taylor devices inc.
90 TAYLOR DRIVE
PO BOX 748
NORTH TONAWANDA, NEW YORK 14120-0748
TELEPHONE: (716) 694-0800
FAX: (716) 695-6015

COMPRESSIBLE MATERIAL DEVICES

Inland Empire Transportation Management Center

FLUID VISCOUS DAMPER
INSTALLATION, OPERATION AND MAINTENANCE MANUAL

Part Numbers: **67DP-18325-01**

Date: September 8, 2008
Updated: October 8, 2008

1.0 TECHNICAL DESCRIPTION

1. **Piston Rod:** Solid 17-4 PH stainless steel, billet machined, through hardened, then hand polished to a mirror finish of less than 4 micro inches.

2. **Piston Head:** Solid steel or bronze construction, machined from billet. Contains fluid flow channels that provide the orificing for the damping function ($F=CV^{\alpha}$).

3. **Seals/Seal Bearings:** Dynamic seals and seal bearings are manufactured by Taylor Devices to patented and proprietary specifications from acetyl resin and/or Virgin Teflon.

4. **Fluid:** Silicone fluid, per Federal Standard VV-D-1078. This fluid is nonflammable and noncombustible under current North American/OSHA standards and is classified as cosmetically inert by the U.S. Food and Drug Administration.

5. **Cylinder:** Heat-treated alloy steel, machined from pierced billet or solid, corrosion protected plating and/or painting.

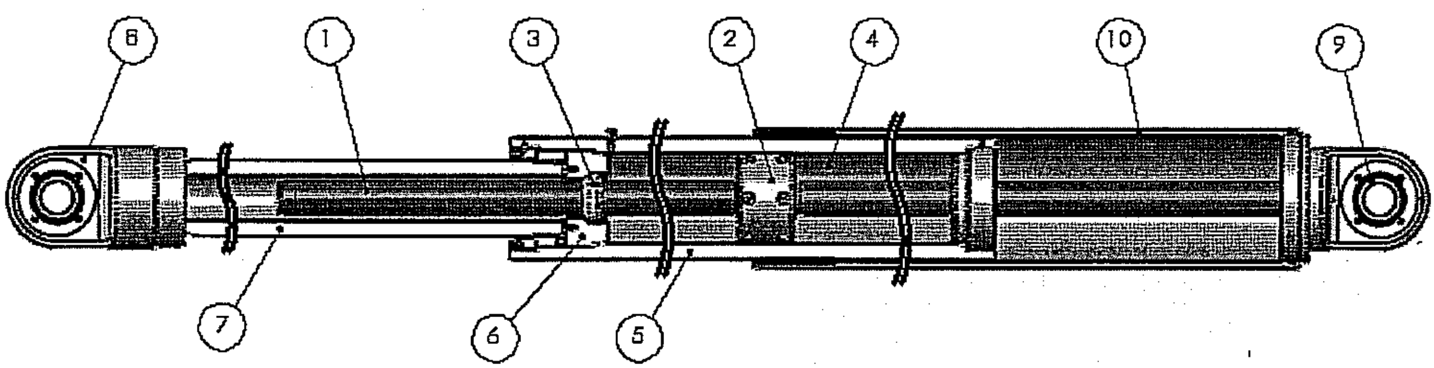
6. **End Cap:** Heat-treated alloy steel, billet machined from wrought condition, through heat treated, and corrosion protected via plating and/or painting.

7. **Extender:** Carbon steel, machined from wrought billet, tube, or pipe, then painted or plated for corrosion protection.

8. **End Clevis:** Heat-treated alloy steel; plated and/or painted.

9. **Spherical Bearing:** Forged from aircraft quality alloy steel, hand fitted and checked for clearance.

10. **Outer Sleeve:** Carbon steel, painted.



2.0 HANDLING

Although Taylor Devices dampers are very robust in design, care should be taken when handling a damper. This section gives the recommended handling procedures.

2.1 Shipping

Each damper will be placed on a wooden skid for shipping and protected by blue shrink-wrap. The crate must remain upright (The 4x4 wooden feet down) at all times to help prevent damage to the damper. <u>DO NOT STACK THE CRATES.</u>

2.2 Storage

The dampers may be stored on their shipping skids for an indefinite period if they are kept in a suitable environment. The wooden shipping skids will deteriorate over time unless it is kept in a relatively dry environment.

2.3 Lifting

The dampers will be shipped on wooden skids. See section 7.0 for weight of dampers. The skid must be lifted in two locations with an evenly distributed force.

After carefully removing the blue shrink-wrap and metal banding, the damper may be lifted from its skid by a single strap located at its balancing point. <u>Care must always be taken when moving the damper so that there is no damage to the factory fill port that protrudes out of the cylinder</u>.

2.4 Unit Care

All surfaces on the damper are coated for corrosion protection (See section 5.2 of this document). Any damage to the painted or coated surface may cause superficial surface corrosion, and must be touched up with paint. Only damage to the underlying steel will be cause for evaluation or corrective action. The factory fill port that protrudes out of the cylinder is a relatively delicate component, compared to the rest of the damper. Cognizance of this port at all times is necessary to prevent damage to it. This port seals a high internal fluid pressure and for safety is wired in place. DO NOT REMOVE THIS PORT OR SAFETY WIRE UNDER ANY CIRCUMSTANCES.

3.0 INSTALLATION

Taylor Devices' Fluid Viscous Dampers are easily installed with a minimum of tools required. For a Fluid Viscous Damper used in a building, dual spherical bearing attachments are provided. Refer to Section 7.0 for drawings of the Fluid Viscous Damper and the mounting hardware.

3.1 Tools Required

- Tape measure
- Hammer (2 to 4 lb.) and heavy pliers
- Light marine grease (Taylor Blu-Grease supplied with dampers)
- Hoist device with straps

3.2 Installation Procedure - Fluid Viscous Damper.

1. Measure eye-to-eye (center of first spherical bearing to center of second spherical bearing) length of Fluid Viscous Damper and compare with mid-stroke length of Fluid Viscous Damper shown in Section 7.0 of this document. If the dimensions do not match to within ⅛ inch, consult a representative from Taylor Devices, Inc. The Fluid Viscous Damper may need to be adjusted. Refer to Section 3.3 & 3.4 for more details.

2. Place mounting brackets into position using a jack or hoist if necessary, per the contract documents and drawings. Attach mounting brackets with bolts or weld per the requirements in the contract documents and drawings.

3. Hoist Fluid Viscous Damper into position, using a jack or hoist as necessary. Clevis ends should easily fit into mounting bracket assemblies with extra play.

4. Clean mounting pins with commercially available parts cleaner and dry completely. Lubricate mounting pins with supplied Taylor Blu-Grease.

5. Align spherical bearing at one end of the Fluid Viscous Damper with the hole in mounting bracket. Use a tapered pin, wood wedges or other means as necessary.

6. By hand, position mounting pin, **beveled edge leading** into mounting bracket hole and push through entire assembly. Re-align and adjust Fluid Viscous Damper as necessary. If difficulty is encountered in pushing the mounting pin through, light tapping with a hammer may be used. If unreasonable difficulty is encountered, consult a Taylor Devices' representative.-

7. Install Retaining Rings on both ends of the mounting pin, as shown in the manual assembly method diagram found in section 7.0.

8. Repeat Steps 3 through 7 for opposite end of Fluid Viscous Damper. If alignment difficulty occurs, consult a Taylor Devices' representative.

3.3 Damper length adjustment using the available ±1/4 inch adjustment for Taylor Devices Part Number 67DP-18325-01.

Dampers 67DP-18325-01 will be shipped in a mid-stroke position that is shown on the drawings in section 7.0. This is the length that should be set between the centers of the holes in the clevis plates where the damper mounting pins will be attached through. The damper units are equipped with an adjustment feature that allows for mechanical adjustment of ±1/4 inch. The clevis is then free to rotate ±1/4 inch (each 180° rotation is equal 0.083 inch). After the damper has been adjusted to the correct length tighten set screw to lock threads. **DO NOT exceed ±1/4 inch adjustment in either direction.** If further length adjustment is required, the damper must be stroked. The Engineer of Record must approve any use of damper stroke for length adjustment.

3.4 Using Damper Stroke for Adjustment Consult the E.O.R

Extension – stroking a damper in extension can most easily be accomplished by lifting the FVD with a strap until the FVD is vertical. This may extend the unit. If the unit does not extend under its own weight, additional weight may be hung from the other end as necessary. Alternatively, a come-along, or a winching device may be used with one end of the damper pinned into its bracket, and the other end pulled by the device.

Compression - To compress the FVD is slightly more difficult. The FVD can be lifted, as previously described, by one end and then set down on the ground on the opposite end. Additional weight may need to be placed on the top clevis as necessary. Care must be taken to avoid damage to the unit, or toppling/collapse of this setup.

If stroking of the FVD is necessary for installed length adjustment, Taylor Devices would recommend that the FVDs be shipped slightly compressed from the mid-stroke position so that all stroking adjustments are done in extension. A written request for this with the desired stroke position identified must be sent to Taylor Devices prior to testing. Note that a force of approximately 2%-4% of the maximum rated force of the damper may be necessary to overcome internal seal gripping forces and allow stroking of the damper.

4.0 INSPECTION

4.1 Periodic Inspection

Taylor Devices' Fluid Viscous Dampers are designed to be completely maintenance free for the life of the damper and life of the building. No periodic maintenance, inspection or spare parts are required, desired, or recommended for Taylor Devices Fluid Viscous Dampers.

4.2 Other Inspection

Visual inspection of the dampers prior to installation is recommended to determine if any obvious damage has occurred from shipping, storage or handling.

5.0 MAINTENANCE

5.1 Periodic Maintenance

Taylor Devices Fluid Viscous Dampers are intended for 100% maintenance free operation and hence, no fluid refill ports are provided. Under normal operation, no maintenance whatsoever is required for the life of the damper.

All Taylor Devices Fluid Viscous Dampers have the main cylinder cartridge sealed at the factory and no field repair or maintenance can be performed. If the damper sustains any damage, the damper must be returned to the address below:

Taylor Devices, Inc.
90 Taylor Drive
North Tonawanda, NY 14120-0748

ATTENTION: Director of Engineering

Taylor Devices' personnel will then contact the owner of the damper concerning the status of the device.

5.2 Painting

For aesthetic value, the dampers can be repainted if a different color is desired or if any surface irregularities develop on painted surfaces. The spherical bearings and chrome plated cylinder should not be painted. External surfaces that can be repainted have been factory painted with a black primer. The top coat color is black. All other surfaces are to be carefully covered and masked to prevent paint spray from contacting these surfaces and from entering the sleeve or spherical bearing assemblies. Always be sure to remove all masking tape after paint has dried. Failure to remove masking, or painting surfaces not recommended for painting; could cause improper function of the damper. Feel free to consult the factory, should there be any additional questions or concerns. Paint information is included in section 7.0 for reference.

6.0 WARRANTY

Taylor Devices Fluid Dampers

SELLER warrants the fluid dampers against defects in materials, operation and workmanship under normal use and service for a period of thirty-five (35) years from the date of installation. Surface coatings are excluded from this warranty.

SELLER warrants that the damping coefficient of the dampers shall be as specified in Specification Section 2.13, including associated addendums and RFIs. Any obligation under this warranty terminates if the fluid dampers are directly exposed to fire, flood, or earthquake demands in excess of the prototype test requirements. In such instance, BUYER may reactivate the warranty by hiring SELLER to inspect all fluid dampers and for BUYER to pay SELLER to recondition any fluid damper that is deemed required.

