

General Overview:

Request for proposal of a plunger actuated composite stanchion to meet the load and fire requirements as specified for the three hold types; Freeze/Chill (F/C), Specialty Cargo, and Holds 1&2. Laminate construction for prototype stanchions is shown in Laminate Construction section.

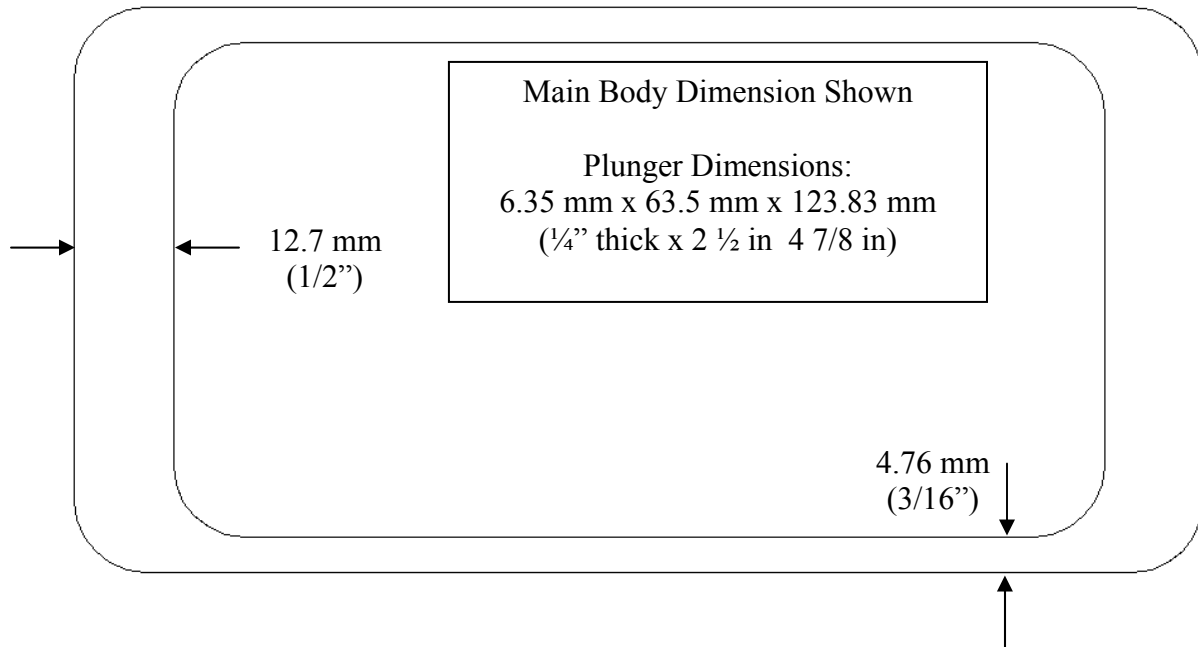
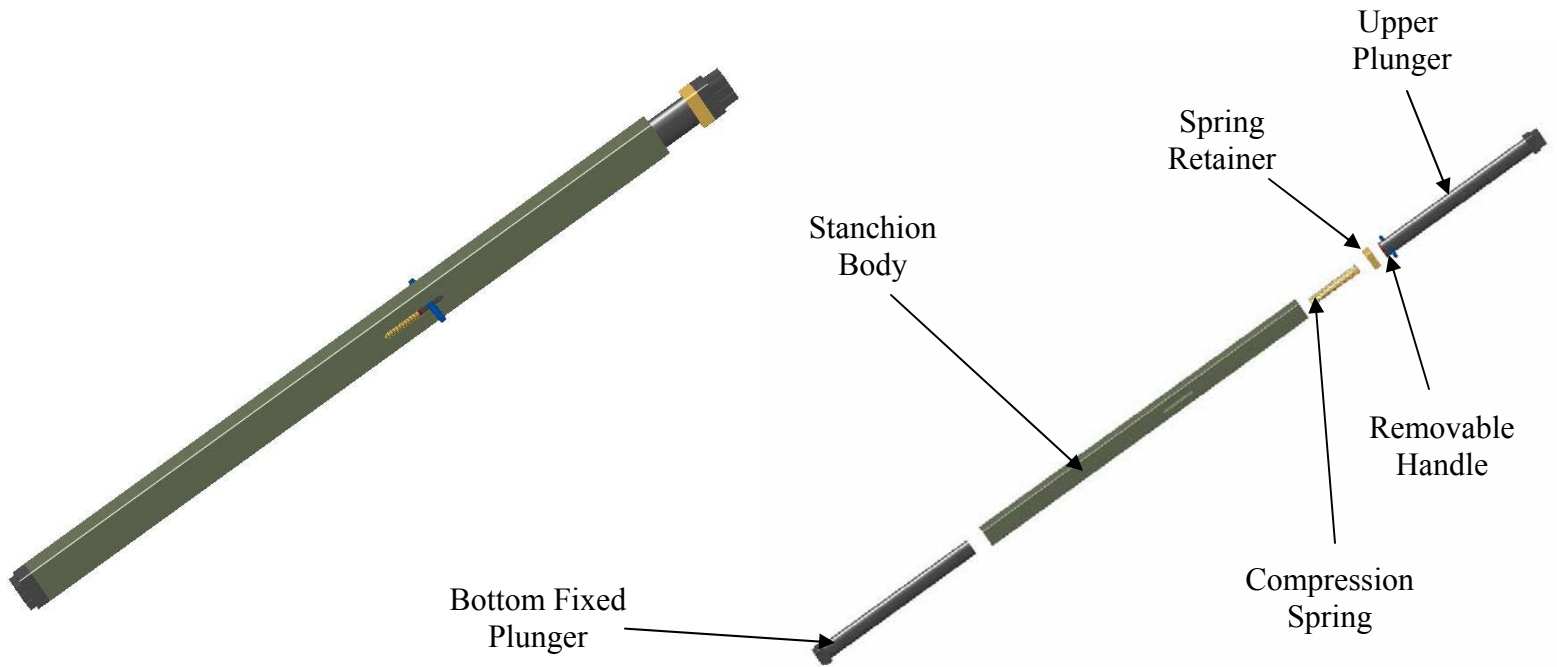


