliability indices (β_o) of the design rules were determined and the results are detailed in Liu and Young [6].

Comparison of Test Strengths with Design Strengths

The test strengths are compared with the unfactored design strengths obtained using the American [1], Australian/New Zealand [2] and European [3] specifications for cold-formed stainless steel structures. The design strengths were calculated using the material properties obtained from both the tensile coupon tests as well as the stub column tests, in which the 0.2% proof stresses were used as the corresponding yield stresses. Figure 3 shows the comparison of the test strengths with the design strengths for Series S1, where PASCE, PAust/NZS and PEC3 are the design strengths calculated using the material properties obtained from tensile coupon tests for American, Australian/New Zealand and European specifications respectively. The P'_{ASCE}, $P'_{Aust/NZS}$ and P'_{EC3} are the design strengths calculated using the material properties obtained from stub column tests. The theoretical elastic flexural buckling loads of the fixed-ended columns are also shown in Fig. 3. In calculating the design strengths and the theoretical buckling loads, the fixed-ended columns were designed as concentrically loaded compression members and the effective length (l_e) was assumed equal to one-half of the column length (L) for the fixed-ended columns ($l_e = L/2$) as recommended by Young and Rasmussen [10]. The design strengths and the theoretical buckling loads were calculated using the average measured cross-section dimensions and the measured material properties for each test series. It is shown that the design strengths predicted by the three specifications are generally conservative for the tested fixed-ended cold-formed stainless steel SHS columns. The reliability analysis shown that the design strengths predicted by the Australian/New Zealand Standard are slightly more reliable than the design strengths predicted by the American and European specifications. The comparison for test Series S2 is shown in Liu and Young [6].

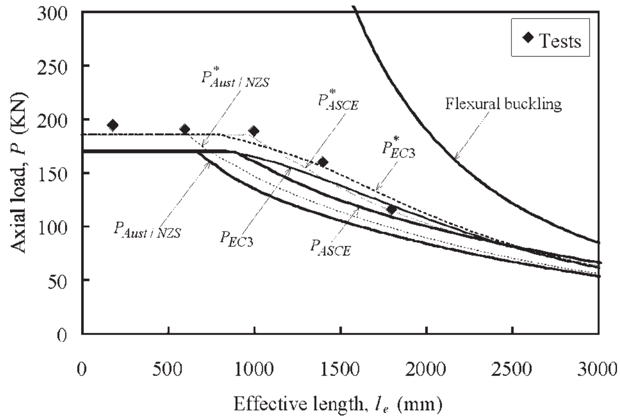

Figure 3 Fixed-ended Column Curves for SHS Series S1

JOINT DESIGN

Test Specimens

A series of tests on welded stainless steel K-joints fabricated from square hollow section (SHS) brace members and chords are described in Rasmussen and Young [11]. The K-joints were tested by varying the ratio of brace width to chord width, and the angle between chord and brace members. The tests consisted of both the gap joint and overlap joint. The SHS tubes were cold-rolled from annealed flat strips of austenitic stainless steel type 304L. The chord consisted of a nominal dimensions of 80x80x3 mm SHS for all specimens, and the brace members consisted of nominal dimensions of 38x38x3, 51x51x3 and 80x80x3 mm SHS that fully welded to chords, thus providing b-ratios of brace width to chord width of 0.48, 0.64 and 1.0 respectively. For each value of b, the brace members were connected at nominal angles (θ) of 30°, 45° and 60°. The fillet welds connecting the chord and brace members were designed according to the AWS Specification [12] and laid using the manual metal-arc welding. A 3.25 mm electrode of type E308L-16 with nominal 0.2% proof stress, tensile strength and elongation of 400 MPa, 610 MPa and 40% respectively was used for all welds.

Material Properties and Test Rig

A longitudinal tensile coupon was cut from the centre of a wall of the specimen, which formed a 90° angle with the wall containing the seam weld. The static 0.2% and 0.5% tensile proof stresses and the tensile strength were obtained as $\sigma_{0.2} = 450$ MPa, $\sigma_{0.5} = 520$ MPa and $\sigma_u = 690$ MPa respectively, and the elongation after fracture was measured as 45%. The initial Young's modulus was obtained as 191 GPa. A schematic view of the K-joints test arrangement is shown in Fig. 4. The material properties of the specimens and the test rig are details in Rasmussen and Young [11].