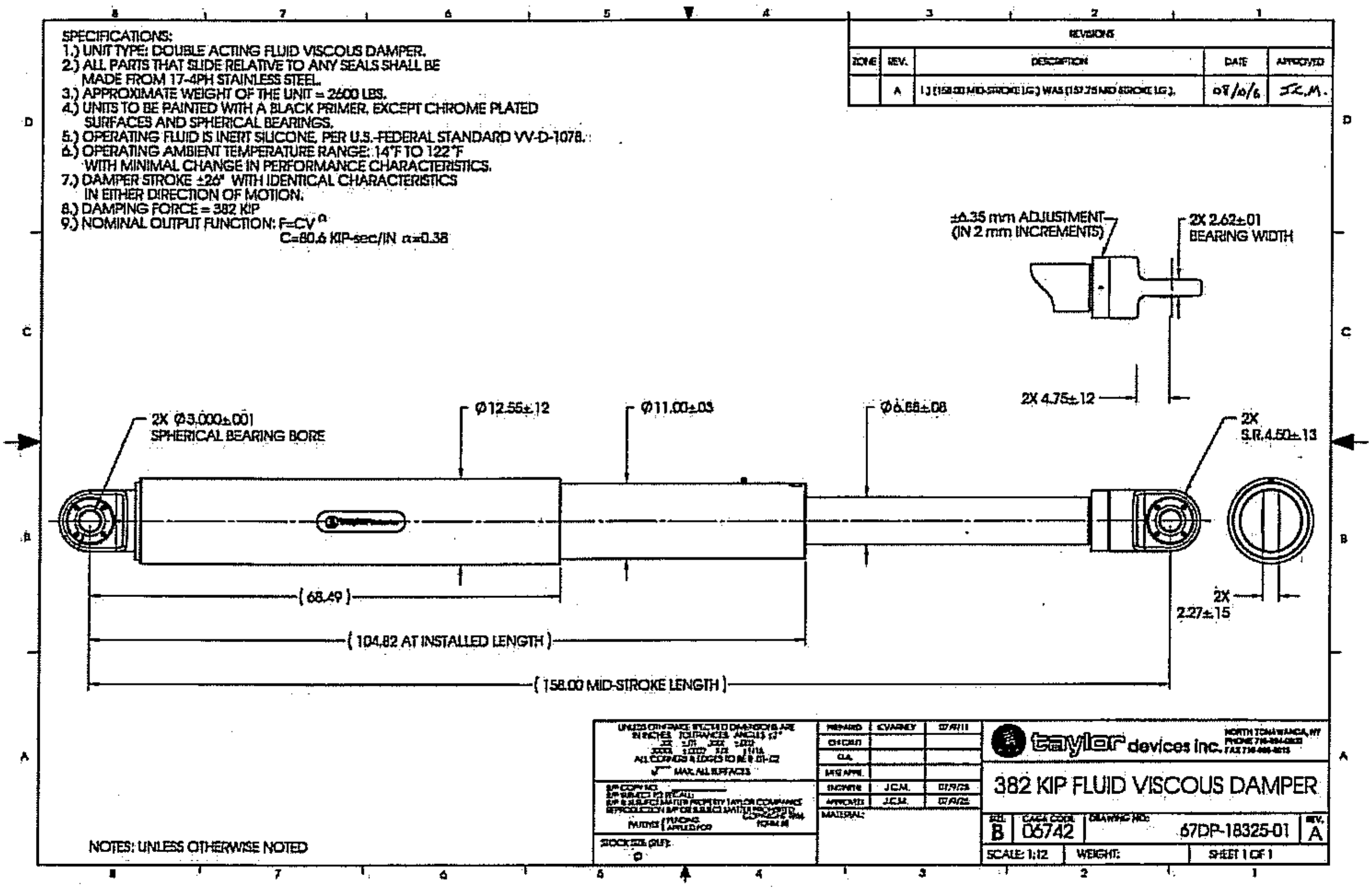
The benefits to BUYER of this warranty are expressly conditioned upon BUYER's care, inspection, and maintenance of the fluid damper in strict accordance with SELLER's Operations and Maintenance Manual.

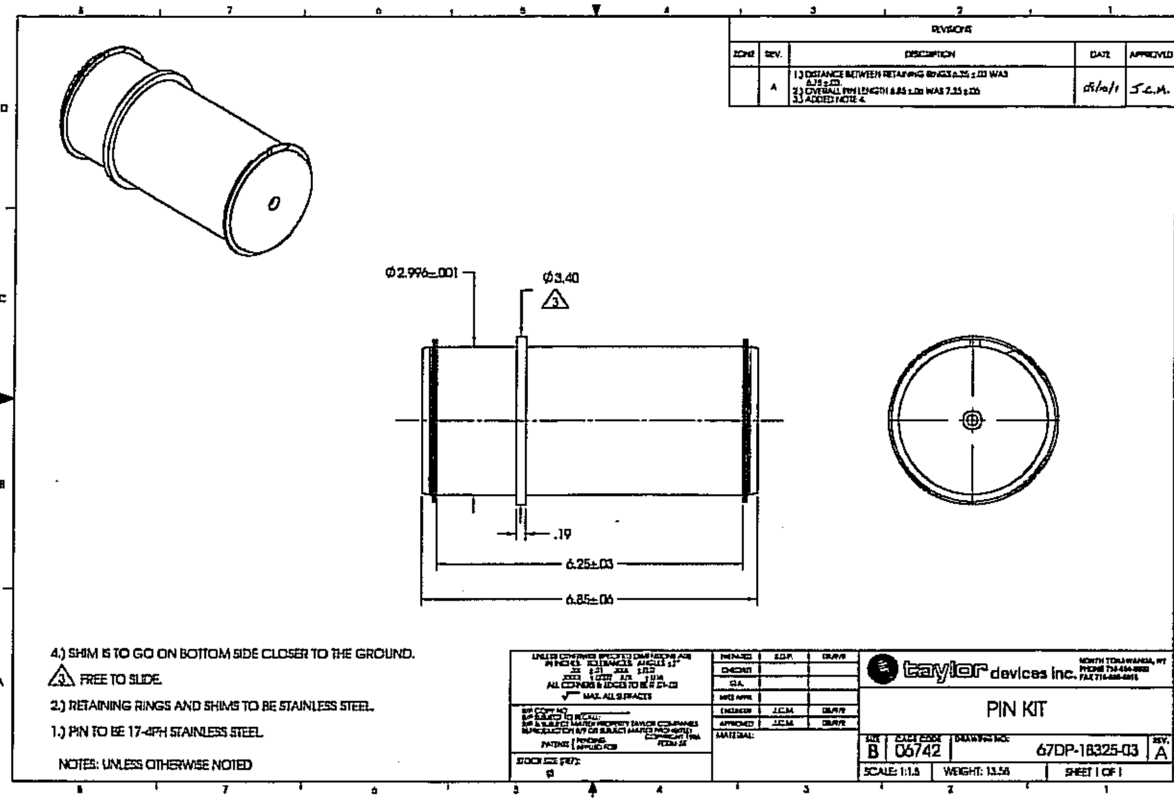
DISCLAIMER OF WARRANTIES

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, WRITTEN, OR ORAL, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OR MERCHANTABILITY OR FITNESS AND IS PROVIDED IN LIEU OF ALL OBLIGATIONS AND LIABILITIES OF SELLER WITH RESPECT TO DEFECTS IN MATERIALS OR WORKMANSHIP. THE RIGHTS AND REMEDIES CONTAINED IN THIS WARRANTY EXCLUDES AND WAIVES ANY RIGHT OF BUYER TO CONSEQUENTIAL OR INCIDENTAL DAMAGES.

7.0 SPECIFICATION DRAWINGS

Outline drawings of the damper and hardware supplied by Taylor Devices are following this page.

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ZONE
REV.
DESCRIPTION
DATE
APPROVED
A
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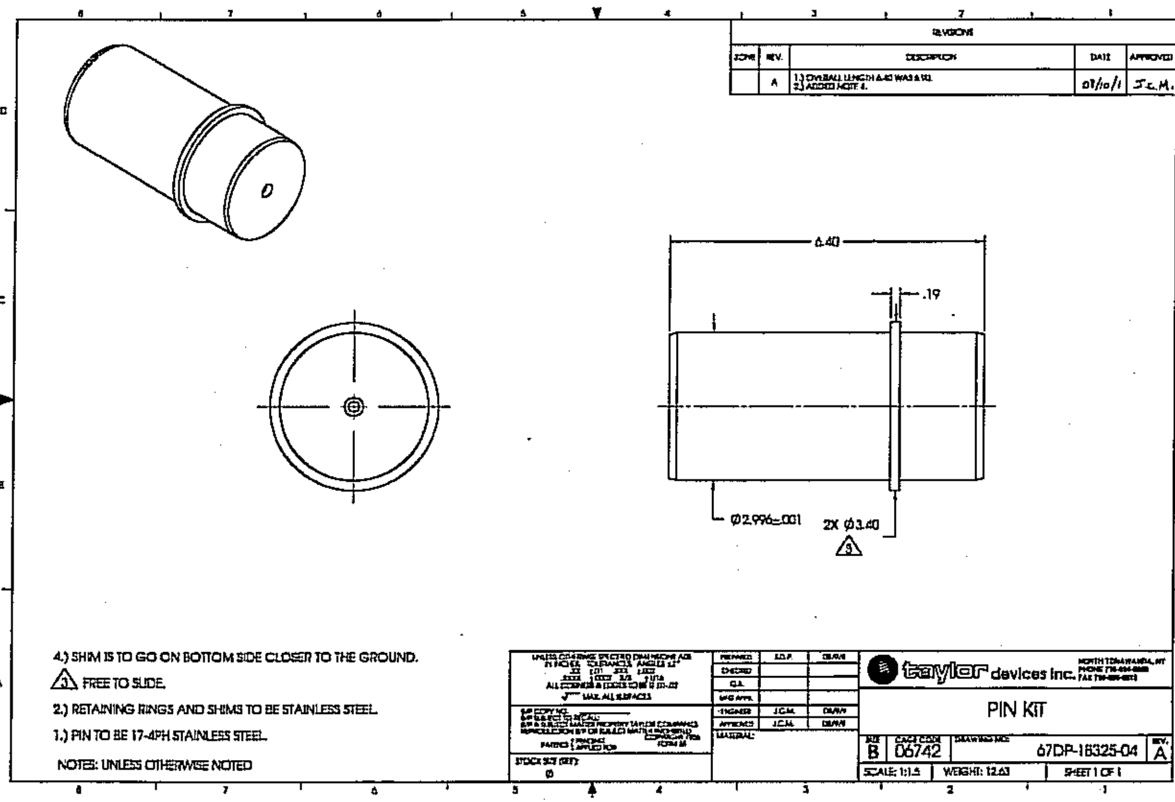
Ø3.40
.19
6.25±.03
6.85±.06
4.) SHIM IS TO GO ON BOTTOM SIDE CLOSER TO THE GROUND.
3 FREE TO SLIDE.
2.) RETAINING RINGS AND SHIMS TO BE STAINLESS STEEL.
1.) PIN TO BE 17-4PH STAINLESS STEEL.
NOTES: UNLESS OTHERWISE NOTED
taylor devices inc.
PIN KIT
B
06742
67DP-18325-03
A
SCALE: 1:1.5
WEIGHT: 13.56
SHEET 1 OF 1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4.) SHIM IS TO GO ON BOTTOM SIDE CLOSER TO THE GROUND.
3 FREE TO SLIDE.
2.) RETAINING RINGS AND SHIMS TO BE STAINLESS STEEL.
1.) PIN TO BE 17-4PH STAINLESS STEEL.
NOTES: UNLESS OTHERWISE NOTED
taylor devices inc.
PIN KIT
B
06742
67DP-18325-04
A
SCALE: 1:1.5
WEIGHT: 12.63
SHEET 1 OF 1

Commercial **Performance** Coatings

HBA-CT

CPC 57

Tinted High Build Alkyd Primer

PRODUCT DESCRIPTION

HBA-CT TINTED HIGH BUILD ALKYD PRIMER

TYPE: Alkyd

RECOMMENDED USE
HBA-CT is a custom-tinted, one component, alkyd primer which exhibits very good corrosion resistance properties, when applied over properly prepared hot or cold-rolled steel. HBA-CT has a VOC level of 2.8 lbs./gal under acetone exempt regulations, 3.5 lbs./gal in non-acetone exempt areas.

