

# **PLASCORE DEFORMABLE BARRIER**



## **EEVC Frontal Offset Barrier**



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## **1. Introduction**

### **1.1 Performance requirements**

The European Enhanced Vehicle-Safety Committee's, Working Group 11 (EEVC WG11) developed a new European frontal impact standard which has become ECE Regulation 94. The standard specifies a barrier which includes a crushable face to simulate the stiffness of the front end of a striking vehicle. The main core of this barrier face assembly is to be constructed from aluminum honeycomb having crush strength of 0.342 MPa (49.6 psi). The Barrier face assembly also includes a bumper constructed of honeycomb having crush strength of 1.711 MPa (248.15 psi). Although, in engineering terms, strength signifies a load, since the term crush strength is commonly used by aluminum honeycomb manufacturers to signify a load per unit area, units of this measure will be MegaPascal (MPa) / pounds per square inch (psi).

Several companies could potentially manufacture this honeycomb material, each having their own method for testing the crush strength of the material. In order to assure equivalence between the barrier faces of the various manufacturers, a standard procedure for certifying the crush strength of the aluminum honeycomb has been established.

### **1.2 Documentation**

The test contractor must obtain a copy of the certification data and procedure used by the honeycomb face manufacturer to certify that the honeycomb barrier meets the 0.342 MPa (49.6 psi).

The test contractors will obtain a copy of the certification data and procedure that the barrier face manufacturer uses to certify that the bumper honeycomb barrier meets the required crush strength of 1.711 MPa (248.15 psi).

**Plascore's Barrier meets all the performance requirements set forth above. Also Plascore does provide all the certification and the documentation mentioned. Examples of certifications and graphs are shown, later in the brochure.**

### **1.3 Other Standard References**

Other Standards using the same barrier face assembly are:

- NHTSA Standard Number 208 – Occupant Crash Protection.
- Insurance Institute for Highway Safety – Offset Barrier Crash Test Protocol (Version IV)

#### **1.4 Test Facility's responsibility:**

The test facility has the responsibility of procuring certified aluminum honeycomb barrier face units from the honeycomb manufacture which meet the crush strength specifications required by the standard. Each honeycomb barrier will be used for only one test, thus the test facility shall procure one barrier face for each vehicle being tested plus one extra barrier face in case something unexpectedly happens to a barrier face. The test facility shall conduct detailed inspection of the honeycomb barrier for shipping damage.

The test facility shall retain a copy of the barrier manufacturers test data used to certify the barrier face and make it available for review by the COTR. This shall consist of certification information for the 0.342 and 1.711 MPa barrier face portions. The test facility shall have the equipment or access to equipment that will allow them to test honeycomb samples.

The test contractor must obtain eight (8) samples that have the following dimensions (150mm x 150mm x 50mm) per block from which the barrier faces were manufactured which will enable verification of the certification data supplied by barrier face manufacturer. This verification entails that the contractor possess the necessary test equipment to conduct barrier face certification testing as outlined in the certification procedure later in this brochure.

## 2.0 Industry Requirements:

The industry requirements for the frontal barrier have been listed below:

### 2.1 Main Honeycomb Block

#### Dimensions

Length: 650mm (25.6") (in direction of honeycomb ribbon (foil) axis)

Width: 1000mm (39.4")

Depth: 450mm (17.7") (in direction of honeycomb cell axes)

All above dimensions  $\pm 2.5\text{mm}$  (0.1")

Material: Aluminum 3003 (BS 1470)

Foil Thickness:  $0.076\text{mm} \pm 15\%$  (.003"  $\pm 15\%$ )

Cell Size:  $19.1\text{mm} \pm 20\%$  (3/4"  $\pm 20\%$ )

Density:  $28.6\text{kg/m}^3 \pm 20\%$  (1.8 pcf  $\pm 20\%$ )

Crush Strength:  $0.342\text{MPa} + 0\%-10\%$  ( 49.6 psi +0% - 10%) (in accordance with test method described in Section 3)

### 2.2 Bumper Element

#### Dimensions

Length: 330mm (13") (in direction of honeycomb ribbon axis)

Width: 1000mm (39.4")

Depth: 90mm (3.5") (in direction of honeycomb cell axes)

All above dimensions  $\pm 2.5\text{mm}$  (0.1")

Material: Aluminum 3003 (BS 1470)

Foil Thickness:  $0.076\text{mm} \pm 15\%$  (.003"  $\pm 15\%$ )

Cell Size:  $6.4\text{mm} \pm 20\%$  ( 1/4"  $\pm 20\%$ )

Density:  $82.6\text{kg/m}^3 \pm 20\%$  (5.2 pcf  $\pm 20\%$ )

Crush Strength:  $1.711\text{MPa} + 0\%-10\%$  ( 248.15 psi +0% - 10%) (in accordance with test method described in Section 3)

### 2.3 Backing Sheet

#### Dimensions

Length: 800mm (31.5")

Width: 1000mm (39.37)

All dimensions  $\pm 2.5\text{mm}$  (0.1")

Thickness:  $2.0 \pm 0.1\text{mm}$  (0.078  $\pm 0.004$ ")

Material: Aluminum 5251/5052 (DS 1470)

### 2.4 Cladding Sheet

#### Dimensions

Height: 1700mm (66.9")

Width: 1000mm (39.37)

All dimensions  $\pm 2.5\text{mm}$  (0.1")

Thickness:  $0.81 \pm 0.07\text{mm}$  (0.032  $\pm .002$ )