Design Rules and Comparison of Test Strengths with Design Strengths

Design rules are proposed for stainless steel SHS K-joints by adopting the rules of the CIDECT [4] recommendations for carbon steel tubular structures and replacing the yield stress in these recommendations by a proof stress. The CIDECT recommendations are also included in Annex K of Eurocode 3 [13]. The comparison of the test strengths with the proposed design strengths is detailed in Rasmussen and Young [11]. It is shown that the 0.2% proof stress can be used to determine the ultimate strength using the CIDECT design rules and that the serviceability limit state corresponding to joint deformations of 1% of the chord width would not be reached if the CIDECT strength rules are adopted. The proof stress can be based on the properties of the finished tube rather than the annealed properties.

Furthermore, tests of X-joints and K-joints with preload applied to the chord are also described in Rasmussen and Young [11].

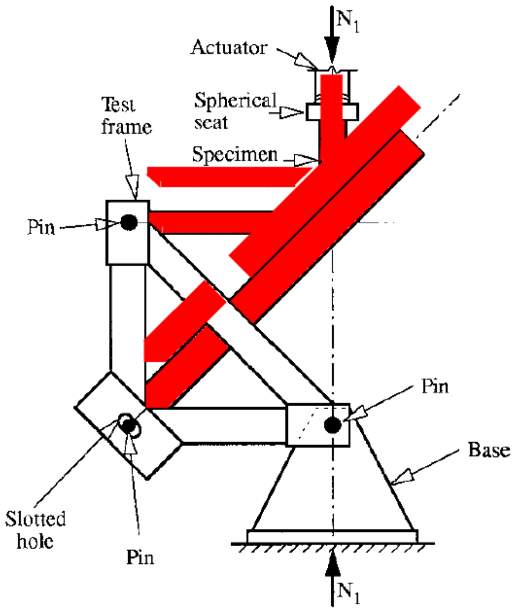

Figure 4 Schematic View of K-joints Test Arrangement

DESIGN RECOMMENDATIONS

- It is recommended that fixed-ended cold-formed stainless steel SHS columns can be designed using the Australian/New Zealand Standard [2] that calculated based on the material properties obtained from either stub column test or tensile coupon test.
- It is proposed that stainless steel SHS K-joints can be designed using the CIDECT [4] recommendations for carbon steel tubular structures by replacing the yield stress with the 0.2% proof stress.

CONCLUSIONS

Experimental investigation and design of stainless steel tubular sections have been described in this paper. The fixed-ended square hollow section columns and welded K-joints have been tested. The test strengths obtained from the column tests were compared with the design strengths obtained using the American, Australian/New Zealand and European specifications for cold-formed stainless steel structures. The design strengths were calculated based on the material properties obtained from the finished specimens, which takes into account of the enhancement of the material properties due to cold-working. Tensile coupon tests and stub column tests were conducted to determine the material properties. The reliability of the design rules has been evaluated using reliability analysis. It is shown that the design strengths predicted by the three specifications are generally conservative for the tested fixed-ended cold-formed stainless steel square hollow section columns. However, the reliability analysis shown that the design strengths predicted by the Australian/New Zealand Standard are slightly more reliable than the design strengths predicted by the American and European specifications. Design rules have been proposed for stainless steel K-joints by adopting the CIDECT design rules and replacing the yield stress by the 0.2% proof stress.

