STATE OF CALIFORNIA
Department of General Services - Office of Procurement
PURCHASE ORDER

Form GSOP 1-PIN (04/98)

Purchase Order No.	Rev.	Date
62197		6/30/2008

Supplier No.	Solicitation No.	Delivery Date	FOB Point	Invoice Terms
811817	57019	266 Days ARO	Destination	

ROBINSON SEISMIC LTD
PO BOX 33093
PETONE 5046
WELLINGTON, NZ 5046
NEW ZEALAND
Attn: ALAN WILSON

Phone: 642-143-5701

Ship To: IETMC
13892 VICTORIA STREET
FONTANA, CA 92336

Charge To: GENERAL SERVICES Z-01
RESD - RAFT ALAFRANJI
707 3RD STREET
WEST SACRAMENTO, CA 95608

Agency Billing	Agency Purchase Estimate	Purchase Estimate	Revision
30331	3119707	67070	1

Agency Contact	Phone	Date Received
RAFAT ALAFRANJI	916-376-1738	

Item No.	Quantity	Unit	Commodity Code	Description	Unit Price	Extension
				NOTE: The actual New Zealand phone no. for supplier is 064 21435701.		
				This purchase order is being awarded on September 23, 2008 pursuant to Government Code Section 13332.17. Any encumbrances made pursuant to this purchase order shall be construed to have been made on the last day of the preceding fiscal year.		
				The general provisions for Non-IT commodities are hereby incorporated by reference. These General Provisions can be obtained by phoning (916) 375-4400 or by accessing our website at:		
				www.documents.dgs.ca.gov/pd/modellang/GPnonIT0407.pdf		
				THE FOLLOWING INFORMATION IS PROVIDED FOR AGENCY USE ONLY:		
				Prime Contractor: NS		
1	33	EA	5700-000-0000-0	CONSTRUCTION MATERIAL (AS DESCRIBED) SEISMIC ISOLATION BEARINGS Designing, manufacturing, and testing seismic isolation bearings in accordance with specifications, designs, and plans. The number of isolators to be supplied includes 31 production units, as appropriate. Prototype tests are not required if an isolator unit of similar properties has been previously tested using specified sequence of tests.	21,500.0000	709,500.00

PO Miscellaneous Charges and Discounts — Dollar Value
BATCH ADJUSTMENT (CHARGE) 55,000.00

Total Value: 764,500.00

FOR THE PURPOSE OF THIS AWARD

Only Free On Board (F.O.B.) Destination will be accepted.

PROGRESS PAYMENTS OPTION AND PERFORMANCE BOND REQUIREMENT

Sales and/or use tax to be extra unless noted above

Buyer	Phone	BOC Number
TIM PATTON	916-375-4412	

STATE OF CALIFORNIA

Department of General Services - Office of Procurement

PURCHASE ORDER CONTINUATION

Form GSOP 2-PIN (04/98)

Purchase Order No.	*Revision*	*Date*	*Supplier No.*	*Supplier Name*
62197		6/30/2008	811817	ROBINSON SEISMIC LTD

Item No.	*Quantity*	*Unit*	*Commodity Code*	*Description*	*Unit Price*	*Extension*

PAYMENT SHALL BE MADE AFTER DELIVERY, INSPECTION AND ACCEPTANCE IN ACCORDANCE WITH TERMS AND CONDITIONS STATED IN THE ATTACHED GENERAL PROVISIONS (GSPD-401Non-IT Commodities) UNLESS THE CONTRACTOR OPTS TO RECEIVE PROGRESS PAYMENTS.

IF THE CONTRACTOR OPTS TO RECEIVE PROGRESS PAYMENTS, BEFORE STARTING MANUFACTURE, THE CONTRACTOR SHALL FURNISH TO THE DEPARTMENT OF GENERAL SERVICES, AT NO COST TO THE STATE, A FAITHFUL PERFORMANCE BOND, IN THE AMOUNT OF 100% OF THE BID. THE BOND SHALL BE ON A FORM FROM AN ADMITTED SURETY INSURER AND MUST GUARANTEE CONTRACTOR'S COMPLIANCE WITH THE TERMS OF THIS CONTRACT. THE PERFORMANCE BOND SHALL BE PROVIDED TO PROCUREMENT DIVISION WITHIN TWENTY-ONE DAYS OF RECEIPT OF ORDER. THE SCHEDULE, NUMBER AND AMOUNT OF PROGRESS PAYMENTS SHALL BE DETERMINED AFTER BID AWARD BY THE STATE REPRESENTATIVE.

TRAVEL PER DIEM

A batch adjustment totaling $55,000.00 has been added to the purchase order. This amount is to cover travel costs for State Personnel. The travel costs shall be for up to seven (7) people taking two (2) eight (8) day trips. The total time for both trips will be sixteen (16) days. Travel arrangements for the transportation, lodging and meals shall be made for State personnel and invoiced for direct, documented costs only.

NOTE :
The travel allowance is estimated based on two 8-day site visits by 7 staff members (sixteen days total). If the testing, called out in the specifications, fails and additional trips or extended stay is required to allow staff the confirmation of the testing success, then the additional travel or stay expense, as necessary, shall be paid by the manufacturer.

SERVICE REPRESENTATIVE

The supplier, at his expense, shall provide a qualified factory authorized service representative to be in attendance at the purchase order delivery site to make any necessary adjustments to the units and to give instructions to the equipment receiving inspectors to assure correct installation of the units supplied. The supplier shall supply the service representative for seven (7) 8-hour day at the delivery destination. The days on-site may be non-consecutive.

LIQUIDATED DAMAGES

In the event that the Contractor fails to deliver in accordance with the Contract requirements, the parties agree that the delay will interfere with the proper implementation of the State's programs, to the loss and damage of the State. From the nature of the case, it would be impracticable and extremely difficult to fix the actual damages sustained in the event of any such delay. The State and Contractor, therefore, presume that in the event of any such delay the amount of damage which will be sustained from a delay will be the amount $10,416.00 per day and the State and the Contractor agree that in the event of any such delay, the Contractor shall pay such amounts as liquidated damages and not as a penalty. Amounts due the State as liquidated damages may be deducted by the

STATE OF CALIFORNIA

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PURCHASE ORDER CONTINUATION

Form GSOP 2-PIN (04/98)

Purchase Order No.	*Revision*	*Date*	*Supplier No.*	*Supplier Name*
62197		6/30/2008	811817	ROBINSON SEISMIC LTD

Item No.	*Quantity*	*Unit*	*Commodity Code*	*Description*	*Unit Price*	*Extension*

State from any money payable to the Contractor. The State shall notify the Contractor in writing of any claim for liquidated damages pursuant to this Paragraph on or before the date State deducts such sums for money payable To the Contractor.

Liquidated damages shall be incurred 287 days after receipt of order.

Delivery Delays

If the Contractor does not deliver all the deliverables listed on the Statement of Work ready for use in substantial accordance with the Contractor's specifications, on or before the Delivery Dates specified in the Statement of Work, the Contractor shall be liable for liquidated damages in the amount of $10,416.00 per day in lieu of all other damages for such nondelivery. Liquidated damages shall accrue for each calendar day between the Delivery Date specified and the actual date of the delivery of such deliverables.

If the State is unable to use the equipment on the installation date because Contractor failed to deliver the product listed in the Statement of Work by the Delivery Date specified in the Statement of Work liquidated damages for equipment noninstallation shall be paid to the State in lieu of damages for nondelivery.

SALES TAX

Sales tax was not included in the bid pricing and is not part of this award. Sales tax should be added at time of invoicing. The sales tax rate applied should be based on the rate of the area the product is to be delivered to.

CHANGE ORDERS

This Purucase Order may be amended, modified, or terminated at any time by mutual agreement of the parties in writing. Change orders amending, modifying or terminating the Purchase Order, including any modifications of the compensation payable, may be issued only by the State Procurement Officer. All such change orders shall be in writing and issued only upon written concurrence of the supplier. Termination, as that term is used in this section, does not include the following provisions as stated in the General Provisions (GSPD-401 Non-IT Commodities, Revised and Effective 4/12/2007): Page 3 - Section 22: Termination for Non-Appropriation of Funds, Page 3 - Section 23: Termination for the Convenience of the State, and Page 3 - Section 24: Termination for Default.

SCPRS

This Purchase Order has been registered into the State Contract and Procurement Registration System (https://www.scprs.dgs.ca.gov/). The registration number is 17600908334030.

STATE OF CALIFORNIA DEPARTMENT OF GENERAL SERVICES

REAL ESTATE SERVICES DIVISION
PROJECT MANAGEMENT BRANCH

PROJECT MANUAL

SPECIFICATIONS

FOR:

SEISMIC ISOLATION BEARINGS

FOR

INLAND EMPIRE TRANSPORTATION MANAGEMENT CENTER
DEPARTMENT OF TRANSPORTATION – DISTRICT 8

AND

CALIFORNIA HIGHWAY PATROL – INLAND DIVISION
SAN BERNARDINO, CALIFORNIA

Rafat Alafrangi, Project Director
Telephone Number: (916) 376-1738
West Sacramento, California

Consultants: DMJM /Holmes & Narver (A/E)

July 23, 2008 118480

NO. TITLE

SPECIFICATIONS GROUP

General Requirements Subgroup

DIVISION 01 – GENERAL REQUIREMENTS

Facility Construction Subgroup

DIVISION 13 - SPECIAL CONSTRUCTION

END OF TABLE OF CONTENTS

SECTION 01 32 16

PROGRESS SCHEDULES AND REPORTS

PART 1 - GENERAL

1.01 PROGRESS SCHEDULE REQUIREMENTS

A. Work in this Contract shall be scheduled and progress monitored using a scheduling system showing relationships or dependencies between activities, such as CPM, Precedence, etc. Scheduling system shall be broken into sub-activities which, as a minimum, shall include major suppliers, approvals, fabrication and delivery, and major subcontractors. Scheduling system shall indicate inter-relationships between trades, suppliers, and/or reviews.

2. Schedule of Contractor's plan of construction shall be based on Contract time duration set forth in the advertisement for bid.

3. Schedule shall also reflect start and completion date as provided upon execution of Contract.

B. Contractor shall be responsible for planning and scheduling the Work, and monitoring progress of Work with respect to the Schedule. Contractor shall be responsible for scheduling all work activities, including those of their subcontractors. Contractor shall establish and maintain, as part of their Project organization, personnel knowledgeable in use and application of schedules. Contractor shall identify, on their organization chart, the person responsible for producing and updating Schedule.

C. The State will use updated version of Schedule in evaluating progress of Work. Schedule, as updated every month, will be basis for determining impact of changes to Contract and delays.

D. Failure of Schedule to include an element of the Work required for performance of this Contract, or inaccuracy in Schedule, will not relieve Contractor from responsibility for accomplishing Work required for complete Contract on time as indicated in the Contract and will not constitute grounds for delay.

1.02 RELATED REQUIREMENTS

A. Section 01 33 00: Submittal Procedures.

1.03 SCHEDULE DESCRIPTION

A. Schedule shall be based on and incorporate Contract Milestone and Completion Dates specified in the Contract Documents. Schedule shall furnish or comply with the following requirements:

1. Bar chart or "Gantt type" Schedule.

2. No activity on schedule shall have duration longer than 7 calendar days, unless otherwise approved by the State. Activity duration shall be total number of actual days required to perform that activity.