All HBA series primers feature fast dry-to-topcoat times and improve productivity in a wide variety of production and fabrication applications. HBA-CT does not contain lead or chromium pigments.

HBA-CT is available in literally hundreds of standard and custom color formulations that can be matched to the topcoat color desired. HBA-CT will exhibit a semi-transparent appearance when tinted to bright organic red, orange or yellow shades. This appearance does not affect product performance.

PHYSICAL CONSTANTS

WEIGHT PER U.S. GALLON
(varies by color) 10.9 - 11.7 LBS./GAL.

PERCENT SOLIDS BY WEIGHT
(varies by color) 66.5% - 70.5%

PERCENT SOLIDS BY VOLUME
(varies by color) 47.5% - 50.5%

FLASH POINTS
Pensky-Martens 48°F (9C°)

VOC
2.8 lbs./gal in Acetone exempt areas
3.5 lbs./gal in Non - Acetone exempt areas

READY TO SPRAY VISCOSITY (varies by color) #3 Zahn 10-30 seconds #2 Zahn N/A

PERFORMANCE FEATURES

96 HOUR HUMIDITY RESISTANCE
Excellent

ADHESION
Very good

IN SERVICE TEMPERATURE LIMITATIONS
200°F

CHEMICAL/SOLVENT RESISTANCE

10% SULFURIC ACID	Excellent	10% HYDROCHLORIC ACID	Excellent
10% AMMONIA	Excellent	10% SODIUM HYDROXIDE	Excellent
XYLENE	Fair	ISOPROPYL ALCOHOL	Excellent
OIL	Excellent	GASOLINE	Good
500 HOURS SALT SPRAY	Very Good		

WATER RESISTANCE: Resistant to intermittent exposure. **Not recommended for immersion**

PPG

SURFACE PREPARATION

The surface to be coated must be free of all contamination, including dust, dirt, oil, grease and oxidation. Chemical treatment or the use of a conversion coating will improve the adhesion and performance properties of the total coating system.

Metal	Recommended Topcoat	Direct To Properly Treated Substrate
Cold Rolled Steel	ALK-200, ALK-200/201, ALK-300, ALK-300LG AUE-280, AUE-280LG, AUE-300, AUE-400LG	Very Good
Hot Rolled Steel	ALK-200, ALK-200/20, ALK-300, ALK-300LG AUE-280, AUE-280LG, AUE-300, AUE-400LG	Very Good
Galvanized		Not Recommended
Galvaneal		Not Recommended
Aluminum	ALK-200, ALK-200/201, ALK-300, ALK-300LG AUE-280, AUE-280LG, AUE-300, AUE-400LG	Fair
Plastic/Fiberglass	The surface should be free of all contamination. Because of the variability of plastic/fiberglass substrates, coating performance should be confirmed by testing on the actual plastic/fiberglass substrate being used.	

APPLICATION DATA

MIXING DIRECTIONS
HBA-CT is ready to spray as supplied. Stir thoroughly before, and occasionally during use.

THINNING
Not recommended where 2.8 or 3.5 lb./gal VOC regulations are in effect.
HBA-CT is supplied at sprayable viscosity.

POT LIFE
N/A

RECOMMENDED WET FILM BUILD
Spray Application: 3.8 - 5.0 mils

RECOMMENDED DRY FILM BUILD
1.8 - 2.4 mils

Application of film thickness in excess of that recommended for this product may cause problems such as adhesion failure, solvent popping and extended dry times.

APPLICATION EQUIPMENT
Conventional Spray: 50-60 psi at the gun.

DRYING TIME
3.5 mils wet at 77°F (25°C) and 50% relative humidity.

To Touch:	10 minutes
Handle:	60 minutes
Dry:	24 hours
To Topcoat:	After 1 hour to 4 days
Recoat:	1 hour to 4 days

Note: After 4 days primer should be mechanically abraded before topcoating or recoating.

Force Dry:

Air Dry:	10 minutes
Bake:	20 minutes @160°F

Primer film is not fully cured for 7 days Drying time listed may vary, depending upon film build, and temperature.

RECOMMENDED SPREADING RATE
762 - 810 sq. ft. at 1.0 mil dry film per U.S. gallon (varies by color). Spreading rate figures do not include losses due to mixing, transfer or application of coating, or losses due to surface irregularities or porosity.

CLEAN UP
Lacquer Thinner or Ketone

APPLICATION PRECAUTIONS AND LIMITATIONS
Apply only when air, product or surface temperature is above 60°F (16°C) and when surface temperature is at least 5°F (3°C) above the dew point.

All Commercial Coatings Performance data is based on spray application, at the recommended film build. If alternative application methods are employed, substrate preparation and film builds listed for spray application must be followed.

SAFETY

These materials are designed for application only by professional, trained personnel, using proper equipment under controlled conditions and are not intended for sale to the general public.
Safe application of paints and coatings requires knowledge of equipment materials and individual training. Directions and precautionary information on both equipment and products should be carefully read and strictly observed for personal safety and property protection. Consideration must be given to eliminate conditions, which may generate hazardous atmospheres during spray application or subject operators or bystanders to injury or illness. Special precautions must be taken when utilizing spray equipment, particularly airless equipment. High-pressure injection of coatings into the skin by airless equipment may cause serious injury requiring immediate medical attention at a hospital. Treatment advice may also be obtained from Poison Centers. Air quality should be maintained with adequate ventilation; applicators can achieve additional protection by wearing respirators and other protective garments such as gloves and overalls. In all cases, wear protective eye equipment. During the application of all coatings materials, all flames, welding and smoking must be prohibited. Explosion proof equipment must be used when coating these materials in confined areas.
PRECAUTIONARY INFORMATION
Before using the products listed herein, carefully read each product label and follow directions for its use. Please read and observe all warnings and precautionary information on all product labels. Prevent all contact with skin and eyes and breathing of vapors and spray mist. Repeated inhalation of high vapor concentrations may cause a series of progressive effects including irritation of the respiratory system, permanent brain and nervous system damage and possible unconsciousness and death in poorly ventilated areas. Eye watering, headaches, nausea, dizziness and loss of coordination are indications that solvent levels are too high. Intentional misuse by deliberately concentrating and inhaling the contents can be harmful or fatal.
KEEP OUT OF THE REACH OF CHILDREN
MEDICAL RESPONSE
Emergency Medical or Spill Control Information (304) 843-1300. CANADA (514) 645 - 1320 Have label information available.
MATERIAL SAFETY DATA SHEET
Material Safety Data Sheets for the PPG products mentioned in this publication are available through your PPG Distributor.
FOR ADDITIONAL INFORMATION REGARDING THIS PRODUCT, SEE THE MSDS AND LABEL INFORMATION.

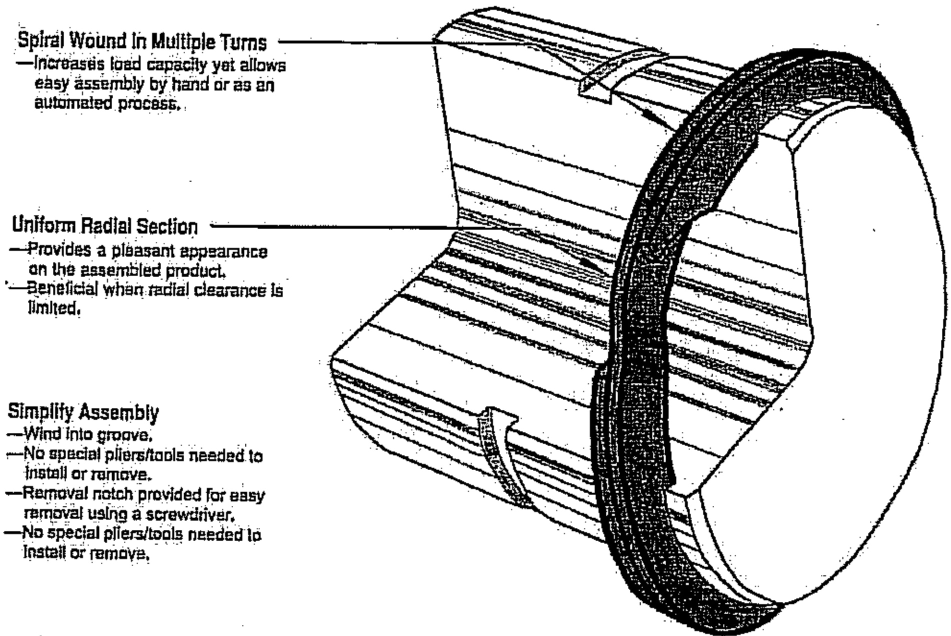
PPG Industries
Commercial Coatings
We're Everywhere You Look

www.ppgrefinish.com

Part No. CPC 57, 8/03

taylor devices inc.

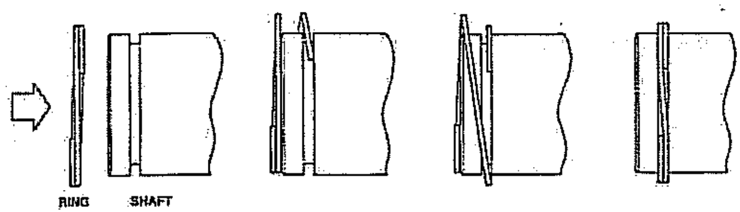
90 Taylor Drive
PO Box 748
North Tonawanda, New York 14120-0748



Manual Assembly

Manual installation on an individual or low production basis within a housing bore or on a shaft is accomplished as follows:

(1) Separate coils and insert end of ring into groove;
(2) wind ring into groove;
(3) inspect for proper seating in the groove



<u>RETAINING RING INSTALLATION:</u> The diagram above corresponds to the instructions given in section 3.1 regarding the proper installation of the damper mounting pin kit and its retaining ring.

SECTION III
WARRANTY

taylor devices inc.
90 TAYLOR DRIVE
PO BOX 748
NORTH TONAWANDA, NEW YORK 14120-0748
TELEPHONE: (716) 694-0800
FAX: (716) 695-6015

WARRANTY

Taylor Devices Fluid Dampers for Use in Structures

SELLER warrants the fluid dampers against defects in materials and workmanship under normal use and service for a period of thirty-five (35) years from the date of first delivery. Surface coatings are excluded from this warranty.

SELLER warrants that the damping coefficient of the dampers will be ±15% of the design value at 70°F within the warranty period. Any obligation under this warranty terminates if the fluid dampers are directly exposed to fire, flood, or if an earthquake occurs which exceeds the specified Design Earthquake level. In such instance, BUYER may reactivate the warranty by hiring SELLER to inspect all fluid dampers and for BUYER to pay SELLER to recondition any fluid damper that is deemed required. Detail of this will be covered in the technical manual.