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INDUSTRIAL FORUM

INTRODUCTION TO ALUMINUM EXTRUSION

Clement Ng
Extrusion and Finishes Consultant

1. Introduction

1.1 Aluminum as a metal

The widely used aluminum metal, in this modern industrialized world, has its great advantages over other materials used, in relation to our living environment:

- Abundance – it exists in the form of bauxite and the quantity is about 8% of the earth crust;
- Attractive;
- Light weight, (sp. Gravity = 2.7, i.e. 35% of iron and 30% of copper);
- Corrosion Resistant, (further improved by surface finishing);
- Strong, (tensile strength up to 100,000 psi, when cold rolling, proper alloying and heat treatment method are applied);
- Recyclable (100%) – Friendly to environment;
- Resilient, (easy to form);
- Non-toxic;

- Non-combustible;
- Non-magnetic;
- Non-sparking;
- Suitable for welding;
- Reflective;
- Good electrical and thermal conductor, (conductivity of alloy 1350 is about 62 % of annealed copper, however the weight is only 1/3 of copper);
- Tough at low temperature;
- Good impact resistance;
- Density: 0.11 lbs/cu.in.;
- Melting point: 1220 F;
- Strength- to- weight ratio similar to steel;
- Low maintenance required, (self healing properties);
- Can be used in almost any metal fabrication process

1.2 From bauxite to aluminum

Production of Alumina and Casting into Aluminum billets

- From bauxite to Alumina by Bayer process
- The main source of alumina is the ore bauxite. It may contain 40-60% of Al_2O_3
- To purify the aluminous material in bauxite, the crushed bauxite is digested with a hot caustic soda solution under pressure
- The alumina hydrates dissolve to form a concentrated sodium aluminate solution while the insoluble impurities, predominantly iron oxide, titania and complex silicates, are separated either by settling them out in thickeners or filtering, or both.
- The clear sodium aluminate solution is cooled and a seed of fine alumina trihydrate added. The now supersaturated sodium aluminate solution decomposes and deposits further alumina trihydrate on the surface of the seed
- This seeding operation was invented by Karl Josef Bayer in Austria and patented by him in 1888
- Primary aluminum from reduction plant
- An alumina reduction plant (smelter), consists of many units of electrical cell will reduce the alumina (aluminum oxide) into pure liquid molten aluminum
- The purity of this molten aluminum is 99.9%, and will be subsequently cast into ingots. Ingots are further melted down and added with alloying element and cast into billets, in a special designed mould applying a water direct chilling method.

2. Forming of aluminum

2.1 Forming of aluminum Sheet

- Blanking, cutting, and piercing;
- Brake forming;
- Roll forming;
- Spinning and flow forming;
- Deep drawing and ironing;
- Embossing, coining, and stamping;
- Other forming: stretch forming, rubber die forming etc.

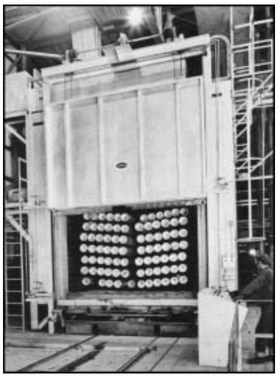
2.2 Forming hollow and solid shapes

- Draw bending and roll bending;
- Ram, press, and compression bending;
- Stretch and hand bending, wire bending, bus bar bending;
- Rotary swaging, expanding and flaring;

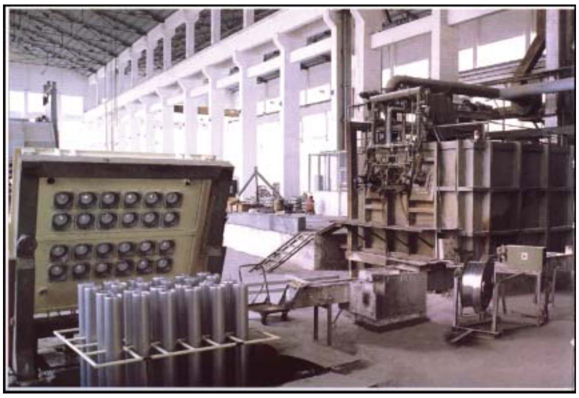
2.3 Forging and cold heading are used for forming mechanical parts of special shape, by using a strong compress force, ready for further heat treatment and machining.