Material: Aluminum 5251/5051 (BS 1470)

## **2.5 Bumper Facing Sheet**

### Dimensions

Length: 330mm (13")

Width: 1000mm (39.37")

All dimensions  $\pm 2.5\text{mm}$  (0.1")

Thickness:  $0.81 \pm 0.07\text{mm}$  ( $0.032'' \pm .002$ )

Material: Aluminum 5251/5052 (BS 1470)

## **2.6 Adhesive**

The adhesive to be used throughout shall be a two-part polyurethane (such as Ciba-Geigy XB5090/1 resin with XB5304 hardener, or equivalent)

### **3.0 PLASCORE'S ALUMINUM HONEYCOMB CRUSH STRENGTH CERTIFICATION PROCEDURE SUMMARY**

#### **3.1 Aluminum Honeycomb Certification**

A complete testing procedure for certification of aluminum honeycomb is given in NHTSA TP-214D-02. The following is a summary of the procedure, as it should be applied to 0.342MPa (49.6 psi) and 1.711 MPa (248.15 psi) materials for the frontal impact barrier.

#### **3.2 Sample Locations**

To ensure uniformity of crush strength across the whole of the barrier face, 8 samples shall be taken from 4 locations evenly spaced across the honeycomb block. For a block to pass certification, 7 of the 8 samples must meet the crush strength requirements of the following sections.

The location of the samples depends on the size of the honeycomb block. First, four samples, each measuring 300mm x 300mm x 50mm thick shall be cut from the block of barrier face material. Please refer to (Figure 1) for an illustration of how to locate these sections within the honeycomb block. Each of these larger samples shall be cut into samples for certification testing (150mm x 150mm x 50mm). Certification shall be based on the testing of two samples from each of these four locations. The other two shall be made available to the customer, upon request.

#### **3.3 Sample Size**

Samples of the following size shall be used for testing:

Length:	150mm ± 6mm
Width:	150mm ± 6mm
Thickness:	50mm ± 2mm

The walls of incomplete cells around the edge of the sample shall be trimmed as follows: In the width direction, the fringes shall be no greater than 1.8mm (see Figure 2). In the length direction, half the length of one bonded cell wall (in the ribbon direction) shall be left at either end of the specimen (see Figure 2).

#### **3.4 Area Measurement**

The length of the sample shall be measured in three locations. 12.7mm from each end and in the middle and recorded as L1, L2 and L3 (Figure 2). In the same manner, the width shall be measured and recorded as W1, W2 and W3 (Figure 2). These measurements shall be taken on the centerline of the thickness. The crush area shall then be calculated as:

$$A = \frac{(L1 + L2 + L3)}{3} + \frac{(W1 + W2 + W3)}{3}$$

### 3.5 Crush Rate and Distance

The sample shall be crushed at a rate of not less than 5.1mm/min. and not more than 7.6mm/min. The minimum crush distance shall be 16.5mm.

### 3.6 Data Collection

Force versus deflection rate are to be collected in either analog or digital form for each sample tested. If analog data are collected than a means of converting this to digital must be available. All digital data must be collected at a rate of no less than 5Hz (5 points per second).

### 3.7 Crush Strength Determination

Ignore all data prior to 6.4mm of crush and after 16.5mm of crush. Divide the remaining data into three sections or displacement intervals (n=1,2,3.) (see Figure 3), where:

n=1	6.4mm-9.7mm inclusive
n=2	9.7mm-13.2mm exclusive
n=3	13.2mm-16.5mm inclusive

For each of these three displacement intervals, calculate the average crush force  $F(n)$  using all of the points measured within the interval. Thus,

$$F(n) = \frac{(F(n)_1 + F(n)_2 + \dots + F(N)_m)}{m}, n = 1, 2, 3$$

where m is the number of data points in each of the displacement intervals.

Using the area A measured as described in Section 3.4, calculate the crush strength of each displacement interval as follows:

$$S(n) = \frac{F(N)}{A}, n = 1, 2, 3$$

Thus, for each sample tested, there should be three values of crush strength, each covering one of the displacement intervals detailed above.

### 3.8 Sample Crush Strength Specification

For a honeycomb sample to pass this certification, the average crush of each of the three displacement intervals must meet the following condition.

$$\begin{array}{ll} 0.308\text{Mpa} \leq S(n) \leq 0.342\text{Mpa} & \text{for } 0.342\text{Mpa material} \\ 1.540\text{Mpa} \leq S(n) \leq 1.711\text{Mpa} & \text{for } 1.711\text{Mpa material} \end{array}$$

n-1,2,3.

Note: It is not satisfactory to calculate the crush strength averaged over the entire crush distance (6.4mm – 16.5mm). A sample may give an overall average that satisfies the requirement while individual displacement intervals may not. The procedure of Section 3.7 must therefore be followed.

### **3.9 Block Crush Strength Specification**

Eight samples are to be tested from four locations, evenly spaced across the block. For a block to pass certification, 7 of the 8 samples must meet the crush strength specification of the previous section.

### **3.10 Adhesive Bonding Procedure**

Immediately before bonding, aluminum sheet surfaces to be bonded shall be thoroughly cleaned using suitable solvent, such as 1,1,1 Trichloroethane. This is to be carried out at least twice or as required to eliminate grease or dirt deposits. The cleaned surfaces shall then be abraded using 120 grit abrasive paper. Metallic/Silicon Carbide abrasive paper is not to be used. The surfaces must be thoroughly abraded and the abrasive paper changed regularly during the process to avoid clogging, which may lead to a polishing effect. Following abrading, the surfaces shall be thoroughly cleaned again, as above. In total, the surfaces shall be solvent cleaned at least four times. All dust and deposits left as a result of the abrading process must be removed, as these will adversely affect bonding.