3. Procurement of major equipment and other major components, through receipt and inspection at job site, identified as separate activity.

4. Dependencies (or relationships) between activities shall be indicated on the Schedule.

5. Processing/approval of submittals and shop drawings for major equipment. Activities dependent on submittal acceptance and/or material delivery shall not be scheduled to start earlier than expected acceptance or delivery dates.

6. Interface with work of other contractors (or entities).

7. Other independent project elements shall be individually identified in network.

B. Overall time of completion and time of completion for each milestone shown on the Schedule shall adhere to the specified Contract time, unless an earlier (advanced) time of completion is requested by Contractor and agreed to by the State. Agreement shall be formalized by Change Order.

C. Schedule shall be the basis for evaluating job progress, progress payments, and time extension requests. Contractor shall develop Schedule and monitor actual progress as compared to Schedule.

D. Software: Contractor shall use Microsoft Project 2000, Primavera Project Planner, Primavera Suretrak, or approved equal.

If Contractor chooses to use an equal to specified software, submit software data for approval and provide the State with licensed copy of latest revision of approved software registered to the State. Software shall be compatible with Microsoft Windows XP operating system.

1.04 SUBMITTALS

A. Schedule: Within 10 calendar days after the Start Date stated in the Notice to Proceed, submit compact disks (CDs) and 3 prints of detailed Schedule presenting orderly and realistic plan for completion of the Work in conformance with requirements of this Section.

1. Provide compact disks (CDs) containing Schedule files.

2. The State will review submitted Schedule for conformance with requirements. Within 7 calendar days after receipt, the State will accept Schedule or will return it with comments. If proposed Schedule is not accepted, Contractor shall revise Schedule to incorporate comments and resubmit Schedule for acceptance within 7 calendar days after receiving it. Accepted Schedule shall become the Official Progress Schedule.

3. Acceptance of Schedule by State, failure of Schedule to include an element of work, or inaccuracy in Schedule will not relieve Contractor from responsibility for accomplishing Work in accordance with the Contract.

B. Procurement Log: Submit 4 copies of a Procurement log, cross-referenced to Schedule, including the following information for each type of material or equipment to be provided:

1. Material or equipment description.

2. Technical specification reference.

3. Duration in calendar days required for preparation and review of submittals.

4. Duration in calendar days required for fabrication and delivery.

5. Cross reference to activities which will be affected by delivery date of material or equipment item.

6. Scheduled delivery dates.

C. Updates, Reports, and Revisions: Submit CDs and 3 copies of updates, reports, and revisions.

1.05 MONTHLY UPDATES

A. Progress update shall be made monthly; exact date to be mutually agreed to by Contractor and the State.

B. Within the first 3 days following agreed date, Contractor shall submit to the State an up-to-date status report for the Contract. Status report shall include:

1. Contractor's estimated percentage complete for each activity in progress.

2. Actual start/finish dates for activities as appropriate.

3. Revisions, if any, to assumed activity durations for activities due to effect of previous update on Schedule.

6. Resolution of conflict between actual Work progress and Schedule logic. When out of sequence activities develop in Schedule because of actual construction progress, Contractor shall submit revisions to Schedule logic to conform to current job status and directions.

7. Narrative report with updated progress analysis, which shall include, but not be limited to, description of problem areas, current and anticipated delaying factors and their impact, explanation of corrective action taken and proposed revisions for recovery plan.

C. The State will review update information submitted by Contractor and meet with Contractor's representative to arrive at mutually agreed upon progress status. If agreement cannot be reached on any issue, the State's determination will be used for processing update.

1.06 FLOAT TIME

A. Float or slack time is defined as amount of time between earliest start date and latest start date or between earliest finish date and latest finish date of activities on Schedule. Contractor acknowledges and agrees that actual delays affecting paths of activities containing float time will not have effect upon Contract completion times, providing that actual delay does not exceed float time, in accordance with latest updated version of Schedule.

1.07 DEFAULT

A. Failure of Contractor to substantially comply with requirements of this Section shall constitute reason that Contractor is failing to prosecute Work with such diligence as will ensure its completion within Contract times and shall be considered grounds for termination or other remedy by the State pursuant to terms of this Contract.

END OF SECTION

SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.01 DESCRIPTION

A. To ensure that specified products are furnished in accordance with Drawings and Specifications, transmittal procedures have been established for submittals for review by the State.

B. Make all following submittals in strict accord with provisions of this Section and with requirements of the Contract.

1. Progress Schedule and Reports.

2. Product Certification.

3. Shop Drawings.

4. Descriptive Data/Material Lists.

5. Certification of Recycled Content.

1.02 RELATED REQUIREMENTS

A. Section 01 32 16: Progress Schedules and Reports.

B. Section 01 60 00: Product Requirements.

C. Test Reports: Pertinent Specification Sections.

PART 2 - PRODUCTS

2.01 PROGRESS SCHEDULE

A. Prepare and submit Progress Schedule and Reports of operations as required by Section 01 32 16.

B. Relate Progress Schedule to entire Project. Indicate dates for submission of required submittals.

2.02 PRODUCT CERTIFICATIONS

A. Where specifically indicated by pertinent Specification Sections, submit proper certification by recognized producer or association. Certifications shall attest to product's compliance with requirements of Contract Documents.

2.03 SHOP DRAWINGS

A. Submittals shall include one original and 6 prints of each original, name and location of project, name of Contractor, work order and contract numbers and cross references to contract

documents. Number shop drawings consecutively. Make drawings legible and complete in every respect.

B. If Shop Drawings show variations from Contract requirements because of standard shop practice or other reason, make specific mention of such variations in letter of transmittal, as well as on drawings, in order that (if acceptable) suitable action may be taken for proper adjustment of Contract. Unless specific changes have been noted and accepted, no deviations from Contract Documents will be permitted.

C. Originals will be returned to Contractor for Contractor's reproduction and use. State will make prints for its own use.

2.04 PRODUCT DATA/MATERIAL LISTS

A. Manufacturer's Standard Schematic Drawings:

1. Modify drawings to delete information which is not applicable to Project.

2. Supplement standard information to provide additional information applicable to Project.

B. Manufacturer's catalog sheets, brochures, diagrams, schedules, performance charts, illustrations and other standard descriptive data:

1. Clearly mark each copy to identify pertinent materials, products or models.

2. Show dimensions and clearances required.

3. Show performance characteristics and capacities.

4. Include calculations when applicable.

C. Material Safety Data Sheets (MSDS): Include for materials which require manufacturer's warnings and application instructions listed on MSDS provided by the product manufacturer.

2.05 SAMPLES

A. Physical examples to illustrate materials, equipment or workmanship, and to establish standards by which completed work is judged.

B. Where size of samples is not specified, office samples should be of sufficient size and quantity to clearly illustrate:

1. Functional characteristics of product or material, with integrally related parts and attachment devices.

2. After review, samples may be used in construction of Project.

C. Field Samples and Mockups:

1. Erect at Project site at location acceptable to State, unless otherwise approved.

2. Construct each sample or mockup complete, including work of all trades required in finished work.

2.06 SUBSTITUTIONS

A. State's Acceptance required:

1. Contract is based on materials, equipment and methods described in Contract Documents.

2. State will consider proposals for alternative materials, equipment and methods only when such proposals are accompanied by full and complete technical data and all other information required by State to evaluate proposed substitution.

3. Do not use alternative materials, equipment or methods unless such substitution has been specifically accepted for this work by the State.

4. Refer to General Conditions of the Contract for Construction, Subparagraph 3.12.10, Substitutions and Approved Equals, and Section 01 60 00, Product Requirements.

B. Coordination: Acceptance of substitution shall not relieve Contractor from responsibility for compliance with all requirements of the Drawings and Specifications, and Contractor shall be responsible at Contractor's own expense for changes in other parts of Contractor's work or work of others, including, but not limited to redesign costs of the Project which may be caused by acceptance of substitution.

C. Submit separate request for each product and support each request with:

1. Product identification.

2. Manufacturer's literature.

3. Samples, as applicable.

4. Comparison of proposed product with specified product.

5. Name and address of similar projects on which product has been used, and date of installation.

D. Submit data relating to changes in construction schedule, if any.

E. Substitute products shall not be ordered without written acceptance of the State.

F. The State will determine acceptability of proposed substitutions (alternatives) and reserves the right to reject proposals due to insufficient information.

PART 3 - EXECUTION

3.01 SUBMISSION REQUIREMENTS

A. Schedule submissions at least three weeks before dates reviewed submittals will be needed and within the time periods specified in 3.01B. The State will review submittals within 21 calendar days unless the State notifies the Contractor in writing that a review of a specific submittal will take longer. Should the State review a submittal sooner, the Contractor shall not assume that a new timeline has been established.

B. Make submissions within 15 days after the Start Date of the Work.

C. Identification: Identify submittals with names and location of Project, name of Contractor and work order and Contract numbers.

1. Submittals shall be accompanied by letter of transmittal addressed to State, to parties as identified in State's letter of instruction to be issued to Contractor at start of Project.

2. Each submittal shall be consecutively numbered and shall contain list of items submitted, properly identified as to drawing numbers, Specifications Section or other identification.

3. Submittals not adequately identified will be returned to Contractor for correction and resubmittal.

D. State will review submittals for conformance with contract documents: Acceptance of submittals by State covers only such conformance. Effort will be made by State to discover errors, but responsibility for accuracy and correction and resubmittal shall be the Contractor's.

E. Acceptance of submittals will be general and shall not relieve Contractor from responsibility for proper fitting and construction of Work, nor from furnishing materials and work required by Contract which may not be indicated on submittals.

F. No portion of work requiring submittals shall be commenced until submittal has been accepted by State. All such portions of work shall be in accordance with accepted submittals.

H. Number of copies required by State: Provide copies as follows; or greater quantity where so specified in individual Specification Sections. Add number of copies required by Contractor for Contractor's distribution to the following numbers:

1. Progress Schedule: One original and 3 copies. Include compact disks (CDs) when CPM schedule is provided.

2. Certification: 3 copies

3. Shop Drawings: Reproducible originals - one original of each drawing, and 6 prints of each original.

4. Product Data/Material Lists: 6 copies

5. Samples: As specifically indicated in pertinent Specification Section.

6. Substitutions: 6 copies of required related data and information.

I. Submittals shall include:

1. Date and revision dates.

2. Project title and work order number.

3. Names of Contractor, subcontractor and supplier or manufacturer.

4. Identification of product or material.

5. Relation to adjacent structure or material.

6. Field dimensions, clearly identified as such.

7. Specification Section number.

8. Consecutive submittal number.

9. Blank space for State's stamp.

10. Contractor's stamp, initialed or signed, certifying to review of submittal, verification of field measurements and compliance with Contract Documents.

END OF SECTION

SECTION 01 45 29

TESTING LABORATORY SERVICES

PART 1 - GENERAL

1.01 REQUIREMENTS INCLUDED

A. The State will employ and pay for services of an independent testing laboratory (hereinafter referred to as "laboratory") to confirm the performance of specified testing as detailed in the technical specifications.