Figure 1: Composite Stanchion

Design Consideration:

A minimum safety factor of three on the provided loads in the Load Requirements Section is required of the design. Provide analysis of stanchion to document that stresses meet the design loads. Analysis shall examine, but is not limited to, the stanchion main body, end cap to main body interface, plunger to main body interface, end cap to plunger interface, etc. State all assumptions and supporting documents for the analysis (i.e. design allowables, textbooks, software, etc.).

Substantiate the stanchion can support 200% of the anticipated service loads in Load Requirement Section by physically testing the stanchion. If utilizing procedures different from those provided, submit the test procedures along with the results, photographs, etc. for the testing.

Provide assessment of stanchion toughness in regards to impact loading when dropped from a height of approximately 1.2 meters onto a concrete surface.

Stanchion Design:

The stanchions design for the Freeze/Chill (F/C) Holds are strength driven while the stanchion design for Holds 1 & 2 and the Specialty Cargo are stiffness driven with a deflection requirement of L/240. Utilize the approximate stanchion length, L, shown in Table 1 in the proposal. The final lengths shall be provided to the winning bidder.

Table 1: Stanchion Lengths for Various Holds

| Hold | Length, L mm | Design Driver |
|-----------------|-------------------------|--------------------------|
| 1 & 2 | 3088 | Stiffness |
| Freeze/Chill | 2800 | Strength |
| Specialty Cargo | 2600 | Stiffness |

The outer size envelope of the stanchion is 76.2 mm x 152.4 mm (3 in x 6 in).

Each stanchion height requires a unique color as to provide visual identification for the three different stanchions. (Color may vary as to vendor choice)

The weight goal for the assembled stanchion is 22.7 kg (50 lb) with an upper weight limit of 27.2 kg (60 lb).