The adhesive shall be applied to one surface only, using ribbed rubber roller. In cases where honeycomb is to be bonded to aluminum sheet, the adhesive should be applied to the aluminum sheet only. A maximum of  $0.5\text{kg/m}^2$  shall be applied evenly over the surface, giving a maximum film thickness of 0.5mm.

### **3.11 Construction**

The main honeycomb block shall be adhesively bonded to the backing sheet such that the cell axes are perpendicular to the sheet. The cladding sheet shall be bonded to the front surface of the honeycomb block. The top and bottom surfaces of the cladding sheet shall NOT be bonded to the main honeycomb block but should be positioned closely to it. The cladding sheet shall be adhesively bonded to the backing sheet at the mounting flanges.

The bumper element shall be adhesively bonded to the front of the cladding sheet such that the cell axes are perpendicular to the sheet. The bottom of the bumper element shall be flush with the bottom surface of the cladding sheet. The bumper facing sheet shall be adhesively bonded to the front of the bumper element.

The bumper element shall then be divided into three equal sections by means of two horizontal slots. These slots shall be cut through the entire depth of the bumper section and extend the whole width of the bumper. The slots shall be cut using a saw, their width shall be the width of the blade used and shall not exceed 4.0mm.

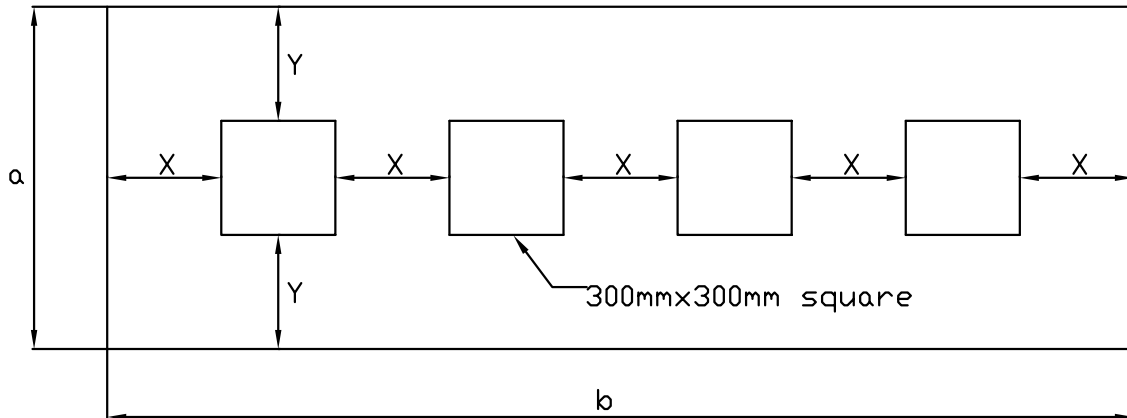
Clearance holes for mounting the barrier are to be drilled in the mounting flanges (shown in Figure 4). The holes shall be of 9.5mm diameter. Five holes shall be drilled in the top flange at a distance of 40mm from the top edge of the flange and five in the bottom

flange, 40mm from the bottom edge of the flange. The holes shall be at 100mm, 300mm, 500mm, 700mm, 900mm, from either edge of the barrier. All holes shall be drilled to  $\pm 1$ mm of the nominal distances. These holes are a recommendation only. Alternate positions may be used which offer at least the mounting strength and security as that provided by the above mounting specifications.

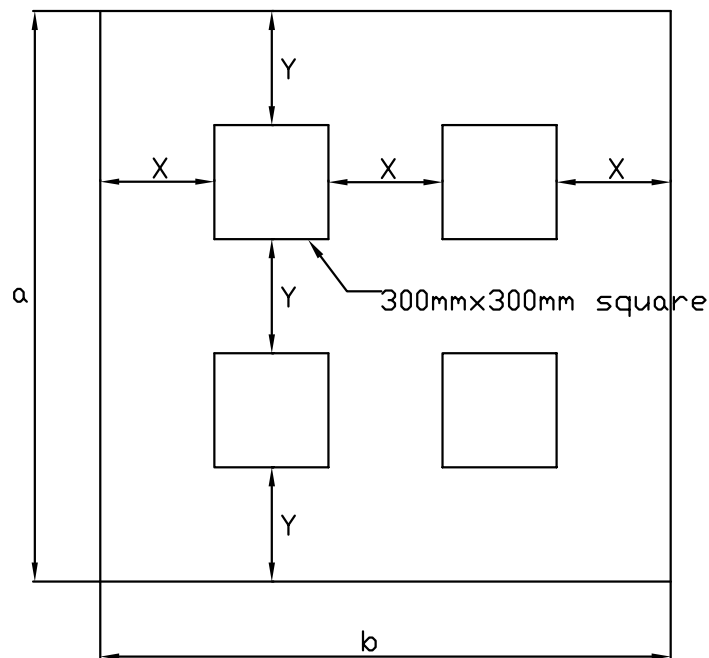
### **3.12 Attachments**

Examples of typical test reports, graphs, and certifications, which will be supplied with the barrier, have been provided for review.