The benefits to BUYER of this warranty are expressly conditioned upon BUYER's care, inspection, and maintenance of the fluid damper in strict accordance with SELLER's inspection and maintenance requirements.

DISCLAIMER OF WARRANTIES

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, WRITTEN, OR ORAL, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OR MERCHANTABILITY OR FITNESS AND IS PROVIDED IN LIEU OF ALL OBLIGATIONS AND LIABILITIES OF SELLER WITH RESPECT TO DEFECTS IN MATERIALS OR WORKMANSHIP. THE RIGHTS AND REMEDIES CONTAINED IN THIS WARRANTY EXCLUDES AND WAIVES ANY RIGHT OF BUYER TO CONSEQUENTIAL OR INCIDENTAL DAMAGES.

Quantity Submitted:	Digital Only	Date: October 8, 2008

TRANSMITTAL LETTER – SUBMITTAL INFORMATION

To: Tom Grant / Nicki Treadway DMJM H&N 999 Town & Country Road Orange, CA 92868	From: ROBINSON Robinson Seismic Limited PO Box 33093, Petone 5046 Wellington, New Zealand Ph 00644 5697840 Fax 00644 5869899 www.rslnz.com

SOLICITATION NUMBER: 57019	**IETMC Project 13892 Victoria St, Fontana CA 92336**	
SPECIFICATION SECTION: 134865	OWNER:	Department of General Services
	SUPPLIER:	Robinson Seismic Ltd
SUBMITTAL NUMBER: RSL004	NEW **x**	RESUBMITTAL ☐

SUBMITTAL DESCRIPTION:

Shop drawings and calculations

This submittal contains a deviation: ☒ Yes ☐ No

ITEM NO	DESCRIPTION	VAR	PARAGRAPH/DWGS

COMMENTS:

The number of layers increased from 50 to 60.

IETMC SHOP DRAWINGS

SEISMIC ISOLATION BEARINGS

SUBMITTAL

To: Tom Grant / Nicki Treadway
DMJM H&N
999 Town & Country Road
Orange, CA 92868

From: Robinson Seismic Ltd
PO Box 33093
Petone 5046
New Zealand

IETMC Project
Solicitation number: 57019
Submittal number: RSL003

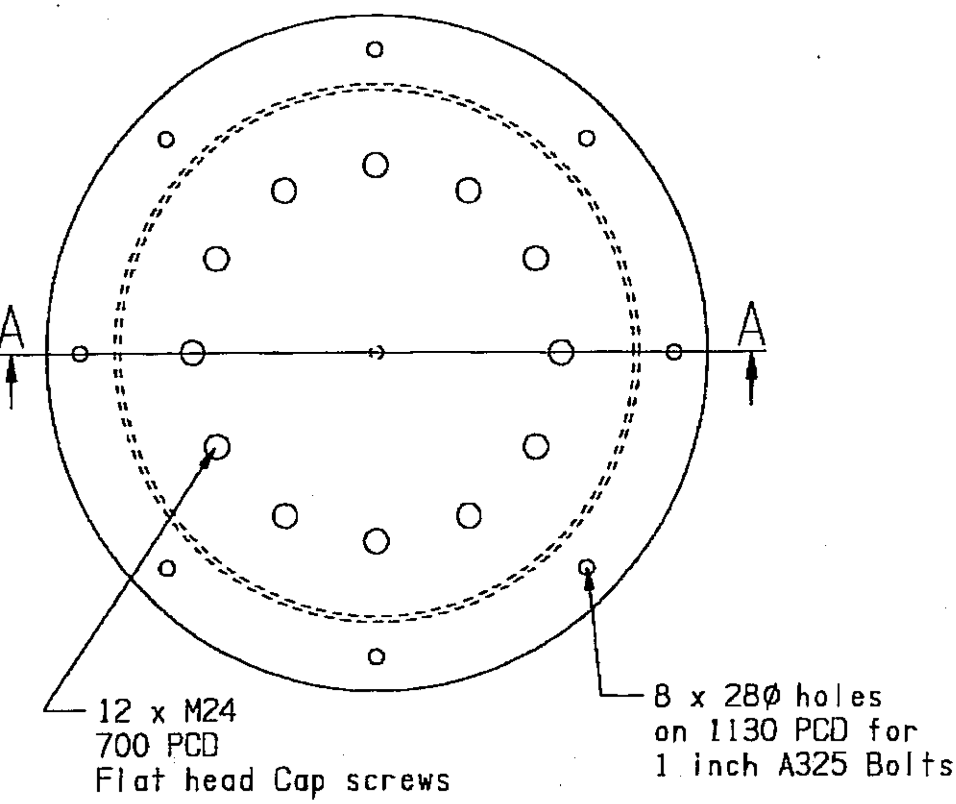
October 08, 2008

ROBINSON

SECTION 1.

Shop Drawings

Top View



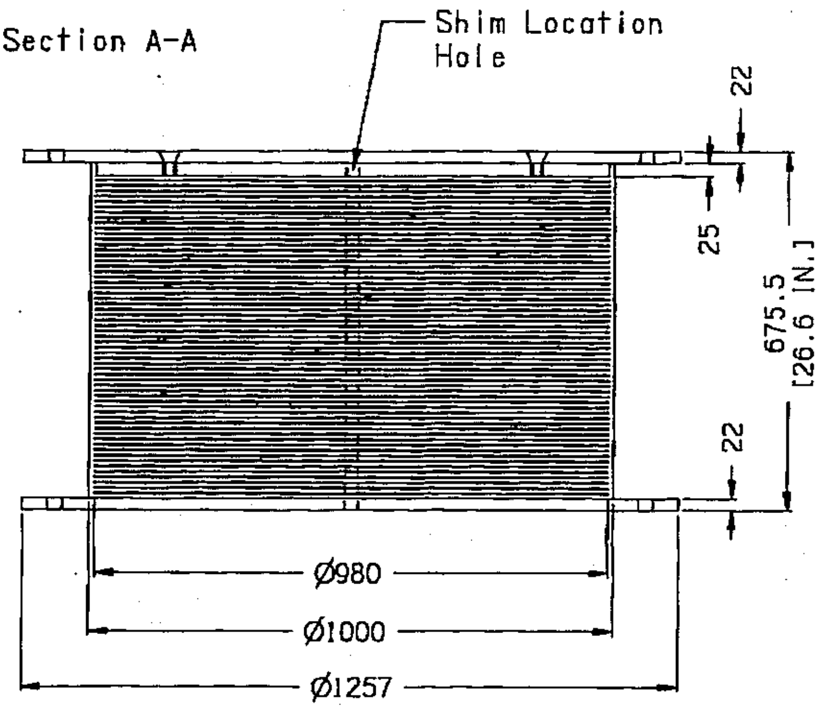
Title	
	Manufacture dwg Inland Enpire RB
Dwg No	87 300 AA

Designed	TREVOR KELLY	01/Oct/08
Drawn	C.GANNON	06/Oct/08
Checked		
Approved		
Scale	1 : 10	

Robinson Seismic Ltd

PO Box 33093 Petone
phone 64 4 5697841 fax 5869890
e-mail info@rsinz.com

Section A-A



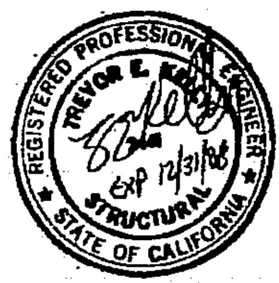
Rubber - 60 x 7.65mm
Steel Shim - 59 x 2.5mm

Title	Manufacture dwg Inland Empire RB
Dwg No	87 300 BA

Designed	TREVOR KELLY	01/Oct/08
Drawn	C. GANNON	06/Oct/08
Checked		
Approved		
Scale	1 : 10	

Robinson Seismic Ltd

PO Box 33093 Petone
phone 64 4 5697841 fax 5869899
e-mail info@rsl.nz.com



ROBINSON

SECTION 2.

Calculations

ROBINSON SEISMIC LTD.

CALCULATIONS FOR
SEISMIC ISOLATION BEARINGS

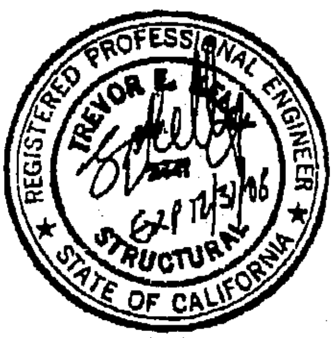
FOR

INLAND EMPIRE TRANSPORTATION CENTRE
DEPARTMENT OF TRANSPORTATION – DISTRICT 8

AND

CALIFORNIA HIGHWAY PATROL – INLAND DIVISION
SAN BERNADINO, CALIFORNIA

Solicitation No. 57019



Trevor E Kelly, S.E.
8 October, 2008

ROBINSON SEISMIC LTD.

CALCULATIONS FOR
SEISMIC ISOLATION BEARINGS

FOR

INLAND EMPIRE TRANSPORTATION CENTRE
DEPARTMENT OF TRANSPORTATION – DISTRICT 8

AND

CALIFORNIA HIGHWAY PATROL – INLAND DIVISION
SAN BERNADINO, CALIFORNIA

Solicitation No. 57019

Trevor E Kelly, S.E.
8 October, 2008

TABLE OF CONTENTS

1 INTRODUCTION

Section 1.7 D of the specification requires that isolator design calculations be submitted to DSA and the SEoR for review and approval. Design calculations are required to confirm that properties are consistent with specification requirements and also include expected ultimate capacities and factors of safety against all ultimate load and displacement capacities. This document contains the calculations to demonstrate such compliance.

2 PROCEDURES USED FOR BEARING DESIGN

This design refers to elastomeric bearings, comprised of alternate layers of natural rubber and steel shims. The design procedures in this section refer solely to this type of bearing.