End Cap Design:

The end caps for the F/C hold shall interface with a composite grating while the end caps in the Holds 1&2 shall interface with a steel channel. (See Figures 2 & 3 for end cap details for F/C and Holds 1&2, respectively).

Assume a simply supported end condition at the end caps for all holds. The pin size in Figure 3 is 31.75 mm (1.25 in). The two pins are evenly spaced along both dimensions of the end cap.

The overhead end cap in the F/C hold is similar to the one shown in Figure 2. The end cap in Holds 1&2 is a single 31.75 mm (1.25 in) pin. The pin is centered on the end cap.

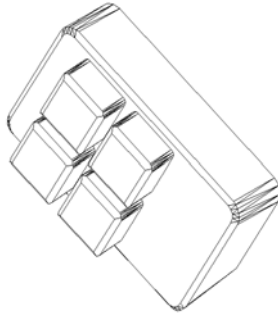
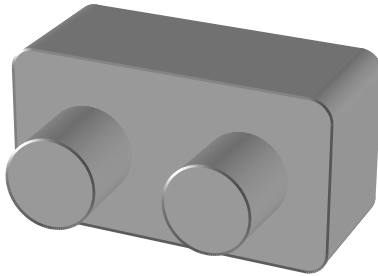
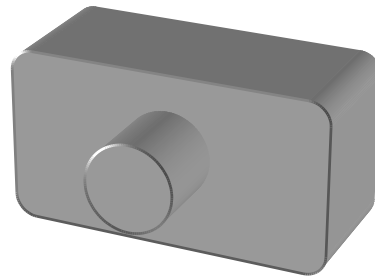


Figure 2: End Cap Design for Composite Grating



a) Deck



b) Overhead

Figure 3: End Cap Designs for Steel Channel / diagonal holes

Spring Design:

The calculations (in English Units) for the original spring design are provided below. The stanchion shall utilize a spring with a spring constant of 1 N/mm (5.7 lb/in). The weight of the upper plunger assembly (plunger, adhesive, and end cap) may necessitate new calculations.

Spring Design (cont.):

References

(a) Machinery's Handbook, Springs Section

Assumptions:

| | |
|--|---|
| spring material | CRES 316 |
| torsional modulus, G (psi) | 10.0E+6 |
| spring service life | average service 10^5 to 10^6 cycles |
| coil ends design | closed and ground |
| wire diameter, d (in) | 0.1875 |
| outside coil diameter, OD (in) | 2.5 |
| required deflection, F (in) - consists of 4" precompression to offset weight of stanchion top and 6" operational compression | 10 |
| maximum available deflection, F_{max} (in) | 10.5 |
| number of active coils, N | 18 |
| minimum required load, P_r (lbs) | 65 |

Calculations

| | |
|--|--------|
| mean coil diameter, $D = OD - d$ (in) | 2.3125 |
| total coils, $TC = N + 2$ | 20 |
| solid height, $SH = TC * d$ (in) | 3.75 |
| free length, $FL = F_{max} + SH$ (in) | 14.25 |
| pitch, $p = (FL - 2 * d) / N$ (in) | 0.77 |
| load, $P = (G * d^4 * F) / (8 * N * D^3)$ (lbs) | 69.41 |
| spring constant, $k = P / F$ (lbs/in) | 6.94 |
| spring index, $SI = D / d$ | 12.33 |
| stress correction factor, K (Fig 13, Ref (a)) | 1.12 |
| stress, $S = P * D / .393d^3$ (psi) | 61,956 |
| corrected stress, $S_c = K * S$ (psi) | 69,391 |
| CRES 302 allowable stress, psi, σ_{all} (Fig 5, Ref (a)) | 86,000 |
| Correction Factor for CRES 316 (Table 1, Ref (a)) | 0.9 |
| CRES 316 allowable stress, psi, σ_{all} | 77,400 |
| Density of Steel lbs/in ³ | 0.2833 |
| Volume of spring in ³ , $= (\pi(d/2)^2) * N * \pi * (OD - d)$ | 4.01 |
| Spring Weight = density * volume, lbs | 1.14 |

Manufacturing Consideration:

Provide Quality Assurance plan for stanchion, including but not limited to, dimensional tolerances, weight variance, batch control, adhesive, etc. Raw material Quality Assurance plan not necessary but accepted.