If  $a < 900\text{mm}$ ;  $X = 1/5(b - 1200)\text{mm}$  and  
 $Y = 1/2(a - 300)$  [for  $a \leq b$ ]

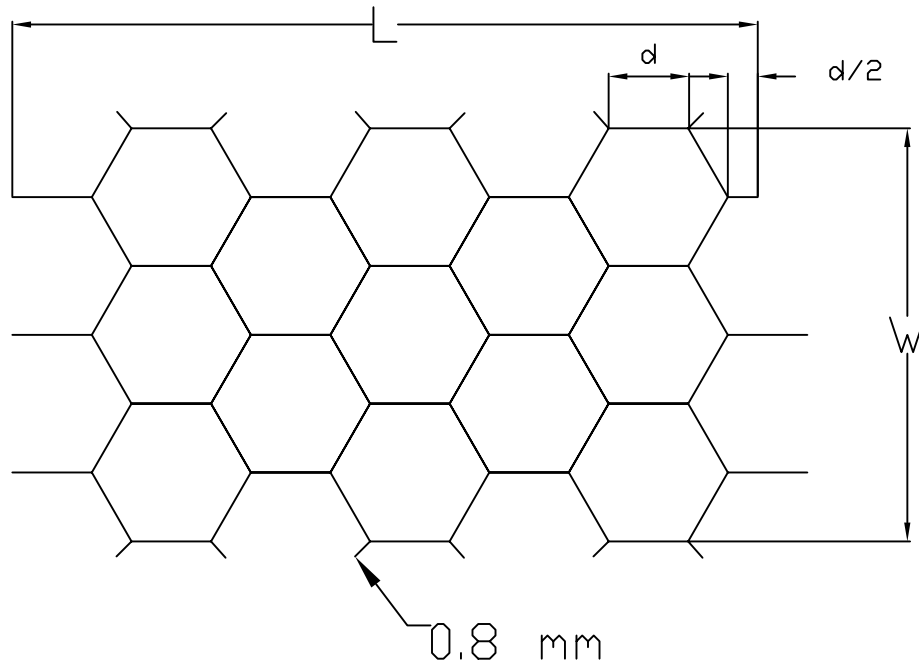


If  $a \geq 900\text{mm}$ ;  $X = 1/3(b - 600)\text{mm}$   
and  $Y = 1/3(a - 600)\text{mm}$  [for  $a < b$ ]