2.1 Definitions

A_b	=	Bonded area of rubber
A_g	=	Gross area of bearing, including side cover
A_r	=	Reduced rubber area at applied lateral displacement
B	=	Overall plan dimension of bearing
E	=	Elastic modulus of rubber (3.3 to 4.0 G depending on hardness)
E_b	=	Buckling Modulus
E_c	=	Effective Compressive Modulus
E_∞	=	Bulk Modulus (usually assumed as 290 ksi)
f	=	Factor applied to elongation for load capacity = 1 / (Factor of Safety)
F_m	=	Force in bearing at specified displacement
g	=	Acceleration due to gravity
G_γ	=	Shear modulus of rubber (at shear strain γ)
H_r	=	Height free to buckle
I	=	Moment of Inertia of Bearing
k	=	Material constant (0.65 to 0.85 depending on hardness)
K_{eff}	=	Effective Stiffness
K_r	=	Lateral stiffness after yield
K_v	=	Vertical stiffness of bearing
K_{vi}	=	Vertical stiffness of layer i
n	=	Number of rubber layers
p	=	Bonded perimeter
P	=	Applied vertical load
P_{cr}	=	Buckling Load
P_γ	=	Maximum rated vertical load
Q_d	=	Characteristic strength (Force intercept at zero displacement)
S_i	=	Shape factor for layer i
t_i	=	Rubber layer thickness
t_{sc}	=	Thickness of side cover
t_{sh}	=	Thickness of internal shims

T_{pl}	=	Thickness of mounting plates
T_r	=	Total rubber thickness
Δ	=	Applied lateral displacement
Δ_m	=	Maximum applied displacement
ε_u	=	Minimum elongation at break of rubber
ε_c	=	Compressive Strain
ε_{sc}	=	Shear strain from applied vertical loads
ε_{sh}	=	Shear strain from applied lateral displacement
ε_{sr}	=	Shear strain from applied rotation
ε_u	=	Minimum elongation at break of rubber
θ	=	Applied rotation

2.2 Vertical Stiffness and Load Capacity

The dominant parameter influencing the vertical stiffness, and the vertical load capacity, of an elastomeric bearing is the shape factor. The shape factor of an internal layer, S_i, is defined as the loaded surface area divided by the total free to bulge area:

$$S_i = \frac{B}{4t_i} \qquad \text{for square and circular bearings}$$

2.2.1 Vertical Stiffness

The vertical stiffness of an internal layer is calculated as

$$K_{vi} = \frac{E_c A_r}{t_i}$$

The apparent compressive modulus, E_c, is a function of the shape factor and material constant as follows:

$$E_c = E\left[1 + 2kS_i^2\right]$$

The reduced area of rubber, A_r, is calculated based on the overlapping areas between the top and bottom of the bearing at a displacement, Δ, as follows:

$$A_r = A_b\left(1 - \frac{\Delta}{B}\right) \qquad \text{for square bearings}$$

$$A_r = 0.5\left\{B^2 \sin^{-1}\left(\frac{\varsigma}{B}\right) - \Delta\varsigma\right\}$$

where for circular bearings

$$\varsigma = \sqrt{\left(B^2 - \Delta^2\right)}$$

When the effective compressive modulus, E_c, is large compared to the bulk modulus E_∞ (generally about 2000MPa or 290 ksi) then the vertical deformation due to the bulk modulus is included by dividing E_c by $1 + (E_c / E_\infty)$ to calculate the vertical stiffness. This is used to calculate vertical deformations in the bearing but not the shear strains due to vertical load.

2.2.2 Compressive Rated Load Capacity

The vertical load capacity is calculated by summing the total shear strain in the elastomer from all sources. The total strain is then limited to the ultimate elongation at break of the elastomer divided by a factor of safety appropriate to the load condition.

The shear strain from vertical loads, ε_{sc}, is calculated as $\varepsilon_{sc} = 6S_i\varepsilon_c$

Where $\varepsilon_c = \dfrac{P}{K_{vi}t_i}$

If the bearing is subjected to applied rotations the shear strain due to this is $\varepsilon_{sr} = \dfrac{B^2\theta}{2t_iT_r}$

The shear strain due to lateral loads is $\varepsilon_{sh} = \dfrac{\Delta}{T_r}$

For service loads such as dead and live load the limiting strain criteria are

$$f\varepsilon_u \geq \varepsilon_{sc} \quad \text{where} \quad f = 1/3 \quad \text{(Factor of safety 3)}$$

And for ultimate loads which include earthquake displacements

$$f\varepsilon_u \geq \varepsilon_{sc} + \varepsilon_{sh} \quad \text{where } f = 1.0 \text{ (Factor of safety 1)}$$

Combining these equations, the maximum vertical load, P_γ, at displacement Δ can be calculated from:

$$P_\gamma = \frac{K_{vi}t_i(f\varepsilon_u - \varepsilon_{sh})}{6S_i}$$

2.2.3 Tensile Rated Load Capacity

For tension loads, the stiffness in tension depends upon the shape of the unit, as in compression, but is lower than the compression stiffness. As more accurate procedures are not available, the same equations are used as for compressive loads except that the strains are the sum of absolute values.

When rubber is subjected to a hydrostatic tension of the order of 3G cavitation may occur. This will drastically reduce the stiffness. Although rubbers with very poor tear strength may rupture catastrophically once cavitation occurs, immediate failure does not generally take place. However, the subsequent strength of the component and its stiffness may be affected. Therefore, the isolator design is based on ensuring that tensile stresses do not exceed 3G under any load conditions.

2.2.4 Bucking Load Capacity

For bearings with a high rubber thickness relative to the plan dimension the elastic buckling load may become critical. The buckling load is calculated using the Haringx formula as follows:

The moment of inertia, I is calculated as

$$I = \frac{B^4}{12} \qquad \text{for square bearings}$$

$$I = \frac{\pi B^4}{64} \qquad \text{for circular bearings}$$

The height of the bearing free to buckle, that is the distance between mounting plates, is

$$H_r = (nt_i) + (n-1)t_{sh}$$

An effective buckling modulus of elasticity is defined as a function of the elastic modulus and the shape factor of the inner layers:

$$E_b = E(1 + 0.742S_i^2)$$

Constants T, R and Q are calculated as:

$$T = E_b I \frac{H_r}{T_r}$$

$$R = \frac{GA_g T_r}{H_r}$$

$$Q = \frac{\pi}{H_r}$$

From which the buckling load at zero displacement is $P_{cr}^0 = \frac{R}{2}\left[\sqrt{1 + \frac{4TQ^2}{R}} - 1\right]$

For an applied shear displacement the critical buckling load at zero displacement is reduced according to the effective "footprint" of the bearing in a similar fashion to the strain limited load but at a lower rate:

$$P_{cr}^{\gamma} = P_{cr}^0 \sqrt{\frac{A_r}{A_g}}$$

The allowable vertical load on the bearing is the smaller of the rated load, P, or the buckling load.

2.3 Lateral Stiffness and Hysteresis Parameters For Bearing

The shear stiffness, K_r, is equal to the shear stiffness of the elastomeric bearing $K_r = \dfrac{G_\gamma A_r}{T_r}$. The maximum force in the bearing can then be calculated as $F_m = K_r \Delta$

3 BEARING DESIGN CALCULATIONS

3.1 Material Properties

The detailed design of the isolation system was performed using an EXCEL spreadsheet based on the design procedures given in Section 2. The properties of the elastomer used were as listed in Table 3-1.

Table 3-1 : Elastomer Properties

	LR A
Shear Modulus (psi)	57
Ultimate Elongation	6.5
Material Constant, k	0.87
Elastic Modulus, E (psi)	194
Bulk Modulus (psi)	286,000

3.2 Design Loads and Displacements

Tables 3-2 and 3-3 list respectively the vertical loads and lateral displacements on the bearings. The design conditions are (1) gravity, maximum long term load (LT) with zero displacement and (2) seismic, short term maximum load (ST) with total maximum design displacement (TM). The specification also requires a test load of 1400 kip at a 22" displacement.

Table 3-2: Design Loads

	Vertical Load (kips)
LT = Long term maximum load (D + L) Max	660
ST = Short term maximum load (1.2D + L + E_{MCE}) Max	950
AL = Average isolator test load (D + 0.5L) Average	290
Test No. 19 Load	1400 @ 22"

Table 3-3: Design Displacements

	Displacement (inches)
DD = Design displacement	13.0
TD = Total design displacement	14.1
DM = Maximum design displacement	22.9
TM = Total maximum design displacement	26.0

3.3 Bearing Dimensions

The bearing dimensions are as given in Table 3-4. The plan dimensions and internal construction were set to meet dimensional limitations and provide the specified stiffness. The isolators are circular in plan shape.

Table 3-4 : Isolator Dimensions

Mounting Plate Size	49.50"
Plan Dimension	39.37"
Layer Thickness	0.301"
Number of Layers	60
Total Height	26.594"

3.4 Bearing Properties

The properties of each bearing were calculated using the formulas from Section 2 and are as listed in Table 3-5. Table 3-6 lists calculations of the buckling strength, which is adjusted depending on applied displacement.

Table 3-5 : Bearing Properties

Gross Area	1217 in^2
Side Cover	0.394"
Bonded Dimension	38.583"
Bonded Area	1169 in^2
Total Rubber Thickness	18.071"
Bonded Perimeter	121.21"
Shape Factor	32.0
Internal Shim Thickness	0.0984"
Mounting Plate Thickness	0.866"
Shear Modulus (nominal)	57 psi
Yielded Stiffness K_r Nominal	3.91 kip/in
Adjusted for Vertical Stress	3.65 kip/in

Table 3-6 Factors for Buckling Load Calculations

Moment of Inertia	108,778 in4
Height Free to Buckle	23.90"
Effective Buckling Modulus	149.3 ksi
Constant T	21,462,009
Constant R	93.4
Constant Q	0.1316
P_{cr} at Zero Displacement	4343 kips

3.5 Serviceability Load Limit State

The vertical stability criteria require a factor of safety on the elongation at break of at least 3 under maximum vertical loads. Table 3-6 summarizes the calculation of the maximum strain in the rubber under the load condition of DL+LL.

Table 3-7 Gravity Load Limit State

Factor on e_u	0.33
Vertical Load	660 kips
Compressive Strain e_c	0.0016
Elastic Modulus	0.193 ksi
Compressive Shear Strain e_{sc}	0.31
Total Shear Strain	0.31
Strain Limit	2.17
Buckling Load Capacity	4343 kips
Status	**OK**

3.6 Seismic Load Limit State

The seismic displacement is used to evaluate the seismic load limit state in the bearings. The total shear strain is calculated from compression (or tension) plus the strain due to applied displacements. A factor is applied to the ultimate elongation, e_u, equal to the reciprocal of the safety factor.

Table 3-7 lists the calculations for the seismic displacement of 26" and 22" and a factor of safety of 1.0 for the minimum load and the maximum load

The minimum load in Table 3-7 is tensile and so the critical condition is the tensile stress, which should be less than the cavitation limit. The tensile stress is approximately 42 psi, compared to the limit of 127 psi and so there is a factor of safety of 3.

Table 3-8 Seismic Limit States

	Minimum Load	Maximum Load	Test No. 19
Factor on e_u	1.00	1.00	1.00
Vertical Load	-50 kips	950 kips	1400 kips
Applied Displacement	26.0"	26.0"	22.0"
Elastic Modulus		0.193 ksi	0.193 ksi
Compressive Strain e_c		0.0109	0.0108
Reduction Factor		0.212	0.316
Compressive Shear Strain e_{sc}		2.10	2.08
Shear Strain from Disp. e_{sh}		1.44	1.22
Total Shear Strain		3.54	3.30
Strain Limit		6.50	6.50
Tensile Stress	42 psi	-	-
Cavitation Limit (=3G)	127 psi	-	-
Buckling Capacity		2001 kips	2440 kips
Status	OK	OK	OK

3.7 Vertical Stiffness

Table 3-9 lists the calculation of the vertical stiffness.

Table 3-9 Vertical Stiffness

E	0.193 ksi
A	1169 in^2
1+2ks^2	1786
e_c	350
e_{cm} (Including bulk modulus effects)	159
K_{vi} (per layer)	615,514 kip/inch
K_v (Total)	10,259 kip/inch

4 CONNECTION DESIGN

4.1 Design Basis

The connection of an isolation bearing to a structure must resist shear forces, vertical loads and bending moments. Bending moments are due to primary (VH) and secondary (PΔ) effects. Design for shear is relatively straightforward but design for moment is complicated by the unknown shape of the compressive block, especially under extreme displacements.

It is recognized that the design approach used here is simplistic and not a true representation of the actual stress conditions at the connection interface. However, the procedure has been shown to be conservative by prototype testing which has used less bolts, and thinner plates, than would be required by the application of this procedure.

