EBAA IRON
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TECHNICAL DATA FOR THE WATER AND WASTEWATER PROFESSIONAL

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PRODUCT TESTING AND HYDROSTATIC FORCES

INTRODUCTION

This paper is a discussion of the methods and procedures used in routine and proof of design testing of EBAA restraint products.

STRESSES WITHIN THE SYSTEM

Pressure within a closed vessel such as a pipe, acts to push outwardly and uniformly on the vessel walls. In the case of a pipe, this outward pressure induces circumferential or hoop stress around the cylinder or barrel of the pipe. When the ends of the pipe are closed, such as with the installation of a cap, the pressure also pushes on the inside surface of the cap in an attempt to separate the cap from the pipe. If the cap is somehow attached to the wall of the pipe then a longitudinal stress is also present in the pipe wall. Attaching the cap (or other fitting) to the pipe is the function of joint restraint devices such as the MEGALUG® restraint.

When a joint device is being used to hold the cap onto the pipe, the force exerted on the cap is transferred through the device and subsequently to the pipe wall. The restraint must be structurally capable of withstanding the end thrust loading while also being capable of gripping the pipe surface. The pressure and forces acting on both pipe and restraint must remain within design limits of both to assure a generous factor of safety for the system.

FROM PRESSURE TO FORCE

You may have noticed in the preceding discussion that we freely moved from pressure to stress to force and back again. These terms are related as follows:

1. Pressure (measured in pounds of force per square inch) acting on a surface area (measured in square inches) produces a force (measured in pounds). Mathematically:

$$\text{Force} = \text{Pressure} \times \text{Area}$$

2. Force transferred to a pipe wall is uniformly distributed throughout the pipe wall. We can say that the force is divided evenly throughout the cross sectional area and that this division of force is called stress. Like pressure, stress is measured in pounds per square inch and is expressed by:

$$\text{Stress} = \text{Force} / \text{Area}$$

By now you are probably wondering what this refresher course in fluid mechanics and mechanics of materials has to do with the topics discussed in the introduction. So, let’s start tying it all together.

TESTING WITH A CAP

Like Rodney Dangerfield, the mechanical joint cap gets no respect. Here at EBAA, our mechanical joint caps are some of the most abused pieces of equipment in the plant. When subjecting our restraint products to either routine evaluation testing or to the rigors of proof of design testing, the test is made against a standardized mechanical joint cap. We use this particular fitting because it is able to subject the restraint being tested to a maximum load, the full dead end thrust force.

The test procedure is quite simple. A short section of pipe is capped on each end using an MJ cap, a gasket, and the restraint device to be tested. The assembly may be done “by the book” or altered to see the effect of modified installation on the performance of the product. Once assembled, the pipe is filled with water and carefully vented of air. Unlike incompressible water, air has the ability to store tremendous amounts of energy when compressed and is therefore very dangerous in a test.

Now the water is pumped up to the desired pressure as monitored on calibrated gauges and is held for a suitable length of time. The joint, restraint device, and the assembly as a whole are monitored for leakage or failure.

It is important to understand that our testing does not stop at the rated pressure of the pipe or device. Like any good design, we want our products to perform better than just good enough. As a minimum, we subject our products to pressures at least twice that of the rating of the device. In some cases third party listings and approvals require testing up to five times the rating of the device. Even then, the MJ caps rarely complain and rarely crack under stress.

HYDROSTATIC FORCES

To follow is a tabular listing of the hydrostatic forces held by several EBAA restraint products at various pressures. The pressure times area calculation is based on the area of the outside diameter of the pipe. The O.D. is used because the seal is made on this surface.

It is interesting to note that the forces increase rapidly with an increase in diameter. This is due to the area increasing by the diameter squared.

Nominal Size (O.D., in.) [Area, in^2]	Products	Rated Working Prssure (psi.)	End Thrust at 100 psi. (lbs.)	End Thrust at Rated Pressure (lbs.)
3 (3.96) [12.3]	1103 Megalug	350	1,230	4,305
	2003PV	150 (DR18)		1,845
	2003PV	100 (DR25)		1,230
4 (4.80) [18.1]	1104 Megalug	350	1,810	6,335
	2004PV	150 (DR18)		2,715
	2004PV	100 (DR25)		1,810
6 (6.90) [37.4]	1106 Megalug	350	3,740	13,090
	2006PV	150 (DR18)		5,610
	2006PV	100 (DR25)		3,740
8 (9.05) [64.3]	1108 Megalug	350	6,430	22,505
	2008PV	150 (DR18)		9,645
	2008PV	100 (DR25)		6,430
10 (11.10) [96.8]	1110 Megalug	350	9,680	33,880
	2010PV	150 (DR18)		14,520
	2010PV	100 (DR25)		9,680
12 (13.20) [136.9]	1112 Megalug	350	13,690	47,915
	2012PV	150 (DR18)		20,535
	2012PV	100 (DR25)		13,690
14 (15.30) [183.9]	1114 Megalug	350	18,390	64,365
	2014PV	235 (DR18)		43,217
	2014PV	165 (DR25)		30,344
16 (17.40) [237.8]	1116 Megalug	350	23,780	83,230
	2016PV	235 (DR18)		55,883
	2016PV	165 (DR25)		39,237
18 (19.50) [298.6]	1118 Megalug	250	29,860	74,650
	2018PV	235 (DR18)		70,171
	2018PV	165 (DR25)		49,269
20 (21.60) [366.4]	1120 Megalug	250	36,640	91,600
	2020PV	235 (DR18)		86,104
	2020PV	165 (DR25)		60,456
24 (25.80) [522.8]	1124 Megalug	250	52,280	130,700
	2024PV	235 (DR18)		122,859
	2024PV	165 (DR25)		86,262
30 (32.00) [804.3]	1130 Megalug	250	80,430	201,075
	-	-		-
	2030PV	165 (DR25)		132,710
36 (38.30) [1,152.1]	1136 Megalug	250	115,210	288,025
	-	-		-
	2036PV	165 (DR25)		190,097
42 (44.50) [1,555.3]	1142 Megalug	250	155,530	388,825
	-	-		-
	-	-		-
48 (50.80) [2,026.8]	1148 Megalug	250	202,680	506,700
	-	-		-
	-	-		-

This is one of a series of CONNECTIONS reports addressing design and application subjects. If you would like copies of other reports or a listing of available reports contact your EBAA Iron representative or call EBAA Iron Sales at (800) 433-1716 or fax (254) 629-8931. EBAA's engineering group can be reached at (800) 633-9190 or fax (254) 629-2079.

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