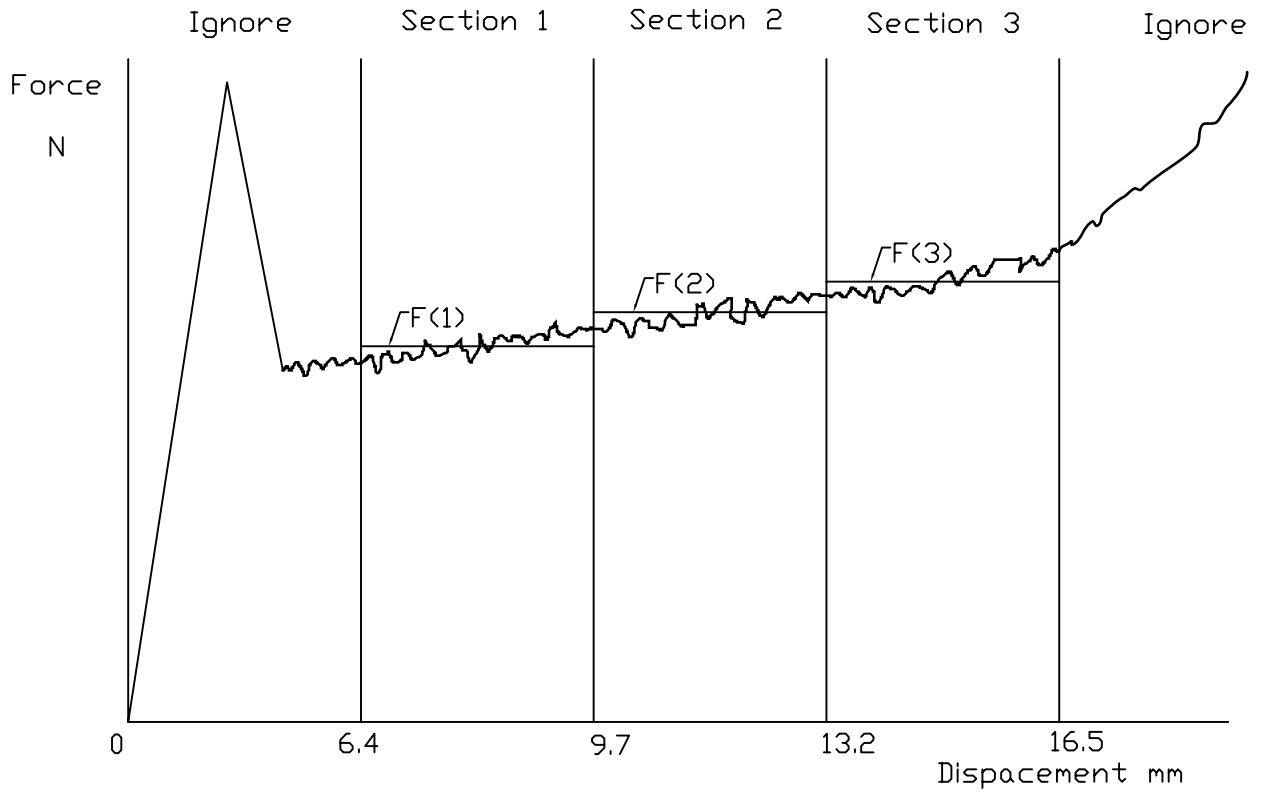
Location of Samples for Certification

Figure 1



Honeycomb Axes and Measured Dimensions

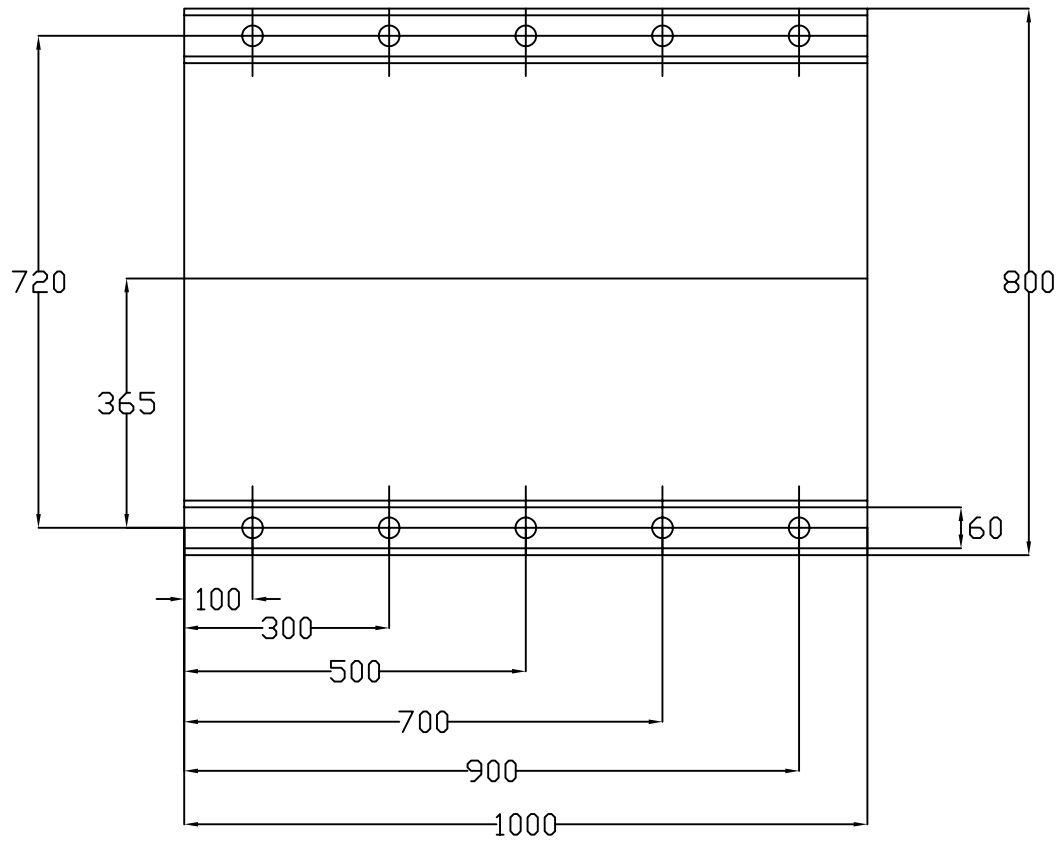
Figure 2



$$\text{Crush Strength } S(n) = F(n) / A ; n=1,2,3$$

Schematic Load-Displacement Trace for Honeycomb Certification

Figure 3



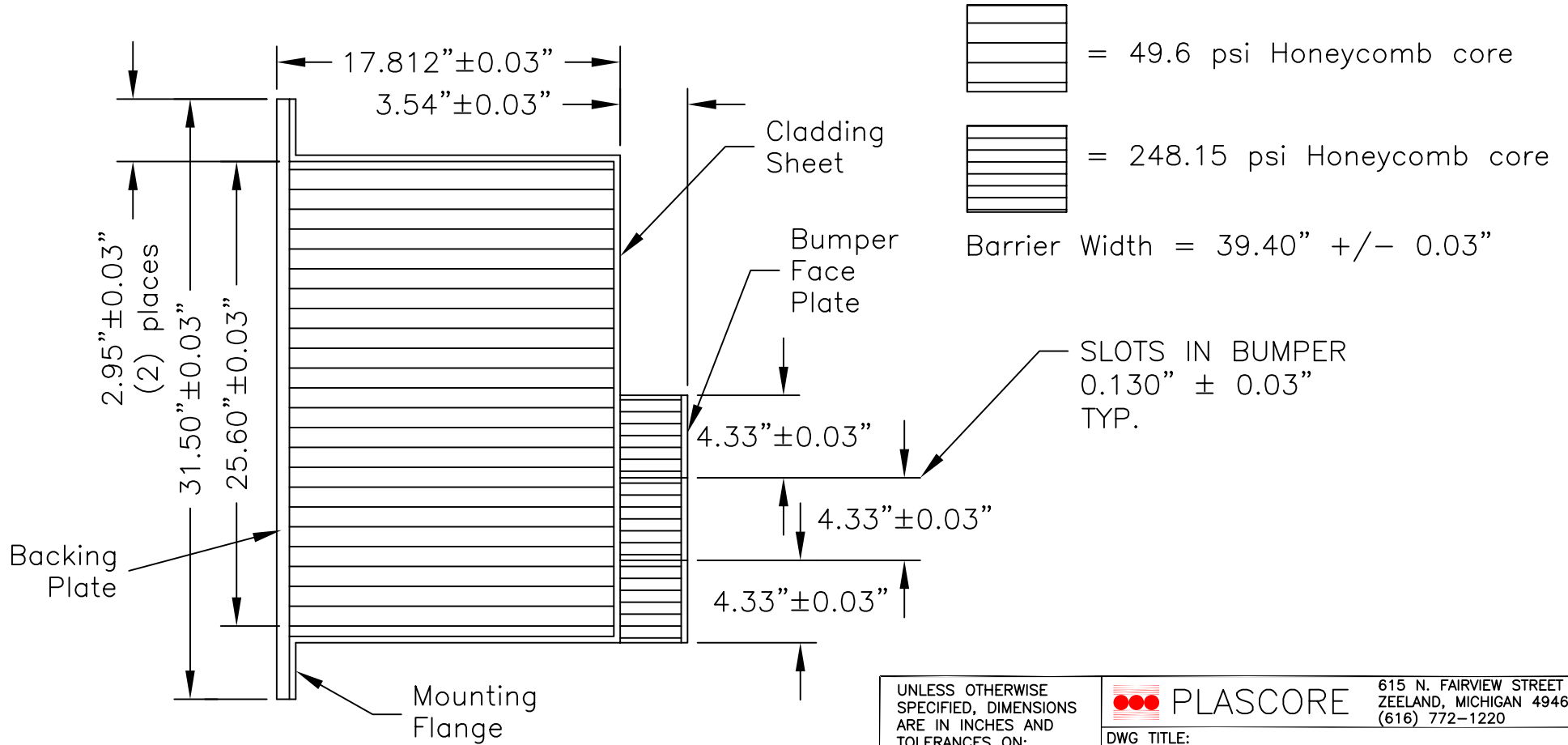
Dimensions in mm  
Hole Diameter = 9.5 mm