Mechanical Property Testing:

To verify/quantify composite material properties used in component manufacturing, ASTM testing data will be supplied in accordance with testing as outlined in the following table.

Table 2: Mechanical Property Coupon Testing

| Mechanical Property | Test Method | Test Condition & Number of Tests | | | Total Number of Tests (3 Batches) |
|-----------------------|--------------------|----------------------------------|-----|-----|-----------------------------------|
| | | CTD | RTA | ETW | |
| 0° Tension | ASTM D 3039 | 5 | 5 | 5 | 45 |
| 90° Tension | ASTM D 3039 | 5 | 5 | 5 | 45 |
| 0° Compression | ASTM D 3410(IITRI) | 5 | 5 | 5 | 45 |
| 90° Compression | ASTM D 3410(IITRI) | 5 | 5 | 5 | 45 |
| In-Plane Shear | ASTM D 4255 | 5 | 5 | 5 | 45 |
| Open Hole Compression | SACMA RM 3 | 5 | 5 | 5 | 45 |
| Open Hole Tension | ASTM D 5766 | 5 | 5 | 5 | 45 |
| 0° Short Beam Shear | ASTM 2344 | | 1 | | 3 |
| Resin Content | ASTM 2584 | | 1 | | 3 |
| Density | ASTM 1622 | | 1 | | 3 |
| Void Content ≤ 2% | ASTM D 2734 | | 1 | | 3 |
| Water Absorption ≤ 2% | ASTM D 570 | | 1 | | 3 |

CTD – Cold Temperature Dry (-29C)

RTA – Room Temperature Ambient

ETW – Elevated Temperature Wet (Equilibrium Conditioning - 95% RH and 49C)

Three batches (minimum) per test. A batch consists of laminates fabricated on three different days.

IITRI is also known as Procedure B.

Fire Requirements & Testing:

Flame Spread

Test:

IMO Resolution A. 653(16) Recommendation on improved Fire Test Procedures for Surface Flammability of Bulkhead, Ceiling, and Deck Finish Materials

Criteria:

- Critical Flux at Extinguishment (CFE) > 20.0 kW/m²
- Heat for Sustained Burning (Q_{sb}) > 1.5 MJ/m²
- Total Heat Release < .7 MJ
- Peak Heat Release Rate < 4.0 kW

Fire Requirements & Testing (cont.):

Smoke Generation

Test:

IMO MSC.61 (67) Part 2 Smoke Test (ISO 5659) **OR** ASTM E 662

Criteria:

IMO – $D_m < 200$ (Criteria for bulkheads, linings, or ceilings)

ASTM – $D_m < 200$ for flaming and non-flaming modes

Toxicity

Test:

ASTM E 662

Criteria: (for flaming mode)

- $CO < 350$ ppm
- $HCN < 30$ ppm
- $HCL < 30$ ppm

Load Requirements:

Apply all loads to the strong axis (i.e. normal to the short dimension) of the stanchion. (See Figure 4 for details) Apply each load in a static manner. Maintain the load for a 10-minute duration.

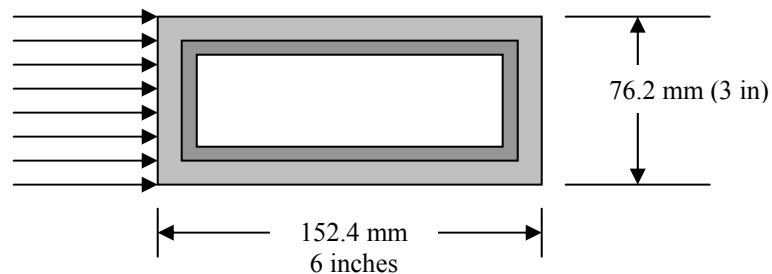


Figure 4: Axis of Loading for Stanchion Cross-section

Loading requirements vary depending on stanchion application. Tables 3 through 5 outline the loads for the three stanchion lengths.