1. Contractor shall cooperate with laboratory to facilitate execution of its required services.

2. Employment of laboratory shall in no way relieve Contractor's obligations to perform work of the Contract.

1.02 REQUIRED TESTS AND INSPECTIONS

A. Tests and Inspections are stipulated within the technical specifications.

1.03 CONTRACTOR'S RESPONSIBILITIES

A. Cooperate with laboratory personnel, provide access to work and to manufacturer's operations.

B. Provide to laboratory adequate quantities of representational samples of materials proposed to be used and which require testing.

C. Furnish copies of products test reports as required.

E. Furnish incidental labor and facilities:

1. To provide access to work to be tested.

2. To obtain and handle samples at source of product to be tested.

3. To facilitate inspections and tests.

F. Notify State's Inspector 3 weeks in advance of operations to allow for laboratory assignment of personnel and scheduling of tests. When tests or inspections cannot be performed after such notice due to delays caused solely by the Contractor or subcontractor, reimburse the State for laboratory personnel incurred due to Contractor's negligence.

G. When additional testing services are needed for Contractor's convenience, pay for services to State's laboratory and pay for additional samples and tests required for Contractor's convenience.

H. The State or its representative shall have the right to reject materials and workmanship which are defective or to require their correction. Rejected workmanship shall be satisfactorily corrected and rejected materials shall be removed from the premises without charge to the State.

I. Should it be considered necessary or advisable by the State at any time before Acceptance of the Work to make examination of work already completed by removing or tearing out same, Contractor shall, on request, promptly furnish necessary facilities, labor and materials. If such work is found to be defective in any respect due to fault of Contractor or subcontractor, shall defray all expenses of such examinations and of satisfactory reconstruction. If, however, such work is found to meet requirements of the Contract, additional cost of labor and material necessarily involved in the examination and replacement will be allowed the Contractor.

J. Contractor shall include the necessary timeframes for all required laboratory testing and inspections in Contractor's schedule required for submission and approval by the State in per Section 01 32 16 – Contractor's Progress Schedule and Reports and Section 01 33 00 – Submittal Procedures.

1.04 SELECTION AND PAYMENT

A. Owner will employ and pay for services of an independent testing laboratory approved by the Division of State Architect (DSA) to perform inspection and testing in accordance with California Code of Regulations and other Standards as referenced in the technical specifications.

B. For required travel by laboratory to test products manufactured by the Contractor, Contractor shall arrange and pay for laboratory's direct costs including round trip transportation, accommodations, and associated costs related to the inspection services. Contractor shall make allowance for seven person team members to attend the necessary inspections for prototype production testing and additional inspections for mass production testing. The seven team members will travel from various locations within the USA to the Contractor's manufacturing and testing facility. An allowance of $55,000 will be added to the Contractor bid amount as a budget allowance to cover the team members' required travel costs. Travel costs involved in retesting will be paid by the Owner and deducted from Contractor's bid amount and final payment (or any funds due and payable) by change order. Travel direct costs receipts, without mark-up, shall be submitted to the Owner for payment. Any remaining funds of the $55,000 allowance shall be credited to the Owner.

C. When tests and inspections are required on an overtime basis due to delays by or convenience of the Contractor or subcontractors, payment will be made by Contractor. At termination of work or completion of project, all costs for overtime testing and inspections will be deducted from Contractor's final payment (or any funds due and payable) by change order.

D. Before testing laboratory submits testing and inspection billings to Owner, they shall be segregated by straight time and overtime costs, and all overtime costs are to be substantiated with a detailed explanation for necessity of such work costs.

E. When materials tested fail to meet requirements herein specified, they shall be promptly corrected or removed and replaced and retested in a manner required by the testing laboratory. Costs involved in retesting will be paid by the Owner and deducted from Contractor's final payment (or any funds due and payable) by change order. Retesting team members shall be limited to only two team members (DSA Approved Special Inspector and the Design Engineer).

F. Employment of testing laboratory shall in no way relieve Contractor of obligation to perform work in accordance with requirements of Contract Documents.

END OF SECTION

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SECTION 01 60 00

PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.01 REQUIREMENTS INCLUDED

A. This Section describes basic requirements governing products including:

1. Workmanship.

2. Manufacturers' instructions.

3. Transportation and handling.

4. Storage and protection.

1.02 RELATED REQUIREMENTS

A. Section 01 32 16: Progress Schedule and Reports.

B. Section 01 33 00: Submittal Procedures.

1.03 PRODUCTS

A. Products include material, equipment, and systems.

B. Comply with specifications and referenced standards as minimum requirements.

C. Components required to be supplied in quantity within a Specification Section shall be the same, and shall be interchangeable.

D. Reference to materials or methods of construction by name and catalog number is done to establish standards of quality, design, utility, suitability, and cost, and shall not be construed as limiting competition.

E. Where the words "or equal" are used following trade names, patented products, or proprietary products or methods, they shall be deemed to read "or equal in quality, design, utility and suitability"; as solely determined by the State. Where such trade names, products, or methods are without the use of the words "or equal", they shall be deemed to be followed by the words "or equal in quality, design, utility and suitability" as solely determined by the State.

F. Materials and methods of equal standards will be accepted for use if first deemed equal, and approved by the State.

1.04 QUALITY ASSURANCE

A. Comply with industry standards except when more restrictive tolerances or requirements indicate more rigid standards or greater quality.

B. Perform work by persons qualified to produce specified quality.

C. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and racking.

1.05 TRANSPORTATION AND HANDLING

A. Transport products by methods to avoid product damage, deliver in undamaged condition in manufacturer's unopened containers or packaging.

B. Provide equipment and personnel to handle products by methods to prevent soiling or damage.

C. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.

1.06 STORAGE AND PROTECTION

A. Store products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weathertight enclosures; maintain within temperature and humidity ranges required by manufacturer's instructions.

B. For exterior storage of fabricated products, place on sloped supports above ground. Cover products subject to deterioration with impervious sheet covering, provide ventilation to avoid condensation.

C. Arrange storage to provide access for inspection. Periodically inspect to assure products are undamaged and maintained under required conditions.

D. Provide coverings to protect products from damage from traffic and construction operations, remove when no longer needed.

1.07 SCHEDULE

A. Contractor shall be responsible to schedule the manufacture and delivery of products to adhere to Contract Milestones and Completion Dates in accordance with Section 01 32 16: Progress Schedule and Reports.

END OF SECTION

SECTION 13 48 65 - SEISMIC-ISOLATION BEARINGS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract apply to this section.

1.2 DESCRIPTION

A. The Work specified herein consists of designing, manufacturing and testing seismic isolation bearings (hereinafter referred to as "isolators"). The isolators shall meet the external dimensions, performance requirements and other detailed requirements as shown on the plans and specified herein.

B. The number of isolators to be supplied includes 31 production units and 2 full-size prototype units or sets of units, as appropriate, per the 2001 CBC, Section 1665A.2.1. Prototype tests are not required if an isolator unit of similar properties has been previously tested using the specified sequence of tests, per the 2001 CBC, Section 1665A.2.8.

C. Only those Manufacturers and Suppliers (herein referred to as "Supplier") of the required isolators who have designed, manufactured, tested and supplied similar isolators (similar in dimensional, technical and performance properties) on at least two similar projects within the past ten years shall be permitted to bid on this project. Evidence of satisfactory performance on previous similar projects, including complete information on the Supplier and the proposed isolators, shall be submitted. The Owner reserves the right to accept or reject such evidence, solely at the Owner's discretion. Only those isolator Suppliers whose pre-qualification package has been accepted by the Owner shall be allowed to participate in the bidding process for this project. Only Natural Rubber bearings shall be considered acceptable for use as isolators on this project.

D. Only those Suppliers (1.2.C) who guarantee testing, manufacture and delivery of the isolators specified herein within the schedule requirements of this project as shown elsewhere in these specifications shall be allowed to bid on this project.

E. The isolation system for this project consists of the isolators specified herein and supplementary dampers (viscous fluid), to be specified and procured separately.

1.3 CODES AND STANDARDS

A. The design, manufacture and testing of the isolators shall conform to the applicable provisions of the current editions of the following standards, except as indicated otherwise in the Drawings and Specifications:

1. The design of the seismic isolation system shall be based on the requirements of 2001 California Building Code (CBC), Appendix Chapter 16A, Division VII, "Earthquake Regulations for Seismic-Isolated Structures", all applicable sections of Chapter 16A, Division IV and other pertinent requirements of the CBC.

2. American Institute of Steel Construction (AISC)

   2.1 Specification for the Design, Fabrication and Erection of Structural Steel for Buildings
   2.2 Code of Standard Practice for Steel Buildings and Bridges

3. ASTM A36 Specification for Structural Steel.

4. ASTM A1011 Specification for Structural Steel Sheet.

5. ASTM D395 Test for Rubber Property: Compression Set.

6. ASTM D412 Test for Rubber Property: Tension.

7. ASTM D429 Determination of Rubber-to-Metal Bond Strength.

8. ASTM D1149 Test for Rubber Deterioration: Surface Cracking.

9. ASTM D573 Test for Rubber Deterioration: Heat Resistance.

10. ASTM D1149 Test for Rubber Deterioration: Ozone Resistance.

11. ASTM D1229 Test for Rubber Property: Compression set at Low Temperature.

12. ASTM D2240 Test for Rubber Property: Durometer Hardness.

13. ASTM D4014-03 Specification for Plain and Steel-Laminated Elastomeric Bearings.

14. ASTM E4 Load Verification of Testing Machines.

15. SSPC Steel Structures Painting Council

16. ISO 9000/9001 International Standards Organization – Quality Assurance Models

17. AWS D1.1 American Welding Society – Structural Welding Code for Steel

B. Additional or alternative codes and standards as may apply to these specifications may be submitted to DSA and the Structural Engineer of Record (SEoR) for review and approval at the SEoR's and DSA's discretion, with appropriate justification. Such codes and standards may be included in these specifications as deemed appropriate by the SEoR.

1.4 QUALITY ASSURANCE

A. All prototype and production isolators shall be manufactured in accordance with a manufacturing and quality assurance plan that shall be submitted by the Supplier for review and approval to DSA and the SEoR. This plan shall be in conformance with the general guidelines of these specifications.

B. Quality assurance shall be performed by the Supplier in accordance with the approved plan (1.4.A). Representative tests on materials and completed isolators shall be supervised by the Supplier or its appointed representative as approved by DSA and the SEoR.

1.5 INSPECTION AND OBSERVATION

A. A DSA qualified independent special inspector (Special Inspector of Record, SIoR) engaged by the owner shall perform the functions defined in this section. The SIoR shall report to and take direction from the Inspector of Record (IoR) and the SEoR. Additionally, the SIoR shall also complete all reporting requirements called for in the CBC. The SIoR shall perform his work in accordance with all applicable sections of the CBC including, but not limited to, Section 1664A.3 of the 2001 CBC, and the Supplier shall afford full cooperation and consideration to the SIoR. The Supplier during the isolator manufacturing process shall afford full access to all sections of the manufacturing facilities involved in the production of the isolators to the SIoR. The SIoR's duties shall include, but may not necessarily be limited to the following activities:

1. Review of the QC procedures for the manufacturing process and the manufacturing schedule for the isolators.
2. Observation of the production manufacturing procedures during the manufacture of the isolators. The level of observation shall be left to the SIoR and the SEoR, based upon the obligations of the SIoR to fulfill the inspection requirements of the CBC and his duties as the agent of the SEoR.
3. Observation of the full scale testing of all prototype and production isolators and observation of component and materials testing as deemed appropriate by the SEoR.
4. Review of material certifications for elastomeric, steel, and other components, and review and approval of calibration certificates for testing equipment.
5. Observation of any part of the manufacturing process and review of the QC documentation.