Recommended Posiitons of Holes for Barrier Mounting

Figure 4

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION WHICH MAY NOT BE DISCLOSED TO OTHERS FOR ANY PURPOSE WITHOUT WRITTEN PERMISSION FROM PLASCORE INC.

PROJECT NAME: \_\_\_\_\_  
 SUBMITTAL REVISION: \_\_\_\_\_  
 APPROVED BY: \_\_\_\_\_  
 DATE: \_\_\_\_\_



UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES AND TOLERANCES ON:

XXXXX = CRITICAL DIM LEVEL 2  
 XXXXX<sup>3</sup> = CRITICAL DIM LEVEL 3

FRACTIONS: =  $\pm 1/16$   
 DECIMALS: X =  $\pm 0.1$   
 .X =  $\pm 0.06$   
 .XX =  $\pm 0.03$   
 .XXX =  $\pm 0.01$   
 ANGLES: =  $\pm 2'$

CAD#: 20670

		615 N. FAIRVIEW STREET ZEELAND, MICHIGAN 49464 (616) 772-1220	
		DWG TITLE: WG-11 OFFSET FRONTAL IMPACT BARRIER GENERAL ASSEMBLY	
SIZE	FSCM	DWG NUMBER:	REV
A	39212	P05-00-00	B
DRAWN BY: B. VanderBrink		DATE: 11-21-01	
ENGRG:		SCALE: NTS	
QC APP.:		SHEET: 1 OF 1	



**OFFSET FRONTAL BARRIER CERTIFICATION**

Date: April 5, 2002

To:

**PURCHASE ORDER INFORMATION**

Customer P.O. Number: 271-13068418-01  
Work Order Number: 10960  
Quantity: 01 piece

**CORE INFORMATION**

Core Type: PCGA-1.8-3/4-P-3003  
Cell Size: 19.05 mm  
Density: 28.8 kg/m<sup>3</sup>