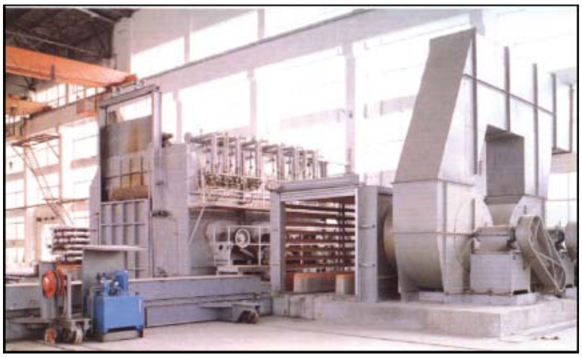
2.4 Extrusion of aluminum

Extrusion of aluminum is one of the most important hot metal working process producing solid shapes and hollow shapes of aluminum alloy in long length for industrial, structural and architectural applications.



A typical homogenizing furnace





3. Aluminum Extrusion Process

Extrusion process produces shapes for industrial, mechanical and architectural applications. A series of different aluminum alloy and their various conditions of mechanical property are specially designed for practical applications.

3.1 Aluminum extrusion alloy

The typical aluminum alloys, in a 4 digits naming system, and their applications:

- Food Industry -- 1xxx,
- Packaging – 1xxx, 3xxx,
- Chemical and pharmaceutical industries – 1xxx,
- Transportation – 3xxx, 5xxx, 6xxx,
- Architectural Building – 6xxx
- Machinery and Equipments – 2xxx, 6xxx,
- Ship Building – 5xxx, 6xxx,
- Aerospace – 2xxx, 6xxx, 7xxx, 8xxx,
- Defense – 2xxx, 6xxx, 7xxx,
- Electrical – 2xxx, 6xxx,
- Consumables – 1xxx, 4xxx,

One of the most frequently use extrusion alloy in the field of architectural and structural application is 6xxx series – the AlMgSi (aluminum magnesium silicon) alloy.

The design of an alloy is based on the requirements for its strength, subsequent fabrication and surface treatment. Certainly, how to achieve the optimum extrudability is always one of the most important issue, when a new alloy is going to be produced.

Metallurgy of 6xxx Alloys – AlMgSi:
The typical composition is as in the following:
% Mg2Si = 1.58 x % Mg
(Alloy 6063)
Mg = 0.53 %, Si = 0.4 %
% Mg2Si = 0.83 %

The composition of the major alloying elements is Aluminum, Magnesium and Silicon. If the alloying elements are not in the right proportion, the required physical properties will be greatly affected, such as tensile strength.

3.2 Designation of temper

The mechanical property of the extruded aluminum alloys will be affected by the use of different hot work process. The temper designation is for identifying the exact hot work and/or cold work process required, during the manufacturing process.

- F - as fabricated – no mechanical property limit,
- O - annealed – lowest strength temper,
- H - strain-hardened for cast, forged and rolled product,
- T - thermally treated to produce stable tempers other than F, O, or H,
  - T4 - solution heat-treated and naturally aged to a substantially stable condition, suitable for further cold work, such as bending,
  - T5 - cooled from an elevated temperature shaping process and then artificially aged. Typical examples of application for alloy 6063-T5 are window, door and architectural applications.
  - T6 - solution heat-treated and then artificially aged.

It is typically applicable for hard alloys, such as 6061-T6, to achieve a maximum tensile strength. Sometimes it is used to achieve the maximum strength as well as for guarantee of producing consistent color, especially on the single step (integral) color anodizing process.

3.3 Tool and die for extrusions

In order to produce a solid or hollow aluminum shape, a precision die (mould) of the shape will have to be made, in a well equipped die shop.