Table 3: Specialty Cargo Holds (2600 mm stanchion)

| Reaction Location | Height of Applied Load mm | Applied Load N/mm |
|----------------------------|----------------------------------|--------------------------|
| Deck Grating Interface | 1219 | 24.2 |
| Overhead Grating Interface | 2438 | 12.4 |
| Maximum Bending Moment | 2438 | 12.4 |

Table 4: Freeze/Chill Holds (2800 mm stanchion)

| Reaction Location | Height of Applied Load mm | Applied Load N/mm |
|----------------------------|----------------------------------|--------------------------|
| Deck Grating Interface | 1219 | 24.2 |
| Overhead Grating Interface | 2438 | 12.4 |
| Maximum Bending Moment | 2438 | 12.4 |

Table 5: Holds 1&2 - Heavy Ammo Storage (3088mm stanchion)

| Reaction Location | Height of Applied Load mm | Applied Load N/mm |
|----------------------------|----------------------------------|--------------------------|
| Deck Grating Interface | 556 | 93.4 |
| Overhead Grating Interface | 2224 | 23.3 |
| Maximum Bending Moment | 2649 | 18.7 |

Stanchion Test Procedure:

Select a load beam with an EI approximately 80%-90% that of the stanchion. The length of the load beam should be equal to the height of the cargo stack. Place the load beam such that one end of beam aligns with the base of the stanchion.

Simply support the ends of the stanchion. Apply the corresponding load found in the Load Requirements section to the center of the selected load beam. Record the deflection and load at the center of the stanchion at a predetermined interval. The interval utilized in previous testing was four strokes of the hydraulic actuator between deflection recordings. Figure 5 depicts the set-up previously utilized to test the prototype stanchions. Please note that this set-up differs from required testing in that the distributed load was centered on the stanchion.