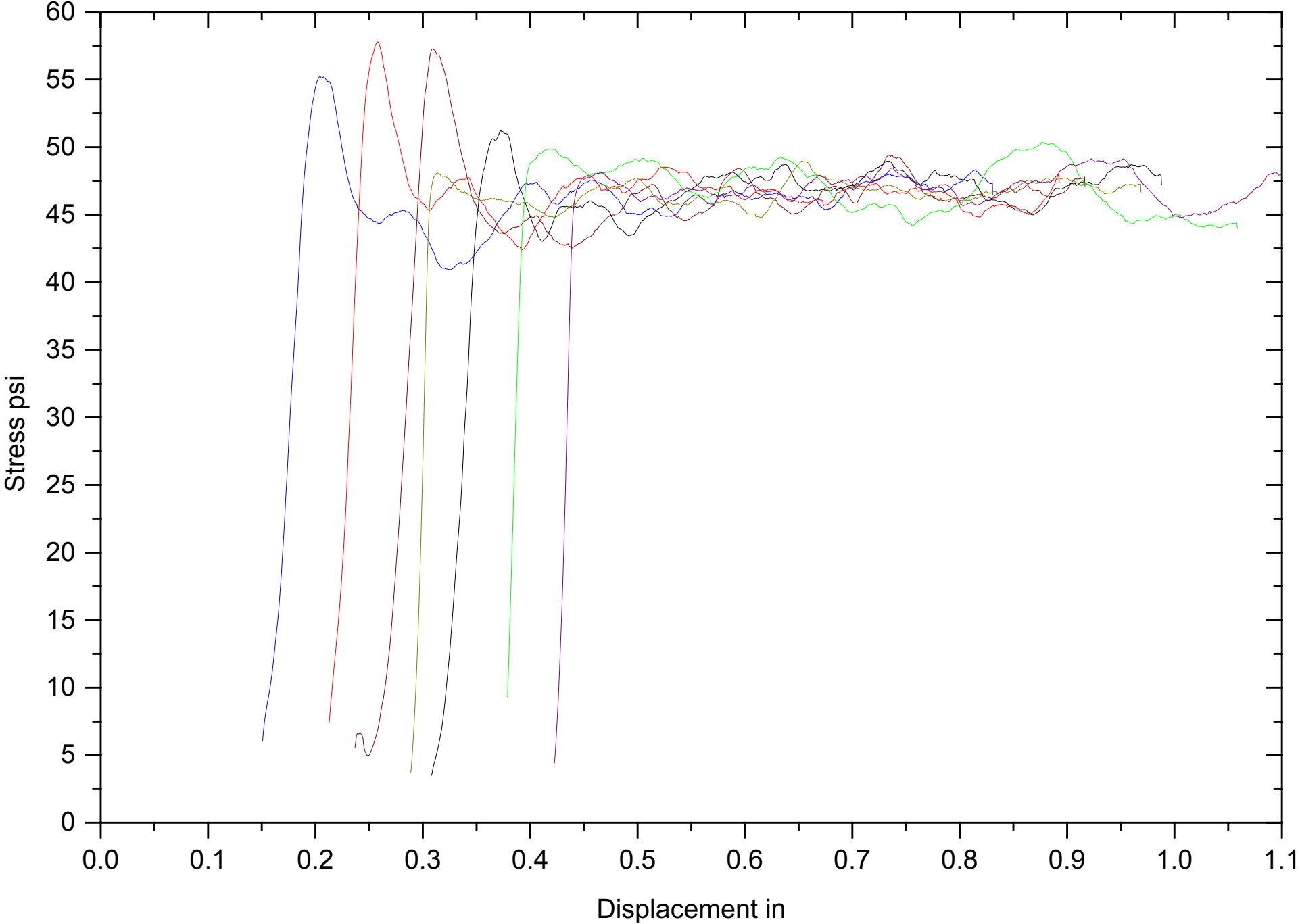
Unit Number: 053C0702

This is to certify that the aluminum honeycomb core supplied, under the unit number provided, meets the crush requirements of (49.6 psi) 0.342 mpa +0, -10% mpa per DWG #P05-00-00 / WG11.

---

Quality Control Representative

Sample ID: IN221252



**Crush Strength Vs Displacement Graph**

Plascore Inc.  
 615 N. Fairview St.  
 Zeeland, MI USA 49464

NHTSA-Crush Test

Test type: Compression  
 Operator name: JIM  
 Sample Identification: IN221252  
 Interface Type: 4200

Instron Corporation  
 Series IX Automated Materials Testing System 7.51.00  
 Test Date: Tuesday, April 10, 2001

Sample Rate (pts/secs): 5.0000  
 Crosshead Speed: 0.3000 in/min  
 2nd Crosshead Speed: 0.0000 in/min  
 Full Scale Load Range: 30000.000 lbf

Humidity ( % ): 50  
 Temperature: 73 F

Block Number 024C0401  
 Core Type 3/4-1.8-P-3003  
 NHSTA 45-50 PSI  
 WG11 44.63-49.59 PSI  
 BOTH 45-49.59 PSI

Sample comments:

	Load at Max.Load (lbf)	Stress at Max.Load (psi)	Stress Between Limits 1 (psi)	Stress Between Limits 2 (psi)	Stress Between Limits 3 (psi)	Width (in)	Thickness (in)
1 .706	1922	55	46.08	46.23	47.18	6.00	5.80
2 .718	2027	58	47.38	46.53	45.97	6.10	5.75
3 .731	1927	57	46.20	47.04	46.61	5.85	5.75
4 .694	1769	51	47.50	47.63	46.93	5.90	5.85
5 .725	1649	49	46.46	46.73	47.08	5.80	5.80
6 .712	1768	50	46.61	47.70	45.64	6.05	5.80
7 .700	1711	49	47.37	47.58	46.20	5.95	5.85
Mean	1825	53	46.80	47.06	46.52	5.95	5.80
S.D.	136	4	0.60	0.59	0.59	0.11	0.04
C.V.	7	7	1.28	1.25	1.27	1.82	0.70
Minimum	1649	49	46.08	46.23	45.64	5.80	5.75
Maximum	2027	58	47.50	47.70	47.18	6.10	5.85

# Test Report



**OFFSET FRONTAL BARRIER CERTIFICATION**

Date: April 5, 2002

To:

**PURCHASE ORDER INFORMATION**

Customer P.O. Number: 271-13068418-01  
Work Order Number: 10960  
Quantity: 01 piece

**CORE INFORMATION**

Core Type: PCGA-5.2-1/4-P-3003  
Cell Size: 6.35 mm  
Density: 83.3 kg/m<sup>3</sup>