The Supplier shall provide the SIoR with adequate advance notice of all activities related to the manufacturing and testing of the isolators in order to enable the SIoR, with reasonable convenience, to perform his/her inspection functions in accordance with these specifications.

B. SIoR nonconformance reporting responsibilities and lines of communication:

1. Product and process nonconformance (deviations from the specification) must be documented on a Nonconformance Report.

2. The SIoR shall issue Nonconformance Reports to the Manufacturer's plant manager and the SEoR.

3. The process for resolution of nonconformance reports shall be stipulated in a plan of work for the SIoR to be developed by the SEoR in consultation with the IoR prior to commencement of isolator manufacture.

C. The SIoR plus a minimum required number of representatives from the Owner and the A/E Team shall be present to observe the prototype tests and selected production unit tests (1.6). The manufacturer shall afford full access and all appropriate facilities to the observers at all times.

1.6 RELATED TESTING AND INSPECTION REQUIREMENTS

A. Allow for site visits for the following representatives during the prototype testing program and the production period: SIoR; SEoR; Base Isolation Consultant (Engineer of Record); Representative of the Base Isolation Peer Review Panel; Owner's Representative; Representative of RESD/PMB; and Representative of Architect of Record.

1.7 SUBMITTALS

All submittals shall be made by the Supplier in a timely manner in accordance with the schedule and processing requirements stipulated elsewhere in the contract documents. Review and approval of submittals by the Architect or SEoR shall not relieve the Supplier in any way of the sole responsibility to fully conform to the requirements of these specifications and all other relevant and applicable regulations, codes and standards governing this project. Submittals shall include, but may not necessarily be limited to the following:

A. Supplier Qualifications Package (1.2C)

B. Manufacturing and Testing Schedules

C. Manufacturing and Quality Control Procedures and Plans for Prototype and Production Isolator Units (To be submitted to DSA for review and approval)

D. Isolator design calculations, stamped by a Structural Engineer licensed in the State of California and experienced in the design of seismic isolators, shall be submitted to DSA and the SEoR for review and approval. Isolator calculations shall clearly indicate and confirm that calculated isolator stiffness and other properties are consistent with the Suppliers' submitted and approved bid information (Appendix Forms) and are also within the limits stipulated by these specifications. Design calculations shall also include the expected ultimate capacities, including the ultimate compression load at zero displacement, ultimate tension loads at zero and maximum displacement, and ultimate lateral displacements at maximum vertical (compression and tension) loads. The submitted document shall indicate

factors of safety against all ultimate load and displacement capacities. All factors of safety shall be within the limits specified in Appendix A.

E. Reports on isolator materials and component testing performed in accordance with the codes and standards listed in section 1.3.A. Complete Raw and processed data shall be submitted as backup information.

F. Isolator shop drawings showing the external and internal dimensions and the hole patterns for connection to structural assemblies above and below the isolators shall be submitted to the SEoR prior to isolator manufacture for review and approval. Shim thickness, rubber layer thickness, number of shim and rubber layers and top and bottom plate thickness shall be clearly indicated.

G. Non-proprietary product data for adhesives and paints shall also be submitted.

H. Certificates of calibration of all test equipment to be used in the testing process shall be submitted to the IoR and SEoR prior to testing.

I. Complete prototype and production test plans and schedules shall be submitted to the IoR and SEoR prior to testing. The production test sequence shall be conducted on the prototype isolators. Subsequent use of the prototype isolators for construction shall not be allowed.

J. A report on the prototype tests shall be submitted to DSA and the SEoR on completion of the prototype tests for review and approval. All raw and processed data shall be submitted as part of this report. The report shall clearly indicate that the tested properties are within the limits stipulated by these specifications and are consistent with the values submitted by the Supplier in Form 1 of Appendix B as part of the contract bid. The interpretation of all test data and its acceptability or non-acceptability shall be at the sole discretion of the SEoR.

K. A complete report on the tests on all production isolators, along with all raw and processed test data, shall be submitted to DSA and the SEoR within 15 days of the completion of isolator production for review and approval. Certificates of compliance with material and isolator test criteria as specified herein for production isolators, along with all raw and processed test data, shall be submitted to the DSA and SEoR along with this report for approval prior to the shipment of the isolators to the jobsite. This documentation may be submitted incrementally in order to facilitate production unit shipments.

L. The Supplier shall submit an isolator installation plan indicating clearly locations of all isolators keyed to isolator serial numbers marked on the isolators. This installation plan shall be based on column grid line references and shall be used by the General Contractor to install all isolators. The installation plan shall be submitted to the SEoR for review and approval at least 30 days in advance of the scheduled installation of the first isolator.

M. A complete isolator monitoring and maintenance plan for the service life of the isolators to be submitted to DSA for review and approval. However the isolators shall be essentially maintenance free under normal expected conditions for the full service life of the isolators.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

A. The isolators shall be delivered to the job site in protective packaging for freight and handling purposes. They shall be stored under cover above ground in the original packaging until installation. Installation shall be completed by the General Contractor in accordance with the Isolator Installation Plan (1.7.L.). Supplier shall provide the General Contractor with any necessary guidance and advice in order to install the isolators in a satisfactory manner.

1.9 WARRANTY

A. The service life of the seismic isolators under expected conditions shall be at least 50 years. Furthermore, the Supplier shall provide a written and irrevocable warranty to the Owner that the isolators supplied to the Project shall perform as specified herein and as submitted by the Supplier for a period of at least 10 years after installation. Any discovered deviation from these performance requirements of any isolator within 10 years from the date of installation shall be cause for Supplier to replace, or repair to the Owner's, SEOR's and DSA's satisfaction, the isolator(s) at no cost to the Owner or any other party for the repaired/replaced isolator.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The base polymer of the isolator elastomer layers shall be natural rubber.

1. Heat Resistance per ASTM D573 (70 deg. Celsius for seven days).

a. Maximum permissible change in tensile strength: -25%

b. Maximum permissible change in ultimate elongation: -25%

c. Maximum permissible change in Durometer hardness: +10 Shore A points.

2. Compression Set per ASTM D395 Method B (70 deg. Celsius for 24 hours).

a. Maximum permissible set: 50%.

3. Low Temperature Properties:

a. ASTM D1229 (Compression Set at 0 deg. Celsius for seven days at 25% compression). Maximum permissible set: 60%

b. ASTM D2240 (Low Temperature Stiffness: conditioned for seven days at 0 deg. Celsius). Maximum permissible change in Durometer hardness: +15 Shore A points.

4. Ozone Resistance of the elastomer or cover rubber exposed to the environment: Ozone resistance shall be determined by tests on strips of representative material mounted as per Method A of ASTM D1149. The tests shall be performed by ASTM D1149 at an ozone concentration of 50 ± 5 parts per hundred million at 20% strain at 38 ± 1° Celsius for 100 hours. The ozone resistance shall be regarded as satisfactory if on conclusion of a test no cracks are visible using 7X magnification.

5. Bond of Elastomer to Steel Laminate: Peel strength tests shall be performed by ASTM D429 Method B. The failure type shall be 100% rubber tear. Minimum bond peel strength shall be 40 lb./in.

6. Tensile Strength and Ultimate Elongation of Elastomer: Minimum tensile strength and ultimate elongation tests shall be performed by ASTM D412. The minimum tensile strength shall be 1100 psi and the minimum ultimate elongation shall be 500%.

7. Hardness of Elastomer: The Durometer hardness at 20 deg. ± 5 deg. Celsius shall be determined by ASTM D2240 and reported.

8. Shear Modulus of Elastomer: The shear modulus of the elastomer at 100%, 200% and 300% shear strain shall be determined by ASTM D4014-03. The test results showing the respective tangent moduli shall be submitted in report form along with backup raw data.

B. Shim plates shall be made from rolled carbon steel conforming to ASTM A1011 Grade 36. Top and bottom mounting plates shall be made from ASTM Grade A36 material. Connecting bolts for isolator mounting/flange plates shall be ASTM A490. Anchor bolts shall be as shown on drawings. Substitute standards shall be well established and shall meet the intent of the standards referenced herein and shall be subject to approval or rejection by DSA and the SEoR.

2.2 FABRICATION AND PERFORMANCE

A. Isolator sizes shall be within the ranges indicated on the drawings. All flatness and mating tolerances specified in the drawings and in these specifications shall be strictly followed.

B. The tolerances on isolator dimensions after manufacture and prior to testing shall be as follows (see drawings for additional requirements):

Dimension	Tolerance
External Plan Dimensions	±¼ inch
Top Variation from Plane Parallel to the Theoretical Surface	Slope relative to the bottom of no more than 0.005 radian
Sides Variation from Plane Parallel to the Theoretical Surface	±¼ inch
Overall Isolator Height	±¼ inch

Dimension	Tolerance
Flatness of Exterior Top & Bottom Surface of Completed Bearing	±1/8 inch offset

C. Exposed steel surfaces, if any, shall be blasted in accordance with SSPC-6, and shall be protected from rust by painting with zinc silicate paint (Carbo Zinc 11 HS), or an equivalent paint as approved by the SEoR. A single top coat of Carboline 133 HB shall be applied.

D. Each isolator shall be permanently marked on the vertical rubber face. The marking shall consist of an isolator serial number specified by the Manufacturer, and any other markings requested by the SEoR. The number shall be easily legible from a distance of 2 feet, shall uniquely, and clearly identify the isolator and its type/size.

E. Production isolators shall be essentially identical to the tested and approved prototype isolators in every respect, including but not necessarily limited to sizes, materials and manufacturing processes.

F. Isolator performance shall be as stipulated in these specifications and in particular in Appendix A of these specifications.

G. Long term vertical creep of the isolator under long term design load shall be less than two times the instantaneous vertical deflection under the same load as limited by the stipulated compression stiffness in these specifications. Long term creep in any horizontal direction of the top of the isolator with respect to the base shall not exceed 0.25".

H. Rubber to metal bond shall be stronger than the rubber material in tension and in shear. All connection hardware within the isolator unit and that used to attach the unit to the structure and the foundation shall have adequate strength to withstand MCE design loads and displacements.

2.3 TESTING

A. Properties of materials used in the manufacturing of the isolator bearings shall be determined in accordance to the relevant standards (1.3). Testing results shall be submitted to DSA and the SEoR for review and approval.

B. Complete prototype and production test plans and schedules shall be submitted to DSA and the SEoR and approved prior to the start of testing.

C. All isolators (prototype and production units) shall be tested for compression stiffness (Section 2.3.E), sustained compression (Section 2.3.D, only 50% of production units) and combined compression/tension and shear (Section 2.3.G). All testing results shall be provided for each production isolator prior to shipment to the job site. All test results shall identify the isolators by the serial number (2.2.D).

Prototype isolators shall be tested for sustained compression and compression stiffness prior to the combined compression/tension and shear tests specified for the prototype isolators.