Bearing design includes the mounting plate and mounting bolts. Design is based on AISC allowable stress values, with a 4/3 stress increase for seismic loads. Allowable stresses used in design are:

1 Bolt shear stress 21 ksi x 4/3 = 28 ksi. Based on allowable values for A325 bolts.

2 Bolt tension. The combined stress equation is used such that

$$F_t \leq \sqrt{(44)^2 - 4.39 f_v^2}$$

3 Plate bending stress: 36 x 0.75 x 4/3 = 36 ksi for Grade A36 mounting plates.

4.2 Design Actions

Table 4-1 lists maximum design shear forces, moments and axial loads. Shear forces, axial loads and displacements are from calculations in Section 3.

The connections are designed for two conditions, (1) maximum vertical load and (2) minimum vertical load, each concurrent with the maximum earthquake displacement and shear force.

The bearing is bolted to the structure top and bottom and so acts as a fixed end column for obtaining design moments. Figure 4-1 shows the forces on the bearing. Figure 4-2 shows how the actions may be calculated as an equivalent column on the centerline of the bearing. The total moment due to applied shear forces, VH, plus eccentricity, PΔ, is resisted by equal moments top and bottom.

Figure 4-1 Forces on Bearing in Deformed Shape

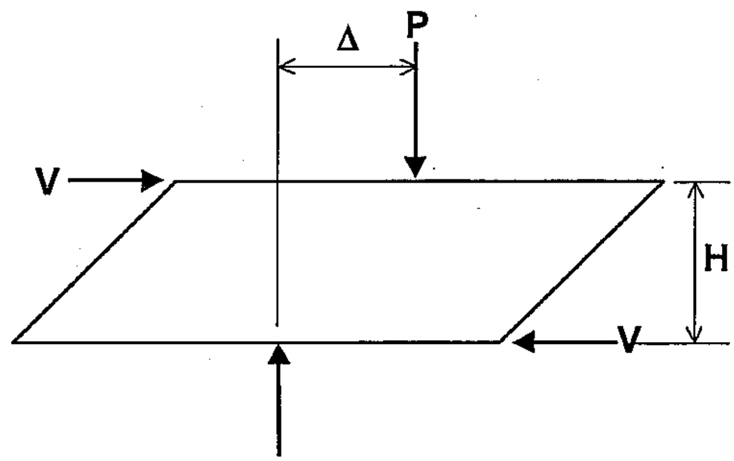


Figure 4-2 Equivalent Column Forces

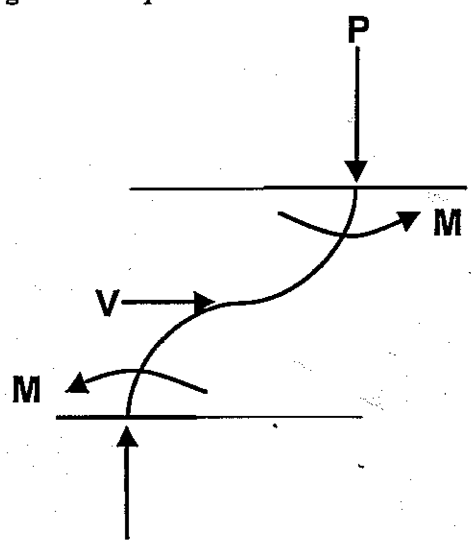


Table 4-1 Design Actions

Bearing Dimensions	
Bearing Diameter	38.58"
Bearing Height	26.61"
Mounting Plate Diameter	49.50"
Bolt Pitch Diameter	44.50"
Plate Net Thickness	0.87"
Plate Strength	36 ksi
Number of Bolts	8
Bolt Type	A325
Bolt Size	1.00"
Vertical Loads	
D + E	950 kips
D – E	-50 kips
Lateral Loads and Displacements	
Maximum Displacement	26"
Maximum Force	95 kips
Design Actions	
Shear Force	95 kips
Primary Moment, VH	2528 kip-in
Secondary Moment, PΔ (Max)	24,700 kip-in
Secondary Moment, PΔ (Min)	-1300 kip-in
Design Moment = (VH + PΔ)/2 (Max)	13,614 kip-in
Design Moment = (VH + PΔ)/2 (Min)	614 kip-in
Design Conditions	
(1) Earthquake Load Down	
Shear Force	95 kips
Vertical Load	950 kips
Bending Moment	13,614 kip-in
(2) Earthquake Load Up	
Shear Force	95 kips
Vertical Load	-50 kips
Bending Moment	614 kip-in

4.3 Mounting Plate Connection

4.3.1 Bolt Stresses

The top and bottom mounting plates are connected to the bearing during manufacture. The mounting plates are then bolted to the upper and lower connection plates.

The design procedure adopted for the mounting plate connection is based on the simplified condition shown in Figure 4-3, where the total axial load and moment is resisted by the bolt group. In Figure 4-3, the area used to calculate P/A is the total area of all bolts and the section modulus used to calculate M/S is the section modulus of all bolts.

If is recognized that in reality the compression forces will be resisted by compressive stresses in the plate rather than bolts. However, the bearing stiffness to calculate the modular ratio, and therefore the neutral axis position, is unknown. This is why the bolt group assumption is made. This assumption is conservative as it underestimates the actual section modulus and so is an upper bound of bolt tension.

Figure 4-3 : Assumed Bolt Force Distribution

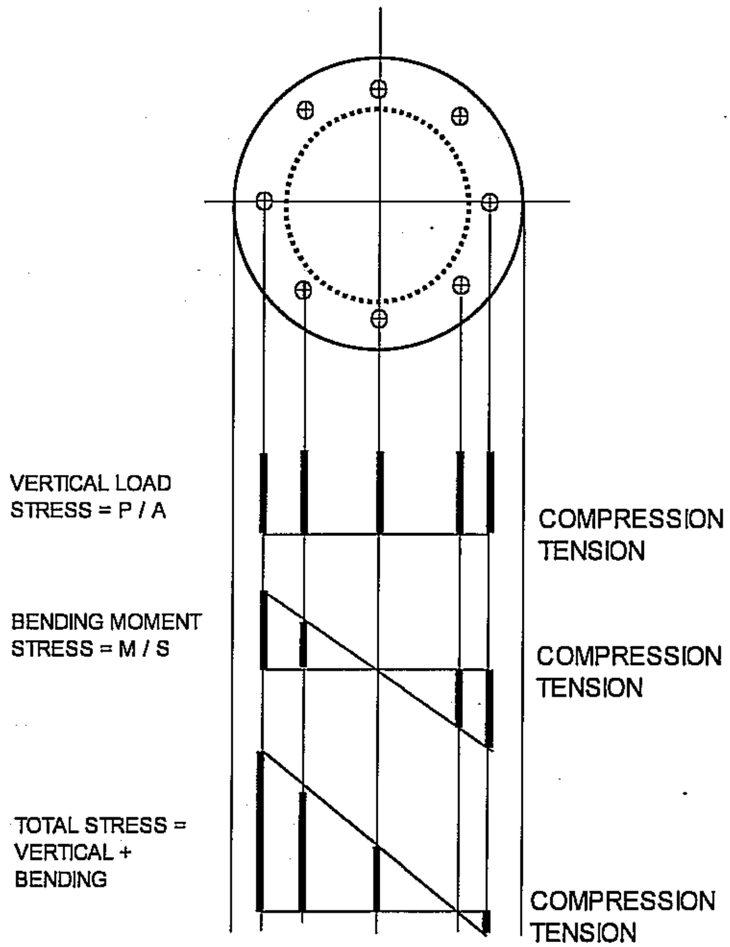


Table 4-2 lists connection design calculations for the bolted connection of the mounting plate. The procedure is:

1 Calculate the axial load per bolt as P/A

2 Calculate the tension per bolt due to the moment as M/S where S is the section modulus of the bolt group.

3 Calculate the net tension per bolt as P/A – M/S

4 Check the bolt for combined shear plus tension.

This is done for maximum and minimum vertical loads.

Table 4-2 Mounting Bolt Design

Bolt Diameter	1.00"
Shear Area	0.785 in^2
Tension Area	0.785 in^2
Number of Bolts	8
Pitch Diameter	44.50"
Section Modulus of Bolts	87 in^3
Shear Force per Bolt	11.88 kips
Load Case 1	
P/A per bolt	-118.75 kips
M/S per bolt	156.41 kips
Tension per Bolt	37.66 kips
Shear Stress	15.12 ksi
Allowable Shear Stress	22.67 ksi
Shear Stress Ratio	0.67
Tensile Stress	47.95 ksi
Allowable Tensile Stress	49.36 ksi
Tensile Stress Ratio	0.97
Status	OK
Load Case 2	
P/A per bolt	6.25 kips
M/S per bolt	7.06 kips
Tension per Bolt	13.31 kips
Shear Stress	15.12 ksi
Allowable Shear Stress	22.67 ksi
Shear Stress Ratio	0.67
Tensile Stress	16.94 ksi
Allowable Tensile Stress	49.36 ksi
Tensile Stress Ratio	0.34
Status	OK

4.3.2 Plate Stresses

Table 4-3 contains the calculations for bending stresses in the mounting plates. The assumed force distribution on which these calculations are based is shown in Figure 4-4. Bending is assumed to be critical in an outstanding segment on the tension side of the bearing. The chord defining the tangent is assumed to be tangent to the side of the bearing. This segment is loaded by a single bolt.

Figure 4-4 Assumed Force Distribution for Plate Stresses

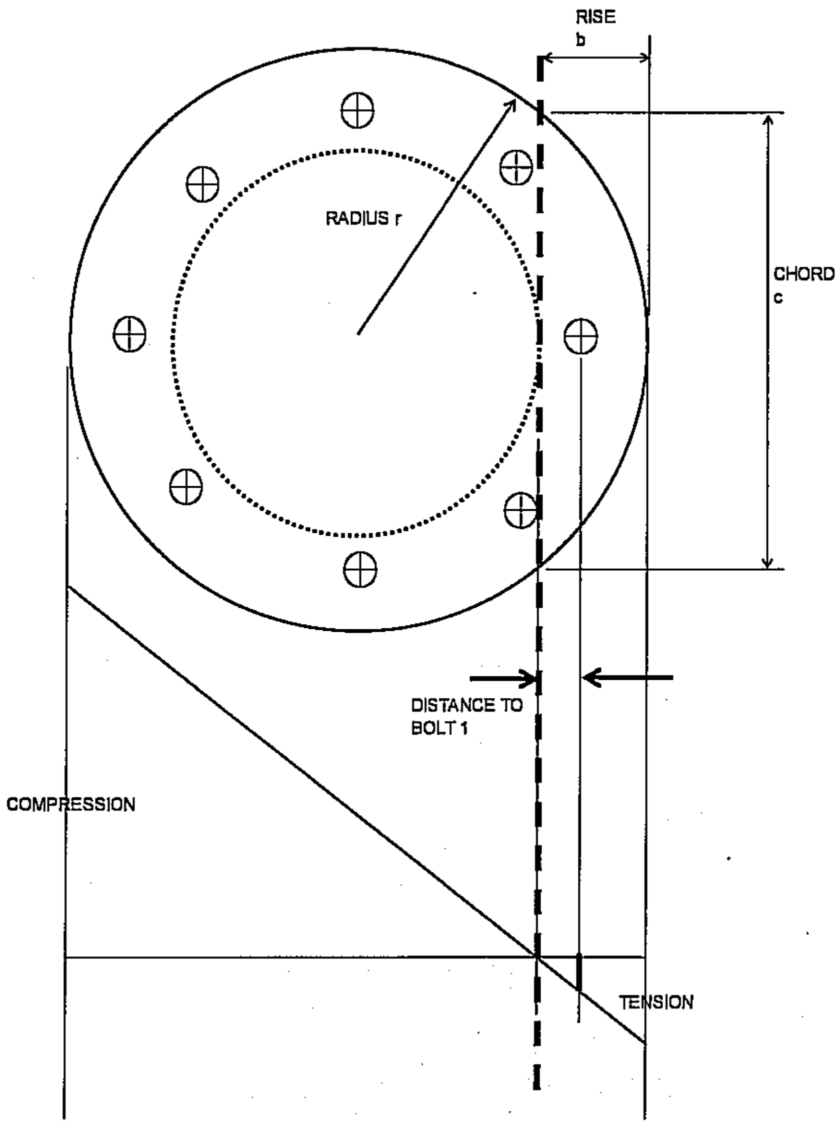


Table 4-3 Mounting Plate Design

Rise, b	5.5"
Radius, r	24.8"
Chord, c	31.0"
Distance to Bolt 1	2.95"
Number of Bolts in Outstand	1
Load Case 1	
Bolt Tension	37.66 kips
Plate Moment	111 kip-in
Section Width	31.01"
Section Depth	0.87"
Section Modulus	3.88 in^3
Bending Stress	28.68 ksi
Load Case 2	
Bolt Tension	13.31 kips
Plate Moment	39 kip-in
Section Width	31.01"
Section Depth	0.87"
Section Modulus	3.88 in^3
Bending Stress	10.13 ksi
Maximum Stress	28.68 ksi
Allowable Stress	36.00 ksi
Status	OK

5 COMPARISON WITH SPECIFICATION REQUIREMENTS

Table 5-1 compares the calculated isolator system properties and capacities with the requirements of the specification. The values in Table 5-21 are extracted from the results in the preceding sections as described in the notes accompanying the table.