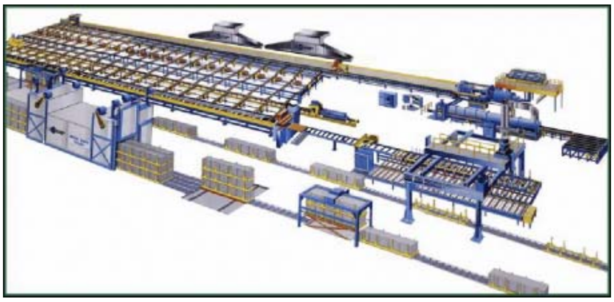
A modern tool and die shop should be equipped with the following material and process:
- Accumulated tool design knowledge;
- Good quality of hot work steel;
- CAD/CAM system;
- Advance CNC machine centers;
- Advance high precision spark wire cutting machine;
- Heat treatment of dies and case hardening (nitriding) of die

Other than the above fully equipped tool shop, skillful tool and die designers and die makers are the most important factor for producing quality die.

3.4 Extrusion process:

- Homogenizing of billets before extrusion
  It is a heat treatment process. Through a properly pre-determined heating and cooling cycle, the aluminum billets will have its constituent elements in a homogeneous solid solution situation. Billets produced this way will have a better extrudability. The extrusions produced from homogenized billet will have a more uniform physical property and smoother metal surface.
- Pre-heat of extrusion die
  Dies are pre-heated to approximately 450 to 470 degree C, before it is put onto the press for use.
- Pre-heat of aluminum billet
  Aluminum billet is pre-heated to 450 to 500 degree C, before extrusion.
- Extrusion presses
  Hydraulic presses with PLC control capability are most commonly used.
- Press sizes from 500 Ton to 4,000 Ton are in use.
  Hydraulic press of 10,000 metric Ton is in operation, in China now.
- Extrusion
  The extrusion press forces the heated aluminum billet through a pre-heated die to form a solid or hollow shape of aluminum alloy.
- Extruding and exit temperature
  The temperature of the metal exit from the die, have to be well controlled.
- Cooling and quenching with air and water
  In conjunction with the extrusion exit temperature, the controlled cooling procedure is to achieve a pre-determined cooling rate.
- Stretching
  It is a stress relieve and straightening process.
- Saw cutting
  Cut to the required length by circular saw.
- Ageing - artificial ageing
  The ageing process has to be controlled according the requirement of TEMPER.
  Some structural material may need to go for fabrication, before the ageing process.
  The ageing cycle time and set temperature, is very important for achieving the right temper.
- Heat-treatable - tensile strength
  It is very important to realize that the whole extrusion related manufacturing process is temperature sensitive and time related.

  Any subsequent fabrication related to HOT WELDING on aluminum extrusion and /or aluminum sheet will greatly affect the mechanical property of the fabricated par part. The welding process need to have good temperature control, in order to ensure the heat of welding does not destroy the mechanical property.



4. Surface Finishing of extrusions

4.1 Mechanical finishes

Grinding, polishing, buffing, satin finishing and linishing, abrasive blast finishing etc. These mechanical processes are mainly used for prepare the metal surface for further treatment.

4.2 Chemical finishes

Cleaning, Etching, Brightening, Polishing and Conversion coating, etc. are surface pre-treatment chemically.

4.3 Electrochemical finishes

Sulphuric acid anodizing,

In the acidic condition, the aluminum extrusion is being racked on the ANODE of the DC circuitry, to obtain an aluminum oxide film. The process is also called "Artificial Oxidation".

4.4 Coloring of anodic film

- Clear anodizing: It is also called "Natural Color". No coloring process has been applied and the anodic film is "Clear" in color.
- Integral color: It is also called "One Step Color". The colored anodic film is formed during the anodizing process. No coloring metal salt is used. It is the most durable color, but the processing cost is rather high.
- Electrolytic color: It is also called "Two Step Color".

  An inorganic (metal) salt, such as metal salt of Tin, Ni, Co and Cu with a Sulphuric acid anion, are commonly used to color the anodized aluminum. It is an electrolytic process, and this operation is performed after anodizing and before sealing of the anodic film with hot water.

4.5 Chemical Brightening and Electrochemical Brightening

This is for producing high clarity and bright finish. It has very high decorative value. An anodizing process has to be applied onto this bright surface to form a protective anodic film.

4.6 Sealing of anodic film

It is a simple step of the whole process, however, it is also the most important step. It sealed of the micro porosity in the anodic film with hot water. Very often, enhancing chemicals are added into the hot water, to ensure the effectiveness of the result of sealing.