During all tests, each isolator shall be closely inspected by the SIoR for evidence of lack of rubber to steel bond, laminate placement faults, any residual overall or localized deformities (bulges, dimples, offsets or bumps in excess of 5mm in depth/height) or three (3) separate surface cracks wider and deeper than 2 mm. Any isolator showing such signs shall be subject to rejection by the SEoR.

D. Sustained Compression Test

All prototype isolators and 50% of all production isolators of each type shall be tested under sustained compression. The test stress for each isolator type shall be equal to the larger of 1500 psi or the stress resulting from two times the calculated average sustained gravity load on that type of isolator (2x290=580 kips). The duration of the sustained compression test shall be one hour. Any resulting failure (see paragraph 2.3.C) of any isolator may result in all isolators being subjected to the sustained compression test at the discretion of the SEoR.

E. Compression Stiffness Tests

The test load for each isolator type shall be equal to the calculated average sustained gravity load on that type of isolator (580kips). Each isolator shall be subjected to three cycles of compression load with applied compression load varying from 0.5 the test load to 1.5 times the test load. Data shall be recorded from the third cycle of loading and unloading. The Supplier shall provide compression stiffness results to the SEoR for review and approval. Tested compression stiffness values shall exceed the minimum specified design values given in Appendix A.

1. Compression stiffness shall be determined from the least squares, straight line fit through the recorded data between 0.5 and 1.5 times the test load.

2. For all production isolators, if the compression stiffness determined in accordance with Section 2.3.E.1 for a particular isolator falls below the specified minimum value, then the isolator shall be subject to re-testing. If the results of the retest also fall below the specified minimum value, the isolator will be subject to rejection by the SEoR.

F. Tension Stiffness Tests

The test load for each isolator type shall be equal to 50 kips. Each isolator shall be subjected to three cycles of tension load with applied tension load varying from 0.5 the test load to 1.5 times the test load. Data shall be recorded from the third cycle of loading and unloading. The Supplier shall provide tension stiffness results to the SEoR for review and approval. At this time the SEoR will compare it to the assumed stiffness and determine in consultation with peer reviewer and DSA (DSA approval required) if any reanalysis is necessary. Any such extra reanalysis will be preauthorized by the Owner. See section 2.3.G.1.f for additional requirements. Tested tension stiffness values shall exceed the minimum specified design values given in Appendix A.

1. Tension stiffness shall be determined from the least squares, straight line fit through the recorded data between 0.5 and 1.5 times the test load.

2. For all production isolators, if the tension stiffness determined in accordance with Section 2.3.F.1 for a particular isolator falls below the specified minimum value, then the isolator shall be subject to re-testing. If the results of the retest also fall below the specified minimum value, the isolator will be subject to rejection by the SEoR.

G. Combined Compression/Tension and Shear Tests

1. Prototype Isolators

a. After completion of the tests for sustained compression and compression stiffness, each prototype isolator shall be subjected to a sequence of combined compression and shear tests consistent with the 2001 California Building Code, Appendix Chapter 16A, Division VII, Section 1665A. This sequence of tests is shown in Table 1 below. Criteria for basic adequacy of a prototype isolator are given in CBC Section 1665A.4. The acceptability of the isolator's tested properties will be based on the design property limits given in Appendix A. The stability tests given in the CBC, shall be carried out by subjecting the prototype isolators to the maximum short term compression load (see Appendix A to these Specifications) and completing one full cycle to +/- D_{TM} displacement as well as by subjecting the isolator to a tension test carried out by applying a net tension load of 100 kips and completing one full cycle to +/- D_{TM} displacement. The lateral and axial displacements and forces shall be continuously recorded. The isolator shall be judged to have acceptable performance if there are no signs of failure (2.3.C) and all adequacy criteria specified in Section 1665A.4 are met.

b. The shear stiffness shall be calculated by the Supplier using digitally recorded data from the tests in 2.3.G.1.a and as described by Section 1665A.3. This information, in tabular and plotted format, shall be forwarded to the SEoR to confirm that measured prototype isolator properties are in accordance with those assumed in design (Appendix A) and consistent with those submitted by the Supplier in Form 1 (Appendix B).

c. Design properties from the tests shall be calculated in accordance with Appendix A of this section and CBC Section 1665A.5. See Appendix A for definitions of terminology and symbols used herein. Stiffness calculations shall be based on Test Nos. 4 and 5 for comparison with specified design stiffness ranges given in the Appendix A. Stiffness values calculated from the tests shall fall within the allowable limits specified in Appendix A of this specification section and CBC Section 1665A.5, including all effects, such as dynamic effects, "scragging" and recovery, aging etc. All modification factors shall be supported by clearly documented experimental or other evidence to the satisfaction of the SEoR.

d. Visible defects appearing in the isolator during/after testing (see section 2.3C) may cause the SEoR to reject the isolator.

e. In response to the stability tests (16 and 17) the isolator shall remain stable, i.e. positive incremental stiffness (shear and tensile) at the extreme displacement and shall exhibit no visible deterioration (section 2.3C).

TABLE 1
CBC TEST REGIMEN FOR PROTOTYPE ISOLATORS
(ALL GIVEN VALUES ARE SUBJECT TO REVISIONS AND SHALL BE CONFIRMED PRIOR TO TESTING)

Test No.	Vertical Load Comb. Dead, Live, EQ Load	Load (Kips)	Lateral Disp.	Disp. (ins)	No. of Cycles	Remarks
1	$(1.0D + 0.5L)_{avg}$	290	D_{wind}	2.2	20	Wind induced displacement
2	$(1.0D + 0.5L)_{avg}$	290	$0.2D_D$	2.6	3	-
3	$(1.0D + 0.5L)_{avg}$	290	$0.5D_D$	6.5	3	-
4	$(1.0D + 0.5L)_{avg}$	290	$1.0D_D$	13	3	-
5	$(1.0D + 0.5L)_{avg}$	290	$1.0D_M$	22.9	3	-
6	$(1.0D + 0.5L)_{avg}$	290	$1.0D_{TM}$	26	3	-
7	$(1.0D + 0.5L)_{avg}$	290	$1.0D_{TD}$	14.1	15	$15C_{VD}/C_{AD}B_D$ cycles = 15 cycles
8	$(1.2D+0.5L+1.0\|E\|_{DBE})_{avg}$	503	$0.2D_D$	2.6	3	
9	$(1.2D+0.5L+1.0\|E\|_{DBE})_{avg}$	503	$0.5D_D$	6.5	3	
10	$(1.2D+0.5L+1.0\|E\|_{DBE})_{avg}$	503	$1.0D_D$	13	3	
11	$(1.2D+0.5L+1.0\|E\|_{MCE})_{avg}$	576	$1.0D_M$	22.9	3	
12	$(1.2D+0.5L+1.0\|E\|_{MCE})_{avg}$	576	$1.0D_{TM}$	26	3	
13	$(0.8D - 1.0\|E\|_{DBE})_{avg}$	363	$0.2D_D$	2.6	3	
14	$(0.8D - 1.0\|E\|_{DBE})_{avg}$	363	$0.5D_D$	6.5	3	
15	$(0.8D - 1.0\|E\|_{DBE})_{avg}$	363	$1.0D_D$	13	3	
16	$(0.8D - 1.0\|E\|_{MCE})_{avg}$	477	$1.0D_M$	22.9	3	
17	$(0.8D - 1.0\|E\|_{MCE})_{avg}$	477	$1.0D_{TM}$	26	3	
18	$(1.2D+1.0L+1.0\|E\|_{MCE})_{max}$	950	$1.0D_{TM}$	26	1	
19		1400		22	1	
20	$(0.8D - 1.0\|E\|_{MCE})_{min/max}$	*	$1.0D_{TM}$	26	1.5	*Proof Tension Test (See 2.3.G.1.f)

f. The proof tension testing (Test No. 19) shall be carried out as follows. (1)Apply vertical compression load equal to $(1.0D + 0.5L)_{avg}$. (2)Laterally

displace isolator to D_{TM}. (3)In the laterally displaced position, apply a tension inducing vertical displacement until cavitation softening is clearly evident (essentially flat Force-Displacement plot) or to a maximum vertical displacement of 0.75" beyond initial tension, whichever occurs first, but not less than 0.25". As an alternate, the tension may be applied prior to lateral displacement if necessary due to equipment limitations, upon the approval of the SEoR. (4)Reapply compression load $(1.0D + 0.5L)_{avg}$. (5)Laterally cycle the isolator for 1-1/2 cycles (twice past the vertical position and bring to rest at vertical. A full record of the force-displacement plots (vertical and horizontal directions) shall be obtained and reported for this test.

2. Production Isolators

a. After completion of the tests for compression stiffness, each production isolator shall be tested in combined compression and shear. The isolators shall be loaded in compression to a load $(1.0D + 0.5L)_{avg}$ expected for that particular isolator type. The compression load shall be maintained while the isolators are subjected to three complete reversed cycles of loading to a displacement corresponding to a displacement of $1.0D_M$ inches. A continuous plot of the shear load and shear deflection shall be digitally recorded to permit an evaluation of the hysteretic performance of the isolators.

b. The shear stiffness of each isolator shall be calculated by the Supplier using the digitally recorded data from the combined compression and shear test from Section 2.3.G.2.a. This information, in tabular and plotted format, shall be forwarded to the SEoR to confirm that measured isolator properties are in accordance with those assumed in design and those submitted by the Supplier as part of his bid (Forms in Appendix B). For individual isolators, the effective stiffness shall be within the range of values assumed in design as given in Appendix A and CBC Section 1665A.5. The aggregate effective stiffness for each type of isolator and for the system of all isolators shall be within the range of values assumed in design as given in Appendix A. These values assume vertical compression load of (1.0D + 0.5L)avg.

3. Test Apparatus Limitations

a. Where testing apparatus lateral deformation capacity is limited, asymmetric shear testing of the isolators may be permitted subject to review and approval by the SEOR and DSA.

PART 3 - EXECUTION

3.1 INSTALLATION – BY OTHERS

A. The isolators shall be installed level and normal to the gravity loads.

B. There shall be no obstructions, including bolt extensions, which prevent the isolators from deforming horizontally in any direction. The area around each isolator shall be cleaned of all debris and construction materials at the completion of the contract.

C. Any welding on steel in contact with an isolator shall only be performed after obtaining express permission from the SEoR and only in such a manner as to avoid heat transfer into the isolator. The temperature of the isolator mounting plates immediately adjacent to the rubber shall remain at a temperature less than 80 deg. Celsius.