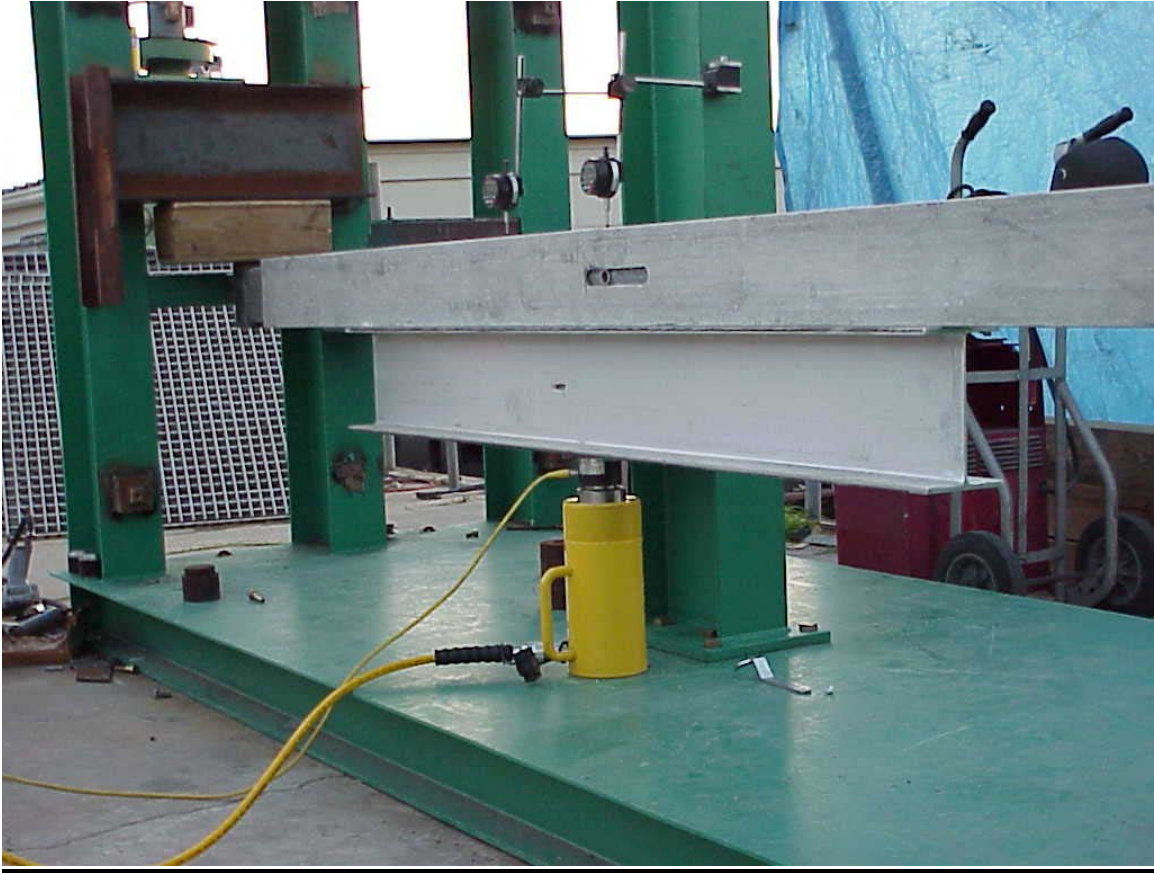
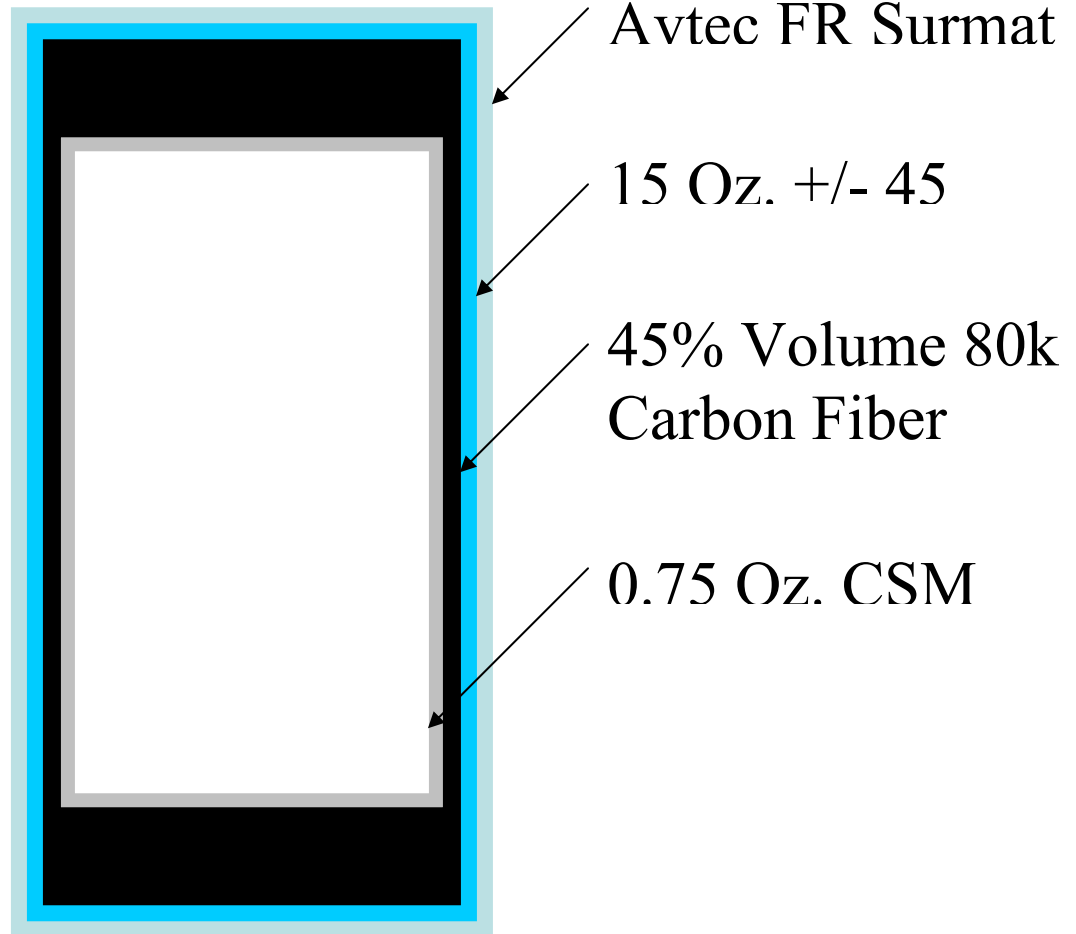