Without proper sealing, the anodic film could easily subject to environmental corrosion. Simply a thicker anodic film could not stop the induced corrosion through the pore filled with inorganic metal salt.

4.7 Applied finishes

Chromic acid conversion coating: is a pre-treatment process for subsequent top surface coating described in the following:

- Alkyd coating;
- Acrylic coating;
- Vinyl coating;
- Epoxy coating;
- Urethane;
- Fluorocarbon decorative and corrosion resistant coating;
- Powder coating,

The Fluorocarbon and Powder are commonly used for architectural application, because of their excellent durability and many choices of attractive color.

4.8 Modern production line of aluminum finishes

Horizontal processing line:

- Low investment cost;
- Flexible for producing extrusions as well as sheet metals;
- Relatively higher manufacturing cost per unit;
- Vertical processing line:
- to 5 times the investment cost;
- Capable of mass production;
- Relatively low operation cost;
- Could achieve a better coating uniformity.

REPORT ON THE INSTITUTE'S PAST EVENTS

There was a wide variety of seminars organized by HKISC since October 2002, such as "Structural assessment of steel-framed buildings subject to explosion and fire" by Dr. B. Izzuddin of University of London on 28 October 2002; "Outlook for Aluminium Structures" on 30 November 2002 which was co-organized by our Institute and the Hong Kong University of Science and Technology; "New concepts in structural steel decking systems and their application in composite steel-frame buildings" by Professor Mark Patrick of University of Western Sydney on 3 December 2002. Our Institute also supported in "The Third International Conference of Advances in Steel Structures (ICASS'02) held on 9-11 December 2002 by the Department of Civil and Structural Engineering of the Hong Kong Polytechnic University. We had invited Dr. Lin Hai Han of The College of Civil Engineering & Architecture of Fuzhou University to give a seminar on "Recent developments in concrete-filled steel tubular structures in the Mainland of China"; On 27 December 2002, our President had been invited by City University of Hong Kong to present a topic on "Testing and design of steel scaffolds against stability strength", all of which were eye-opening and well received. In-depth discussions were achieved and after these seminars, we believed the audience had much better grasp of the structural behaviour and their applications in the above-mentioned aspects.

We would like to thank again all those involved in these seminars. Nonetheless, the support of the audience was much appreciated.

CALL FOR ARTICLES

HKISC bulletin is circulated among engineers, architects, building and construction professionals. If you wish to express an opinion or submit an article of interest, please send to HKISC for review.

CALL FOR MEMBERSHIP

HKISC is a registered non-profit making organization to promote the healthy development and the quality and competitiveness of steel related structures. Anyone interested in steel construction is welcome to join HKISC. Members will receive information on local and overseas technologies, conferences and seminars.
Please download the membership qualification and application form from the institute's web-site.
http://www.hkisc.org

THE FIRE GROUP (FG)

Fire is one of the most horrifying threats to human beings. If not managed properly, fire can lead to devastating consequences in loss of property and human lives. On the other hand, if controlled effectively, it leads to reduction in building cost, improved safety and possible lowering of insurance cost under a proper fire management system.

In recent years, the performance-based fire engineering becomes more popular in technologically more advanced countries. It involves more careful fire fighting plan when compared to the prescriptive design method against fire which simply limits building materials to their supposingly safe temperatures such as 5500C for steel. However, performance-based fire engineering requires more extensive and intensive engineering and research on fire which needs cooperation and joint effort between different professionals including architects, builders, engineers, fire-fighting professional, fire-product suppliers and surveyors.

This fire group (FG) is aimed at uniting the efforts of these professionals to assist in implementing the safer and more cost-effective performance-based fire engineering approach. The group is operated in conjunction with The Hong Kong Institute of Steel Construction (HKISC website: www.hkisc.org) with members from academics, government officials and building professionals. The link is believed to allow the fire professionals to work closer with the building professionals for promotion of better fire fighting strategy which eventually contribute a safer and better live environment to the people in Hong Kong and the region including Southeast Asia and China.