END OF MAIN SECTION 134865

APPENDIX A:
PAGE 1 OF 2

INDIVIDUAL ISOLATOR SPECIFIED DESIGN PROPERTIES

TYPE OF ISOL.*	DISPLACEMENTS (ins)				VERTICAL LOADS (kips)			EFFECTIVE STIFFNESS[1] (kips/in)					
								@DD			@DM		
	DD	TD	DM	TM	LT	ST	AL	MIN	TARGET	MAX	MIN	TARGET	MAX
B-1	13.0	14.1	22.9	26	660	950	290	3.23	3.80	4.37	3.23	3.80	4.37

*NO MORE THAN TWO TYPES OF ISOLATORS ALLOWED

ISOLATION SYSTEM SPECIFIED DESIGN PROPERTIES

TYPE OF ISOLATOR	NUMBER	AGGREGATE EFFECTIVE STIFFNESS @ DD[2] (kips/in.)			AGGREGATE EFFECTIVE STIFFNESS @ DM[2] (kips/in.)		
		MIN.	TARGET	MAX.	MIN.	TARGET	MAX.
B-1	31	100	118	135	100	118	135
TOTAL	31	100	118	135	100	118	135

Notes:

DD = Design Displacement
TD = Total Design Displacement
DM = Maximum Design Displacement
TM = Total Maximum Design Displacement

LT = Long term max. load; (D+L)max
ST = Short term max. load; (1.2D+L+Emce)max
AL = Avg. isolator test load; (D+0.5L)avg at D_D
D = Dead Load; L = Code reduced live load; Emce = MCE earthquake load

MAX. and MIN. = Upper and Lower Bound property, respectively, accounting for all factors including, but not limited to, manufacturing tolerances, age, dynamic effects, environment, scragging, recovery etc. Stiffness values shall be calculated as per CBC 1665A.5.

APPENDIX A:
PAGE 2 OF 2

1. All testing and other requirements of the 2001 California Building Code, Appendix Chapter 16A, Divn. VII shall be complied with for this project.
2. Minimum Axial Compressive Stiffness shall be 9,000 kips/in for all isolators. Maximum tension force developed in Test No. 19 (2.3.F) shall be no greater than 200 kips.
3. All isolators shall be capable of withstanding the direct net tension force developed in Test No. 19 (2.3.F) without failure.
4. Each isolator shall laterally deflect no more than 2.2 ins under a maximum wind design lateral load of 10.1 kips as evidenced by data obtained from the average of the first three cycles of Test No. 1 of Table No. 1 of these specifications.
5. All other requirements for seismic isolators given in the Project Technical Specifications shall be fully complied with.
6. All isolators shall have a minimum factor of safety against failure under all given loading conditions of not less than 1.25

[1] Tested effective stiffness for each cycle of the test for each isolator shall be within the given tabulated values. Prototype tests results (average effective stiffness) shall fall within plus or minus 15% of the given Target Stiffness. Production isolator tests results (average effective stiffness) shall fall within plus or minus 15% of the given Target Stiffness. Section 134865.2.3.G.2.b shall apply to all these tests.
[2] Aggregate effective stiffness for each type of isolator based on the project specified testing and the resulting system effective stiffness shall be within tabulated values

AN ALTERNATE COMBINATION OF ELASTOMERIC ISOLATOR TYPES (NO MORE THAN TWO TYPES OF ISOLATORS IN ALL CASES) MAY BE PROPOSED PROVIDED THAT SYSTEM PROPERTY LIMITS AS GIVEN ABOVE ARE ADHERED TO AND GUARANTEED BY THE SUPPLIER. ALL ISOLATOR LOADING RANGES MUST BE CONSIDERED WHEN PROPOSING ALTERNATE SYSTEMS. THE DETERMINATION OF THE ACCEPTABILITY OF ANY PROPOSED ALTERNATE, BUT ESSENTIALLY EQUIVALENT, COMBINATION OF ISOLATORS SHALL BE MADE SOLELY BY THE OWNER BASED ON THE RECOMMENDATIONS OF THE STRUCTURAL ENGINEER OF RECORD AND SUBJECT TO DSA REVIEW AND APPROVAL. SUCH AN ALTERNATE SYSTEM, THOUGH TECHNICALLY ACCEPTABLE, MAY NOT BE ALLOWED DUE TO SCHEDULE OR OTHER NON-TECHNICAL CONSIDERATIONS SOLELY AT THE DISCRETION OF THE OWNER. SUPPLIER SHALL BEAR ALL THE COSTS OF EVALUATION FOR ACCEPTABILITY OF THE PROPOSED "ALTERNATE SYSTEM", INCLUDING BUT NOT NECESSARILY LIMITED TO A&E FEES, PLAN CHECK/PEER REVIEW FEES, CONSTRUCTION COST IMPACT, ETC.

END OF SECTION 134865 – APPENDIX A

APPENDIX B:

FORMS TO SUBMIT WITH CONTRACT BID, NAME OF MANUFACTURER:_____
FORM 1, PAGE 1 OF 3

INDIVIDUAL ISOLATOR DESIGN PROPERTIES

TYPE OF ISOL.*	DISPLACEMENTS (ins)					MAX. ALLOWABLE VERTICAL LOADS (kips)			EFFECTIVE STIFFNESS[1] (kips/in)							
									@DD			@DM				
	DD	TD	DM	TM		LT	ST	AL	MIN	TARGET	MAX	MIN	TARGET	MAX		
B-1								-								
								-								

*NO MORE THAN TWO TYPES OF ISOLATORS ALLOWED

ISOLATION SYSTEM DESIGN PROPERTIES

TYPE OF ISOLATOR	NUMBER	AGGREGATE EFFECTIVE STIFFNESS @ DD[2] (kips/in.)			AGGREGATE EFFECTIVE STIFFNESS @ DM[2] (kips/in.)		
		MIN.	TARGET	MAX.	MIN.	TARGET	MAX.
B-1							
TOTAL							

APPENDIX B:

FORMS TO SUBMIT WITH CONTRACT BID, NAME OF MANUFACTURER: _____
FORM 1, PAGE 2 OF 3

Notes:
DD = Design Displacement
TD = Total Design Displacement
DM = Maximum Design Displacement
TM = Total Maximum Design Displacement

LT = Long term max. load; (DL+RLL)max
ST = Short term max. load; (DL+RLL+Em)max
AL = Avg. isolator test load; (DL+0.5xRLL)avg
DL = Dead Load; RLL = Code reduced live load; Em = MCE earthquake O/T load

All testing and other requirements of the 2001 California Building Code, Appendix Chapter 16A, Divn. VII shall be complied with for this project.

ISOLATOR TYPE	DIRECT NET TENSION FORCE CAPACITY WITHOUT FAILURE* (KIPS)	TENSION DISPLACEMENT AT TENSION CAPACITY LOAD (INS) and Stiffness (k/in)	LATERAL DEFLECTION AT 11 KIPS LATERAL LOAD (INS)	MINIMUM COMPRESSION STIFFNESS OF ISOLATOR (KIPS/IN)
B-1				

*FAILURE MEANS CAVITATION, DEBONDING, TEARING ETC. AND/OR ANY SIGNIFICANT LOSS OF LOAD CARRYING CAPACITY. All other requirements for seismic isolators given in these Project Technical Specifications shall be fully complied with.

MINIMUM FACTOR OF SAFETY AGAINST FAILURE UNDER ALL GIVEN LOADING CONDITIONS = _____

[1] TESTED EFFECTIVE STIFFNESS OF EACH ISOLATOR IS GUARANTEED TO BE WITHIN THE GIVEN TABULATED VALUES SEE APPENDIX A OF THE SPECIFICATIONS.
[2] AGGREGATE EFFECTIVE STIFFNESS FOR EACH TYPE OF ISOLATOR BASED ON THE PROJECT SPECIFIED TESTING AND THE RESULTING SYSTEM EFFECTIVE STIFFNESS IS GUARANTEED TO BE WITHIN TABULATED VALUES. SEE APPENDIX A OF THE SPECIFICATIONS.

APPENDIX B:

FORMS TO SUBMIT WITH CONTRACT BID, NAME OF MANUFACTURER: _____
FORM 1, PAGE 3 OF 3

BILINEAR MODEL OF ISOLATOR FOR COMPUTER ANALYSIS

PROPERTIES AT DD = INS.

ISOLATOR TYPE	INITIAL STIFFNESS, K1 (KIPS/IN)			YIELD FORCE, Fy (KIPS)			YIELD DISPLACEMENT, Dy (INS)			YIELDED STIFFNESS, K2 (KIPS/IN)			MAX. FORCE AT MAX. DISPL. Fmax, (KIPS)		
	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
B-1															

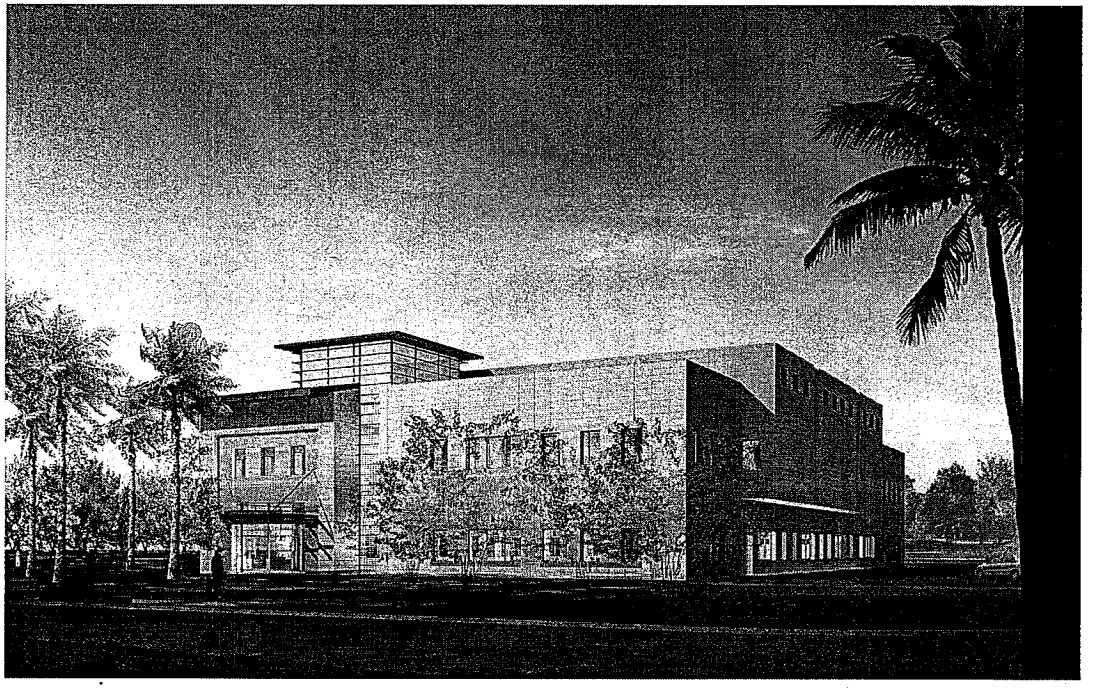
PROPERTIES AT DM = INS.