Notes to Table 5-1:

(1) The failure of an elastomeric bearing is defined as the ratio of total applied shear strain to the allowable strain. As listed, the isolator has a minimum factor of safety of 1.84 under maximum ST loads. See Tables 3-6 and 3-7 for calculations of total strain.

(2) The vertical load capacity of the isolators is calculated by increasing the vertical load until the total strain limit listed in note (1) above is reached.

(3) There is considerable uncertainly about tension capacity of isolators. The limit has been calculated assuming a net tension stress of 3G = 171 psi based on tests performed on natural rubber isolators.

(4) The maximum applied displacement is calculated by increasing the applied displacement until the total strain limit listed in note (1) above is reached. The maximum displacement under tensile loads in indeterminate but has been listed as equal to the displacement under maximum compression based on observed behavior.

(5) The axial compressive stiffness is as listed in Table 3-8. This is based on a bulk modulus $K_\infty = 290$ ksi, the usual industry value. However, these bearings have a very large shape factor of 32 and are highly dependent on K_∞ . For the lower bound value of 220 ksi the vertical stiffness reduces from 10,259 kip/inch to 8,677 kip/inch.

(6) The wind load displacement is based on an assumption that the shear modulus for strains less than 20% is 1.5 times the shear modulus at strains of 100% or higher. This provides an effective stiffness of 1.5 x 3.65 = 5.48 kip/in and a displacement of 10.1 / 5.79 = 1.74" under the 10.1 kip wind load.

(7) The effective stiffness of the natural rubber material is assumed constant between shear strain levels of 72% (at DD) and 127% (at DM) and so the effective stiffness is listed the same at both displacements. In practice, these will be different but within the specified tolerances.

(8) The maximum tension force under Test No. 19 is estimated to be approximately 200 kips, the cavitation limit calculated as noted in (3) above.

Table 5-1 Load and Displacement Capacity of Isolator

	Note	Specification Value	Capacity	Comment
Total Strain in Elastomer LT loads (D + L) ST loads (1.2D + L + E)	(1)	 0.31 3.54	 2.17 6.50	 F.S. 7.0 F.S. 1.84
Vertical Load on Isolator LT loads (D + L) ST loads (1.2D + L + E)	(2)	 660 kip 950 kip	 4343 kip 4620 kip 2001 kip 2280 kip	 Zero displacement Buckling Zero displacement Strain 26" displacement Buckling 26" displacement Strain
Tension on Isolator	(3)	-50 kip	-204 kip	F.S. 4.08
Total Maximum Displacement (TM)	(4)	26.0"	31.3" 31.3"	Capacity at 950 kip load Capacity at -50 kip load
Axial Compressive Stiffness	(5)	> 9,000 kips/in	10,259 kip/in	Bulk modulus = 290 ksi (8,677 for bulk modulus 220 ksi)
Deflection under 10.1 kip wind load	(6)	< 2.20"	1.74"	Based on $G_{10\%} = 1.5G_{100\%}$
Effective Stiffness at DD (13.0") Effective Stiffness at DM (22.90")	(7)	3.23 – 4.37 3.23 – 4.37	3.65 3.65	
Tension force Test No. 19 (2.E.F)	(8)	< -200 kip	-204 kip	Estimated cavitation limit

6 APPENDIX B FORMS

Notes to Appendix B Forms:

[1] Individual isolator properties list maximum displacement at ST load and maximum load capacity at TM displacement.

[2] Effective stiffness average values are for the bearings as designed. The effective stiffness of the natural rubber material is assumed constant between shear strain levels of 72% (at DD) and 127% (at DM) and so the effective stiffness is the same at both displacements. It is assumed that maximum and minimum values will be within specification limits.

[3] Total isolation system properties assume 31 isolators with similar properties.

[4] The tension axial stiffness is indeterminate from theory. Empirically, the stiffness is based on 15" rubber tensile strain at failure = 0.15 x 18.071" rubber thickness = 2.71" at failure. Stiffness is the failure load of 204 kips divided by 2.71".

[5] The bearings are linear elastic and so the bilinear model uses equal initial and yield stiffness.

INDIVIDUAL ISOLATOR DESIGN PROPERTIES

Displacement (inches)				Maximum Allowable Vertical Loads			Effective Stiffness (kips/in)					
							@ DD			@ DM		
DD	TD	DM	TM	LT	ST	AL	Min	Target	Max	Min	Target	Max
-	-	31.3"	-	4343	2001	-	3.23	3.65	4.37	3.23	3.65	4.37

ISOLATION SYSTEM DESIGN PROPERTIES

Effective Stiffness (kips/in)					
Aggregate effective stiffness at DD			Aggregate effective stiffness at DM		
Min	Target	Max	Min	Target	Max
100	113.2	135	100	113.2	135

Direct Net Tension Force Capacity Without Failure (kips)	Tension Displacement at Tension Capacity Load (ins) and Stiffness (k/in)	Lateral Deflection at 10.1 kips Lateral Load	Minimum Compression Stiffness of Isolator (kips/in)
204 kips	2.71" at Failure K = 75 kip/in	1.90"	10,259

BI-LINEAR MODEL OF ISOLATOR FOR COMPUTER ANALYSIS

PROPERTIES AT DD = 13.0 INCHES

Initial Stiffness, K1 (kips/in)			Yield Force, Fy (kips)			Yield Displacement, Dy (kips)			Yielded Stiffness K2 (kips/in)			Max. Force at Max. Disp. Fmax (kips)		
Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
3.23	3.65	4.37	-	-	-	-	-	-	3.23	3.65	4.37	42.0	47.5	56.8

PROPERTIES AT DM = 22.9 INCHES

Initial Stiffness, K1 (kips/in)			Yield Force, Fy (kips)			Yield Displacement, Dy (kips)			Yielded Stiffness K2 (kips/in)			Max. Force at Max. Disp. Fmax (kips)		
Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max
3.23	3.65	4.37	-	-	-	-	-	-	3.23	3.65	4.37	74.0	83.6	100.0

Quantity Submitted:	Digital Only	Date: October 9, 2008

TRANSMITTAL LETTER – SUBMITTAL INFORMATION

To:	From:
Tom Grant / Nicki Treadway DMJM H&N 999 Town & Country Road Orange, CA 92868	ROBINSON Robinson Seismic Limited PO Box 33093, Petone 5046 Wellington, New Zealand Ph 00644 5697840 Fax 00644 5869899 www.rslnz.com

SOLICITATION NUMBER: 57019	**IETMC Project**	
SPECIFICATION SECTION: 134865	OWNER:	Department of General Services
	SUPPLIER:	Robinson Seismic Ltd
SUBMITTAL NUMBER: RSL006	NEW	RESUBMITTAL X

SUBMITTAL DESCRIPTION:

Product Installation Plan 1.8A – IETMC Project. Individual bearing weight 2.0 US tons.

This submittal contains a deviation: ☐ Yes ☒ No

ITEM NO	DESCRIPTION	VAR	PARAGRAPH/DWGS

COMMENTS:

Isolator Installation Sequence for bearings for IETMC Project.

Individual bearings weight 2.0 US tons.

ROBINSON

PRODUCT INSTALLATION PLAN

SEISMIC ISOLATION BEARINGS

SUBMITTAL

To: Tom Grant / Nicki Treadway
DMJM H&N
999 Town & Country Road
Orange, CA 92868

From: Robinson Seismic Ltd
PO Box 33093
Petone 5046
New Zealand

IETMC Project
Solicitation number: 57019
Submittal number: RSL006

October 09, 2008

ROBINSON

Inventors and developers of the Lead Rubber Bearing
Research engineering and suppliers in the fields of mechanical damping and seismic isolation

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ISOLATOR INSTALLATION SEQUENCES IETMC PROJECT

WITHOUT RETROFIT

(a) Form and reinforce foundations

(b) Position Template 1 and fix securely (Sketch 1).

(c) Pour concrete to 1 inch below underside of plate

(d) Remove Template 1

(e) Position base plate and bearing on 1 inch steel shims (Sketch 2)

(f) Grout base of base plate using Conbextra flowable grout with a "flowthrough technique". Allow to cure (Sketch 3)

(g) Tighten bolts (Sketch 4)

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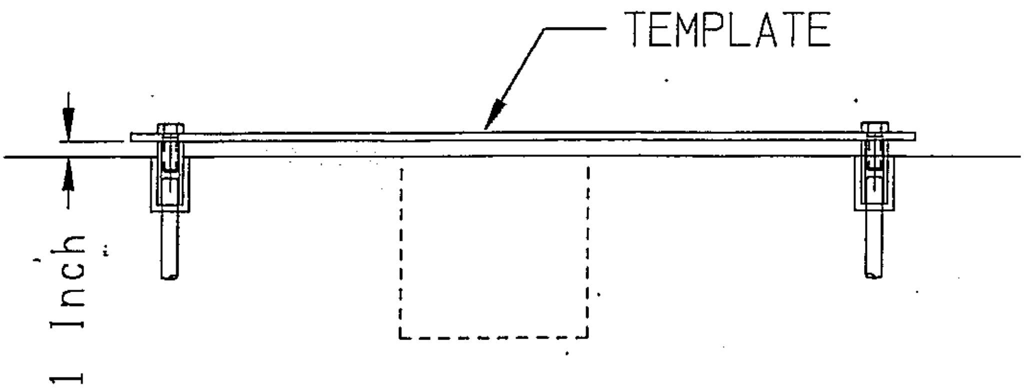
STANDARD INSTALLATION FOR IETMC PROJECT– SKETCH 1.