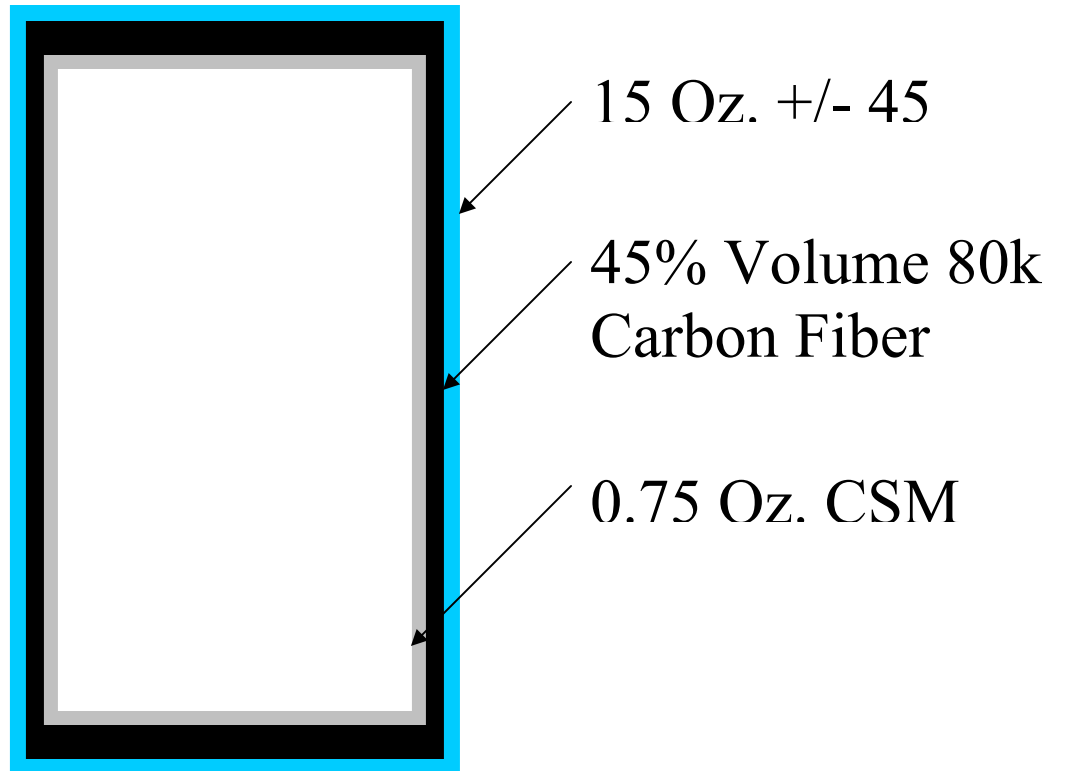
Figure 5: Stanchion Deflection Test

Laminate Construction:



Stanchion Main Body
Laminate Schedule

Laminate Construction (cont.):



Stanchion Plunger Tube Body
Laminate Schedule