ISOLATOR TYPE	INITIAL STIFFNESS, K1 (KIPS/IN)			YIELD FORCE, Fy (KIPS)			YIELD DISPLACEMENT, Dy (INS)			YIELDED STIFFNESS, K2 (KIPS/IN)			MAX. FORCE AT MAX. DISPL. Fmax, (KIPS)		
	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX	MIN	AVG	MAX
B-1															

END OF SECTION 134865 – APPENDIX B

SEISMIC ISOLATION BEARINGS
FOR THE
INLAND EMPIRE TRANSPORTATION MANAGEMENT CENTER

DEPARTMENT OF TRANSPORTATION AND CALIFORNIA HIGHWAY PATROL
13892 VICTORIA STREET, FONTANA CA 92336
SAN BERNARDINO COUNTY, CALIFORNIA



PROJECT

PROJECT ADDRESS
13892 VICTORIA STREET
FONTANA, CA 92336

CLIENT

STATE OF CALIFORNIA
DEPARTMENT OF GENERAL SERVICES
REAL ESTATE SERVICES DIVISION
PROJECT MANAGEMENT BRANCH
707 3rd STREET, SUITE 5-100
SACRAMENTO, CA 95814
PROJECT DIRECTOR: KEN KEIN
TELEPHONE: (916) 375-7715

DESIGNER

DMJM H&N | AECOM

1111 TOWN & COUNTRY ROAD ORANGE CALIFORNIA 92868
T: 714.567.2400 F: 714.567.2424 www.dmjmhn.com

CONSULTANTS

STATUS

MAY 14, 2008

ISSUE

MARK	DATE	DESCRIPTION

PROJECT NO.	60004333.4000
DRAWN BY:	E BUSTAMANTE
CHECK BY:	T GRANT

KEY PLAN

SHEET TITLE

COVER SHEET

T-000

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PROJECT INFORMATION

SCOPE OF WORK:

THIS PACKAGE IS FOR THE DESIGN AND MANUFACTURING OF SEISMIC ISOLATION BEARINGS THAT WILL BE USED IN THE CONSTRUCTION OF THE INLAND EMPIRE TRANSPORTATION MANAGEMENT CENTER (IETMC) AND ACCESSORY STRUCTURES ON A SITE SHARED WITH CALTRANS SOUTHERN REGIONAL LAB (SRL). THE IETMC BUILDING IS A TWO STORY BASE ISOLATED STRUCTURE OF CONSTRUCTION TYPE II-A, OCCUPANCY GROUP B, OF APPROXIMATELY 43,000 SQ FT OF BUILDING AREA, FULLY SPRINKLERED. THE IETMC IS DESIGNED AS AN "ESSENTIAL SERVICES BUILDING" PER REQUIREMENTS OF CBC CHAPTER 16A, TABLE 16A-K. THIS FACILITY SHALL BE ACCESSIBLE TO PERSONS WITH DISABILITIES IN ACCORDANCE WITH THE REQUIREMENTS OF CBC 2001 CHAPTER 11B.

CLIENT

CLIENT

DEPARTMENT OF GENERAL SERVICES
707 THIRD STREET, 3-305
WEST SACRAMENTO,
CALIFORNIA 95605
TEL: (916) 376-1719

USERS

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DEPUTY DIRECTOR OPS.
464 FOURTH STREET
SAN BERNARDINO, CA 92401
TEL: (909) 383-4535

CALIFORNIA HIGHWAY PATROL
RUSSELL KINGSTON
847 E. BRIER DRIVE
SAN BERNARDINO, CA 92408
TEL: (909) 388-6036

GENERAL NOTES

1. ALL WORK SHALL CONFORM TO TITLE 24, CALIFORNIA CODE OF REGULATIONS (CCR)

2. CHANGES TO THE APPROVED DRAWINGS AND SPECIFICATIONS SHALL BE MADE BY AN ADDENDA OR A CHANGE ORDER APPROVED BY THE OFFICE OF THE STATE ARCHITECT, AS REQUIRE BY SECTION 4-338 PART 1, TITLE 24 CCR

3. A CERTIFIED "CLASS 1" INSPECTOR MUST BE EMPLOYED BY THE DISTRICT (OWNER), AS THE REQUIRED INSPECTOR OF RECORD (IOR), AND SHALL BE DSA APPROVED. THE INSPECTOR AND ASSISTANT INSPECTORS SHALL PROVIDE CONTINUOUS INSPECTION OF THE WORK. THE DUTIES OF THE INSPECTOR ARE DEFINED IN SECTION 4-342 PART 1, TITLE 24 CCR.

INDEX OF SHEETS

CODES

APPLICABLE CODES AND STANDARDS

CALIFORNIA BUILDING CODE (CBC) 2001 EDITION

PROJECT TEAM DIRECTORY

SEISMIC ENGINEER:
SAIF HUSSAIN
COFFMAN ENGINEERS
16133 VENTURA BLVD, STE. 1160
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GEOTECHNICAL ENGINEER:
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PROJECT MANAGER:
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STRUCTURAL ENGINEER:
DAVID KILPATRICK, PE
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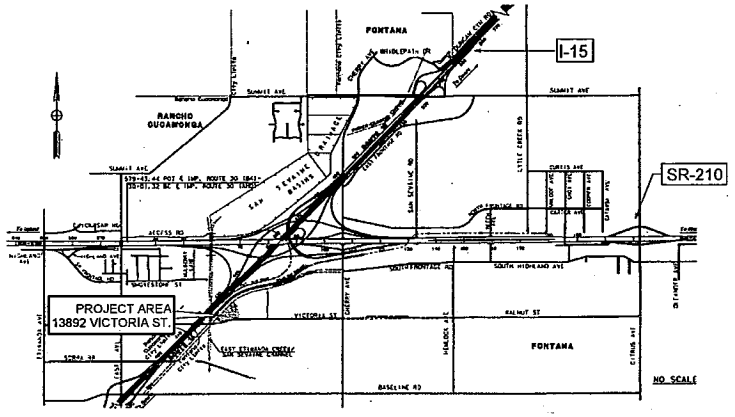
ORANGE, CA 92868
TEL: (714) 567-2400

LOCATION/VICINITY MAP



PROJECT

CLIENT

STATE OF CALIFORNIA
DEPARTMENT OF GENERAL SERVICES
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PROJECT MANAGEMENT BRANCH
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CONSULTANTS

STATUS

MAY 14, 2008

ISSUE

MARK	DATE	DESCRIPTION

PROJECT NO: 60004333.4000
DRAWN BY: E BUSTAMANTE
CHECK BY: T GRANT

KEY PLAN

SHEET TITLE

PROJECT INFORMATION AND INDEX OF DRAWINGS

T-001

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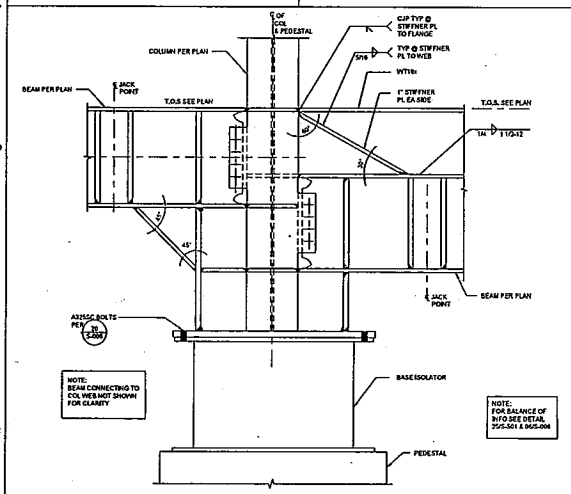
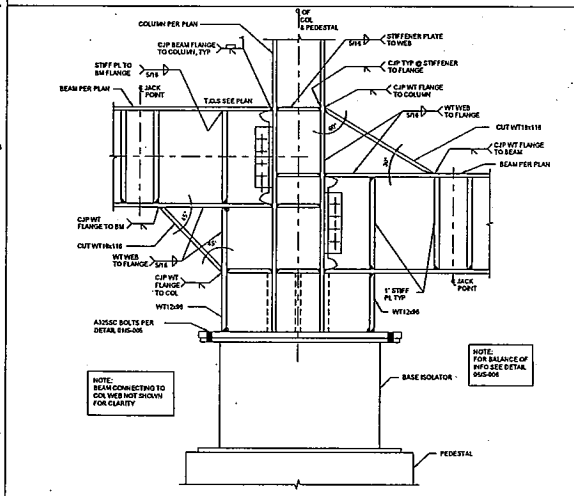


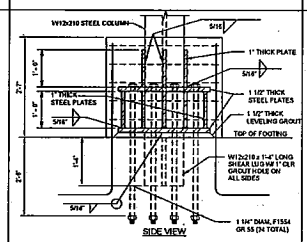
27 ISOLATOR BASE ACCESS FLOOR MID-BEAM

S-501 1" = 1'-0"



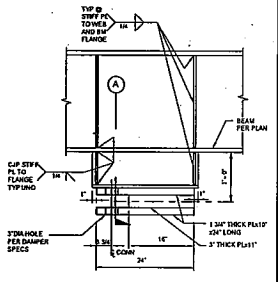
25 ISOLATOR BASE ACCESS FLOOR AT COLUMN

S-501 1" = 1'-0"



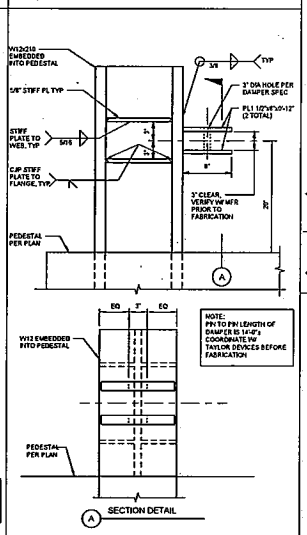
12 DAMPER PEDESTAL ELEVATION

S-501 S-501 3/4" = 1'-0"



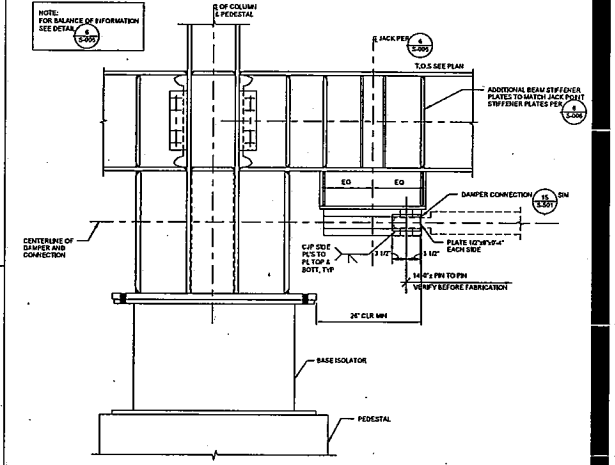
15 TYP DAMPER BEAM CONN

S-501 S-200A 1" = 1'-0"



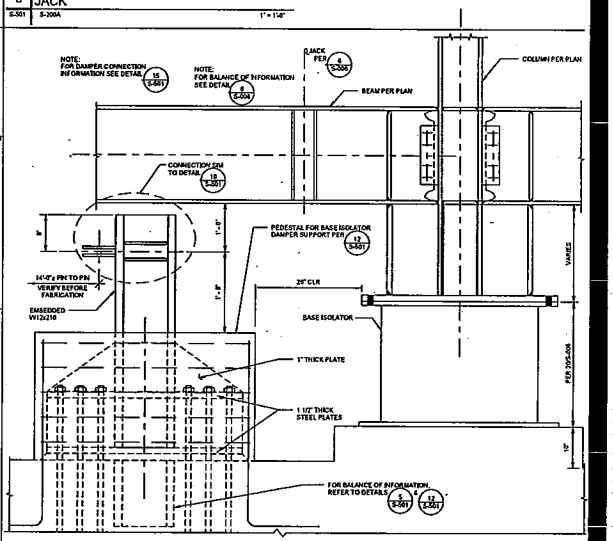
10 TYP DAMPER PEDESTAL

S-501 S-200A 1 1/2" = 1'-0"