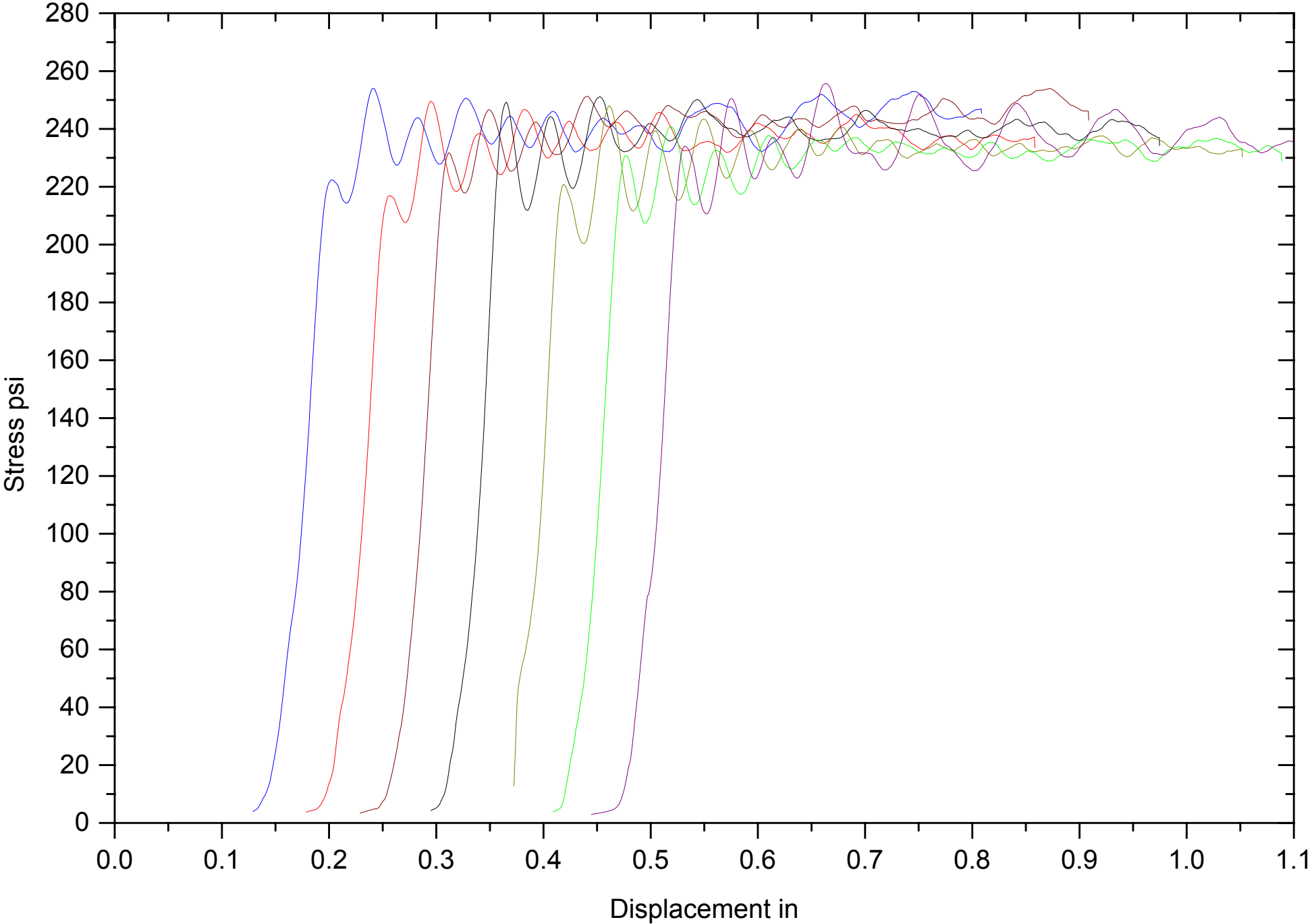
Unit Number: 053A0402

This is to certify that the aluminum honeycomb core supplied, under the unit number provided, meets the crush requirements of (248.15) 1.711 mpa +0, -10% mpa per DWG #P05-00-00 / WG11.

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Quality Control Representative

Sample ID: IN221630



**Crush Strength Vs Displacement Graph**

Plascore Inc.  
 615 N. Fairview St.  
 Zeeland, MI USA 49464

NHTSA-Crush Test

Test type: Compression  
 Operator name: JIM  
 Sample Identification: IN221630  
 Interface Type: 4200

Instron Corporation  
 Series IX Automated Materials Testing System 7.51.00  
 Test Date: Wednesday, May 23, 2001

Sample Rate (pts/secs): 5.0000  
 Crosshead Speed: 0.3000 in/min  
 2nd Crosshead Speed: 0.0000 in/min  
 Full Scale Load Range: 30000.000 lbf

Humidity ( % ): 50  
 Temperature: 73 F

Block Number 084B0501  
 Core Type 1/4-5.2-P-3003  
 NHSTA 232-250 PSI  
 WG11 223.3-248.1 PSI  
 BOTH 232-248.1 PSI

Sample comments:

	Load at Max.Load (lbf)	Stress at Max.Load (psi)	Stress Between Limits 1 (psi)	Stress Between Limits 2 (psi)	Stress Between Limits 3 (psi)	Width (in)	Thickness (in)
1 .244	8911	254	238.47	244.14	246.49	6.10	5.75
2 .249	8682	249	236.92	239.55	-	6.00	5.80
3 .239	8617	254	242.65	244.56	-	5.85	5.80
4 .242	8376	251	239.95	239.58	-	5.80	5.75
5 .263	8702	248	234.60	233.42	234.07	6.05	5.80
6 .261	8452	241	233.14	233.18	233.42	6.00	5.85
7 .255	9052	256	238.53	237.30	-	6.00	5.90
Mean	8685	250	237.75	238.82	0.00	5.97	5.81
S.D.	238	5	3.21	4.58	0.00	0.11	0.05
C.V.	3	2	1.35	1.92	0.00	1.80	0.92
Minimum	8376	241	233.14	233.18	0.00	5.80	5.75
Maximum	9052	256	242.65	244.56	0.00	6.10	5.90

## Test Report

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