P.O. BOX 1081
2120 HEWITT AVE
EVERETT, WASHINGTON 98206-1081

Diversified Design Inc.
PROFESSIONAL ENGINEERS AND DESIGNERS

Bricking Solutions Inc.
1144 Village Way
Monroe, Washington 98372

May 10, 2006

Attn: Mr. Bill Barraugh

Subject: Engineering review of round versus square tubular section structural fabrications

Dear Bill;

The following is a review of the advantages and disadvantages in the comparison of square and round tubular shapes when used in structural aluminum fabrications:

I. The use of aluminum in industrial structural fabrications is primarily for weight reduction, especially when used in fabrications that have to be installed manually.

A. To maximize the strength and again, minimize the weight of these fabrications a heat treated aluminum alloy is usually used. Alloys such as 6061-T6 for instance have a tensile yield strength in excess of 40,000 psi. Therefore if a fabrication is properly designed and fabricated and the deflections are within good design practices for the application, the engineer can provide the end user with a finished product that weighs between 30-35% of a similar fabrication designed in mild steel.

B. The choice of aluminum structural sections in the heat treated alloys is some what limited, especially in large sections, however for manually handled assemblies, fabrications are usually made-up of structural sections not exceeding 8" - 12".

Continued on Page -2-

TELEPHONE [redacted] ■ 252-5126 FAX [redacted] ■ [redacted]

II. Fabrication of heat treated alloy aluminum has some very special design requirements because of the extreme reduction of strength in the welds and in the heat effected parent metal areas. The 6061-T6 alloy that is common use for its high strength characteristics is reduced to a yield strength in the 10 - 15,000 psi range in the welds and heat effected areas of its parent metal.

A. The above strength reductions require both the designer and the fabricator to be utmostly aware of every assembly's high stressed connections.

B. These high strength aluminum alloys also require advanced quality control, welding techniques and welder experience that is far above the basic requirements for mild steel fabrication.

III. The basic comparison between aluminum structual sections again comes down to the strength to weight ratio that is the primary objective of the designer. All bending stress is based on the moment of inertia and section modulus of the particular shape.

A. For a simple comparison a 6" round shape with a 1/4" wall has an "I" (moment of inertia) of 18.3 in. to the 4th. power and a 6" square tube with a 1/4" wall has an 'I' of 31.7. This represents a 70% strength increase in the square versus the round with only a 26% weight increase.

B. For same weight sections of round versus square the square is approximately 35% stronger than the round section shape.

IV. In addition to the the basic strength to weight improvement that square sections have over round sections, the square shapes have a great advantage over the round sections in the areas of fitting, weld locations , gusseting and attachment of reinforcement plates.

Continued on Page -3-

IV. (cont)

A. The radiused corners of the square tubes adapt very well for the placement of welds with out extensive preparation.

B. The square tube's flat sides allow optimum placement of exterior reinforcement plates that can be welded longitudinally along the tube to maintain the structural integrity of the fabrication.

V. This basic comparison reviels that when strength to weight is the main objective in fabrication design the square section shapes have the ability to produce a finished fabrication of the same strength as a similar assembly fabricated from round section shapes with an approximate 20% weight reduction and simpler fitting and weld placement.

If there are any questions regarding the above comparisons, please contact Verne Lindberg at (425) 232-9128

Yours Truly,

Verne L. Lindberg P. E.
Engineering Manager DDI

MAY 12, '06

VERNE L. LINDBERG
STATE OF WASHINGTON
08995
REGISTERED
PROFESSIONAL ENGINEER

Expires: 11-6-06