1

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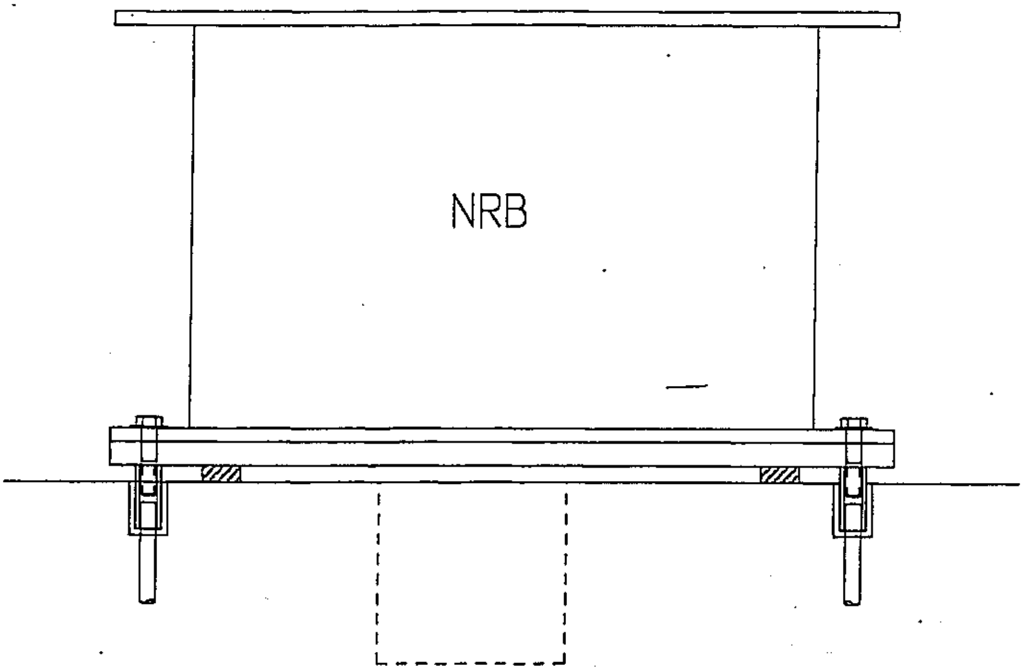
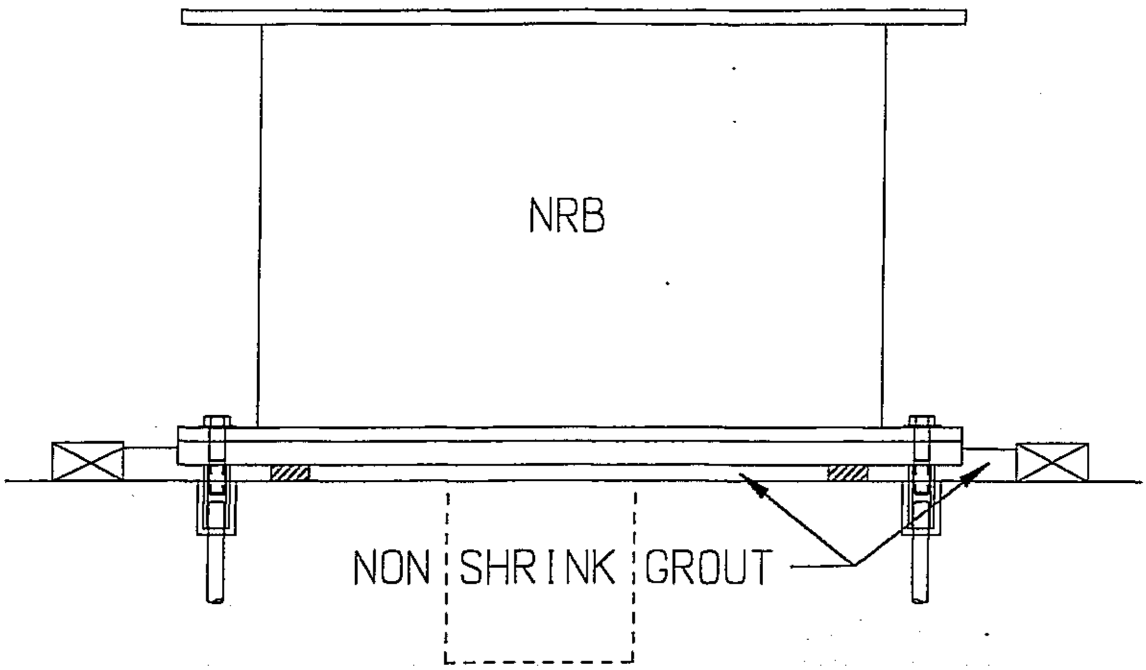
STANDARD INSTALLATION FOR IETMC PROJECT – SKETCH 2



2

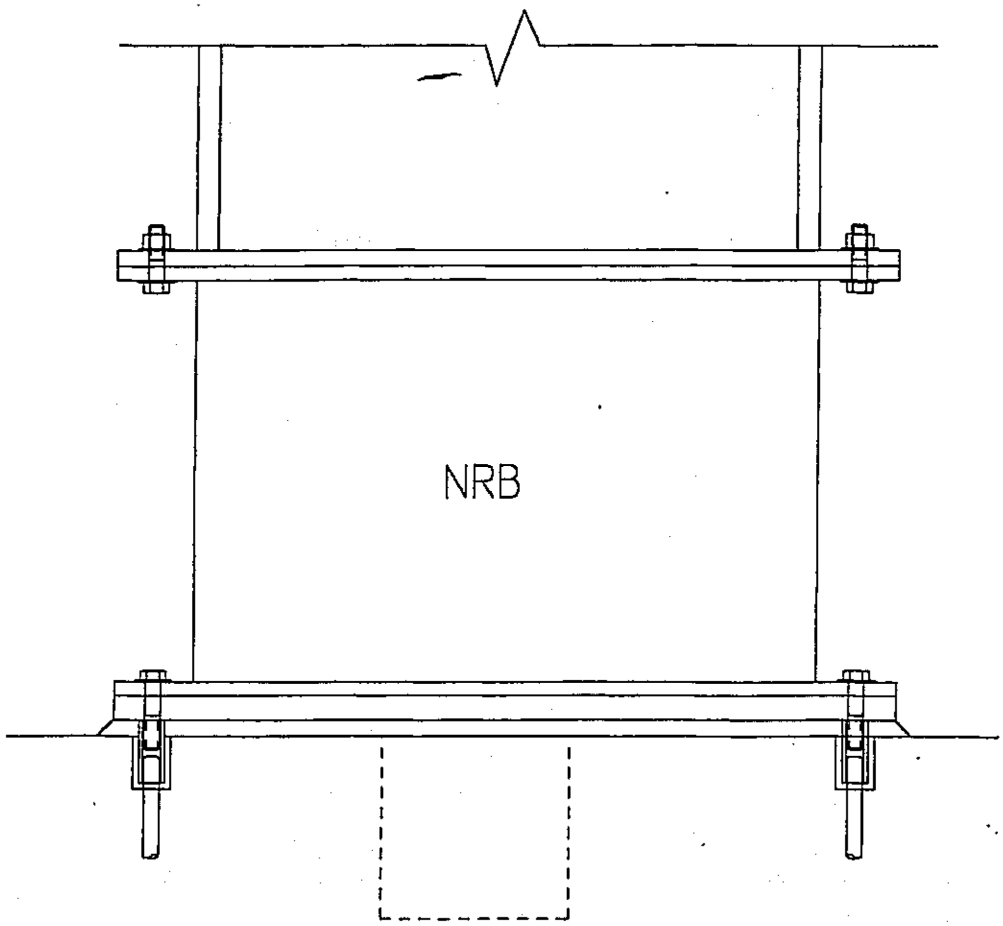
ROBINSON

STANDARD INSTALLATION FOR IETMC PROJECT – SKETCH 3

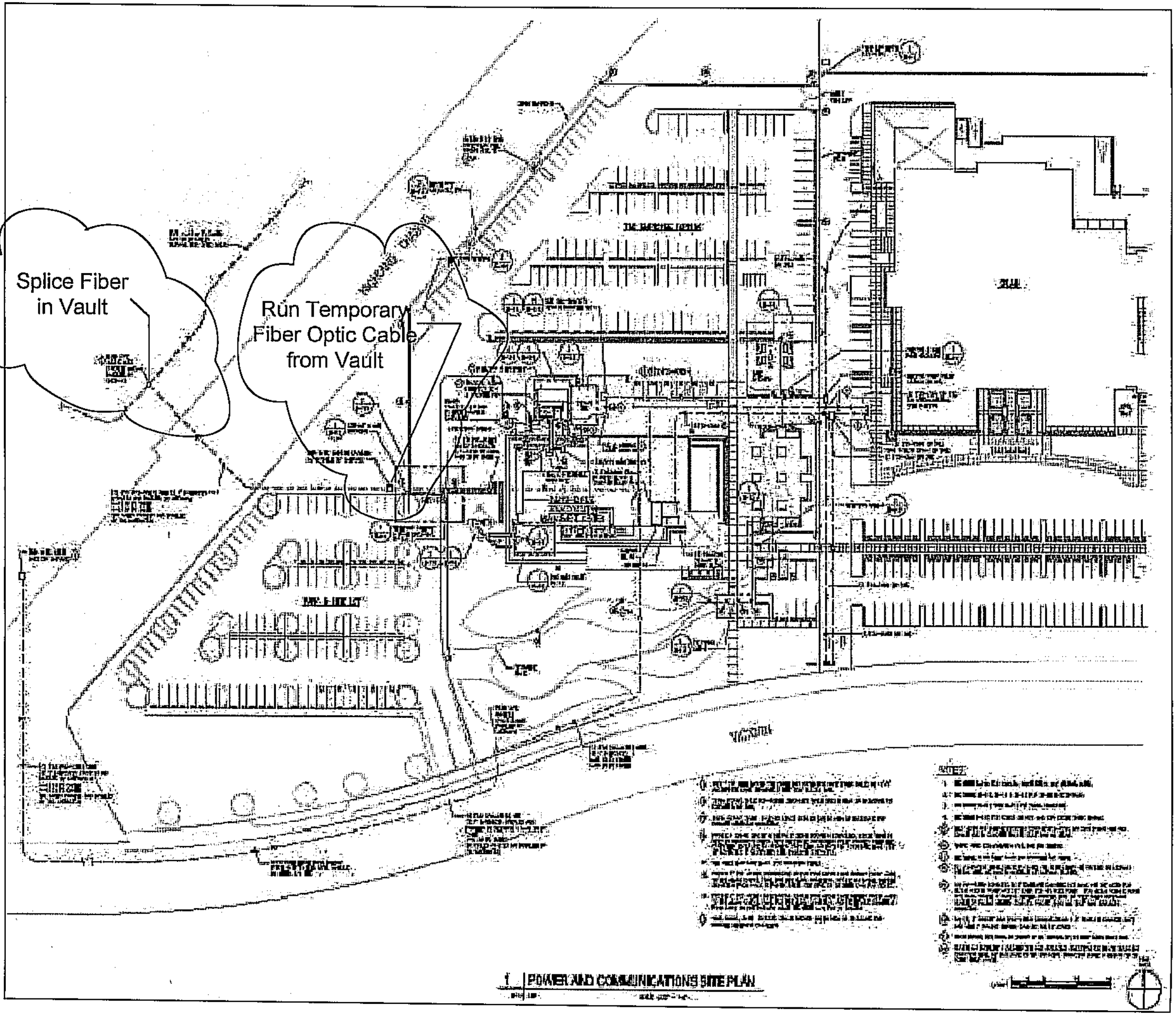


3

STANDARD INSTALLATION FOR IETMC PROJECT – SKETCH 4



4


Splice Fiber in Vault
Run Temporary Fiber Optic Cable from Vault
POWER AND COMMUNICATIONS SITE PLAN