All interested professionals involved in fire prevention, fighting, research and engineering are welcome to join the group. As administrative cost due to renting of seminar halls for courses and seminars and daily operation will be partly covered by HKISC, the membership fee is set is **HK$200** per year which includes **free admission to seminars and reduction in admission to short courses organized by HKISC and FG**. Last year, HKISC has organized more than 10 seminars with average more than 100 participants. These seminars not only allow us to upgrade our knowledge in the field, but also realize more about other professionals

Please send the completed registration form together with the registration fee pay by cheque** to Miss Yvonne Lo,

** Cheques should be crossed and made payable to "Hong Kong Institute of Steel Construction Limited".

The registration form may be downloaded from the web-site of Hong Kong Institute of Steel Construction (http://www.hkisc.org) or requested through Miss Yvonne Lo on 2766 6070.

THE COMPANIONS AGAINST METHOD OF EFFECTIVE LENGTH (CAMEL CLUB)

In December 2002, The **Companions Against Method of Effective Length (CAMEL Club)** has been set up. CAMEL club draws the strength of international researchers and engineers by sharing experience in using nonlinear and second-order analysis and design method in place of the deficient effective length method. You can write to us on some of your experience, views on and photographs of collapse incidents we will then distribute to CAMEL members after editing. For details, please visit our website at *http://www.hkisc.org/camelclub.htm/*.

MEBERSHIP RENEWAL

For current members of the Institute, we cordially invite you to renew your membership before **the end of March 2003** by sending your membership renewal form and cheque (payable to **THE HONG KONG INSTITUTE OF STEEL CONSTRUCTION)** to:

c/o TU704, Department of Civil and Structural Engineering,
The Hong Kong Polytechnic University, Hung Hom.

For further enquiries, please contact Miss Yvonne Lo at 2766 6070 or via email: ceyvonne@polyu.edu.hk.

MEMBERSHIP FEE

Fellow member	HK$400 per year
Corporate member/ Affiliate member	HK$200 per year
Associate member	HK$100 per year

Membership expiry date: 1st January every year.

Further information can be obtained from
Professor S.L. Chan,
Department of Civil and Structural Engineering, the Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong.
Email: ceslchan@polyu.edu.hk
Tel: 27666047 Fax: 23346389

CALENDER FOR COMING SEMINARS AND CONFERENCES

A series of interesting topics are scheduled from January 2003.

- "Design and Practice of Steel Scaffolding Systems in U.K" on 15 January 2003 by Mr. Rob Beale, Oxford Brooke University, U.K.
- "Repair and Retrofit of Structures: Recent Development" on 15 February 2003, organized by Professor J.G. Teng, The Hong Kong Polytechnic University.
- "Use of Profiled Steel Decking in Composite Construction" in February 2003, organized by Dr. K.F. Chung, The Hong Kong Polytechnic University.
- "Fire Engineering and Composite Construction" in March 2003, organized by Dr. K.F. Chung, The Hong Kong Polytechnic University.
- "Metal, Bamboo and Steel Scaffolding" in May 2003, organized by Dr. S.W. Poon, The University of Hong Kong.
- "Mainland China, Taiwan and Hong Kong conference on 'Steel and Metal Structures' 2003" on 29-30 May 2003.
- "Non-linear Application in Steel Structures" in September 2003, organized by Professor S.L. Chan.
- "Design of Stainless Steel Structures" in October 2003, organized by Dr. Ben Young, The Hong Kong University of Science and Technology.

Please refer to the updated seminar programme on the institute's web-site. (http://www.hkisc.org/)

CALENDAR FOR CONFERENCES OVERSEAS & CALL FOR PAPER SUBMISSION

- Advances in Structures – Steel, Concrete, Composite and Aluminium, ASSCCA '03. Sydney, Australia
  23-25 June 2003 organized by The University of New South Wales and The University of Sydney
  Website: http://www.civil.usyd.edu.au/asscca03

Please refer to Institute via HKISC web-site for more information on conferences and seminars