8 DAMPER BEAM CONNECTION UNDER JACK

S-501 S-200A 1" = 1'-0"



6 DAMPER PEDESTAL AND CONNECTION

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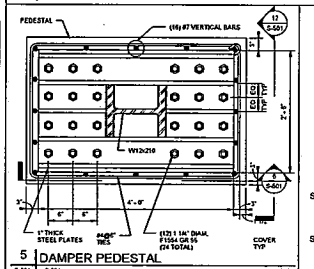

5 DAMPER PEDESTAL

S-501 S-501 1" = 1'-0"

SCALE: 1 1/2" = 1'-0"

0' 6" 1' 2'

SCALE: 1" = 1'-0"

0' 6" 1' 2' 4'

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PROJECT

CHP

PROJECT ADDRESS:
13462 AUTOPIA STREET
POWAY, CA 92064

CLIENT

DGS

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REAL ESTATE SERVICES DIVISION
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PROJECT DIRECTOR: ROSA EDEN
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DESIGNER

DMJM H&N | AECOM

CONSULTANTS

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STATUS

MAY 14, 2008

ISSUE

MARK	DATE	DESCRIPTION

PROJECT NO: 60004333.4000
DRAWN BY: M. RAMIREZ
CHECK BY: J. LIVERMORE

KEY PLAN

SHEET TITLE

SECTIONS AND DETAILS FOR REFERENCE ONLY

S-501

GENERAL NOTES

GENERAL

1. EACH STRUCTURE IS DESIGNED AS A STABLE UNIT AFTER ALL THE COMPONENTS ARE IN PLACE. THE CONTRACTOR SHALL PROVIDE TEMPORARY BRACING AS REQUIRED TO ENSURE VERTICAL AND LATERAL STABILITY OF THE STRUCTURE AND PORTIONS THEREOF DURING CONSTRUCTION.
2. STRUCTURAL DRAWINGS SHALL BE READ IN CONJUNCTION WITH SPECIFICATIONS AND ALL OTHER DRAWINGS RELATING TO THE WORK.
3. CONTRACTOR SHALL VERIFY ALL DIMENSIONS, ELEVATIONS AND CONDITIONS AT THE SITE AND SHALL NOTIFY THE ARCHITECT OF DISCREPANCIES BETWEEN THE ACTUAL CONDITIONS AND INFORMATION SHOWN ON THE DRAWINGS. REMEDIAL ACTION SHALL BE TAKEN BEFORE PROCEEDING WITH THE WORK.
4. SPECIFIC NOTES AND DETAILS SHALL TAKE PRECEDENCE OVER GENERAL NOTES AND TYPICAL DETAILS. DO NOT SCALE DRAWINGS

DESIGN CRITERIA

(PER PART 2, TITLE 24, CBC 2001 PLUS SUPPLEMENTS, UNO)

1. ROOF LIVE LOAD = 20 PSF (REDUCIBLE PER CBC TABLE 16A-C), TYPICAL MECHANICAL EQUIP ROOM = 50 PSF IN OPEN AREAS AROUND EQUIPMENT
2. FIRST & SECOND FLOOR LIVE LOAD = 80 PSF (REDUCIBLE PER CBC SECTION 1606A) + 20 PSF PARTITION DEAD LOAD, OR 2000 POUND CONCENTRATED LOAD PLACED UPON ANY SPACE 30 SQUARE INCHES.
   1ST FLOOR ACCESS FLOOR SYSTEMS = 100 PSF +10 PSF PER 1606A.2 EXCEPTION.
   2ND FLOOR ACCESS FLOOR = 50 PSF +10 PSF PER1606A.2 EXCEPTION OR 2000 POUND CONCENTRATED LOAD.
   EXIT FACILITIES = 100 PSF (REDUCIBLE PER CBC SECTION 1606A) STORAGE = 125 PSF.
3. WIND LOADS.
   WIND PEAK GUST VELOCITY = 90 MPH, EXPOSURE C, I_w=1.15.
4. SEISMIC PARAMETERS (PER CBC CHAPTER 16A)
   MINIMUM DESIGN SEISMIC BASE SHEAR $V = \frac{0.52I_wW}{R}$ W & V_t=0.11C_aI_wW
   NEAR SOURCE FACTOR N_a = 1.26, N_v= 1.73, C_a=0.40%, C_v=0.56*N_v
   FOR d_t=4.2 Km; SEISMIC SOURCE TYPE A.
   Z = 0.4S (ZONE 4)
   R = 5.4 OCBF.
   I = 1.0
   Ω=2.2
5. SEISMIC ISOLATION SYSTEM DESIGN (PER CBC APPENDIX CHAPTER 16A DIV. VII
   SOIL TYPE = S_D (PER SOIL REPORT)
   NEAR SOURCE FACTOR N_a = 1.26, N_v= 1.73, C_a=0.40%, C_v=0.56*N_v
   FOR d_t=4.2 Km; SEISMIC SOURCE TYPE A.
   R_I = 1.5
6. SEISMIC DYNAMIC ANALYSIS FOR SITE SPECIFIC DESIGN GROUND MOTION PER: CBC SECTION 1954A - 1965A.
   FOR SITE SPECIFIC DESIGN GROUND MOTION INCLUDING DESIGN RESPONSE SPECTRA (DBE AND MCE) AND THREE PAIRS OF MATCHED TIME HISTORIES SEE "GEOTECHNICAL INVESTIGATION REPORT NO. 2005-056 (DATED 8-24-2007) BY DIAZ-YOURMAN AND ASSOCIATES, IRVINE, CA., ALSO SEE "PROBABILISTIC SEISMIC HAZARD ANALYSIS AND REPRESENTATIVE GROUND MOTION TIME HISTORIES" DATED 10-5-2007 BY HUSHMAND ASSOCIATES INC. 290 GODDARD, IRVINE, CA. 92618 (949) 727-1266.
7. ANALYSIS/DESIGN UTILIZES THE "ETABS" VERSION COMPUTER SOFTWARE.

STRUCTURAL STEEL

1. MATERIAL AND WORK SHALL CONFORM TO AISC "SPECIFICATION FOR STRUCTURAL STEEL BUILDINGS", LATEST EDITION.
2. MATERIAL FOR STRUCTURAL STEEL WIDE FLANGE SHAPES SHALL CONFORM TO ASTM A992 (F_y= 50 KSI) UNO. STRUCTURAL STEEL PLATES, ANGLES, CHANNELS AND WT SHALL CONFORM TO ASTM A36 U.N.O.
3. STRUCTURAL TUBING SHALL CONFORM TO ASTM A500, GRADE B, F_y=46KSI
4. STRUCTURAL PIPES SHALL CONFORM TO ASTM A53, GRADE B, F_y=35KSI
5. ALL STRUCTURAL STEEL CONNECTIONS SHALL BE MADE WITH HIGH STRENGTH TYPE BOLTS CONFORMING TO ASTM A325N UNO.
   BOLTS DESIGNATED AS SLIP-CRITICAL & BOLTS SUBJECT TO DIRECT TENSION LOADS SHALL BE PRETENSIONED PER AISC "SPECIFICATION FOR STRUCTURAL JOINTS USING ASTM A325 OR A490 BOLTS."
6. ALL BOLTED CONNECTIONS SHALL HAVE A MINIMUM OF TWO (2) BOLTS, UNO.
7. MINIMUM EDGE DISTANCE (DISTANCE FROM CENTER OF BOLT TO NEAREST EDGE OF PLATE OR STRUCTURAL ELEMENT) SHALL BE 2 BOLT DIAMETERS OR 1 1/2", WHICHEVER IS GREATER, UNLESS NOTED OTHERWISE.
8. ANCHOR BOLTS SHALL BE A307 HEX HEAD BOLTS WITH FLAT WASHERS OR F1554 THREADED RODS WITH NUTS AND FLAT WASHERS UNO ON DWGS.
9. ALL WELDING SHALL CONFORM TO STANDARDS OF AISC, AWS D1.1 & D1.3 USING E70 LOW-HYDROGEN ELECTRODES AND SHALL BE PERFORMED BY WELDERS CERTIFIED PER AWS REQUIREMENTS.
10. CONTINUOUS VISUAL INSPECTION IS REQUIRED PER AWS CODE FOR ALL FIELD WELDING. ALL FULL PENETRATION GROOVE WELDS SHALL BE ULTRASONICALLY INSPECTED.
11. ALL STRUCTURAL STEEL AND MISCELLANEOUS STEEL EXPOSED TO WEATHER SHALL BE GALVANIZED.
12. GUSSET PLATES SHALL BE 3/8" THICK MINIMUM, UNLESS NOTED OTHERWISE.
13. ALL TESTING AND INSPECTION OF STRUCTURAL STEEL SHALL CONFORM WITH THE REQUIREMENTS OF PART 2, TITLE 24, C.C.R., SECTION 2305A.
14. CLEARLY MARK THE LOCATION OF ALL JACKING POINTS ON BEAMS DESIGNATED AS JACKING BEAMS.

SPECIAL INSPECTION

1. SPECIAL INSPECTION BY A REGISTERED BUILDING INSPECTOR APPROVED BY THE DIVISION OF STATE ARCHITECT (DSA) SHALL BE REQUIRED FOR THE FOLLOWING TYPES OF WORK, SEE PROJECT SPECIFICATIONS FOR SPECIFIC REQUIREMENTS. ALL INSPECTIONS SHALL CONFORM WITH THE REQUIREMENTS OF PART 2, TITLE 24, C.C.R., SECTION 1705A.
2. SEISMIC ISOLATION SYSTEM
   A. SPECIAL INSPECTION PER CBC 2001 SECTION 1601A.2.8.
   B. SPECIAL INSPECTIONS DURING ISOLATOR TESTING PER INSTRUCTIONS FROM THE STRUCTURAL ENGINEER OF RECORD, OR AS STATED IN THE SPECIFICATIONS.

STRUCTURAL OBSERVATION

1. STRUCTURAL OBSERVATION AS INDICATED IN THE CALIFORNIA BUILDING CODE SECTION 1705A IS REQUIRED. CONTRACTOR SHALL NOTIFY THE STRUCTURAL ENGINEER OF RECORD (EOR) AT LEAST THREE WORKING DAYS IN ADVANCE TO FACILITATE THE SCHEDULING.
2. SEE PROJECT SPECIFICATIONS AND DRAWINGS FOR ADDITIONAL OBSERVATION REQUIREMENTS AND ALSO FOR OBSERVATION INSPECTION REQUIREMENTS BY OTHER SPECIALISTS.
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR NOTIFYING THE EOR 72 HOURS IN ADVANCE OF REQUIRED OBSERVATION(S) FOR SCHEDULING PURPOSES. FAILURE TO MEET OBSERVATION SCHEDULES MAY REQUIRE REMOVAL OF ANY FINISHES THAT HAVE BEEN SUBSEQUENTLY INSTALLED. APPROVAL BY DSA INSPECTOR DOES NOT PRECLUDE OBSERVATION BY THE ENGINEER OF RECORD (E.O.R.) AND APPROVAL BY THE E.O.R. DOES NOT PRECLUDE THE INSPECTION PROCESS BY THE DSA INSPECTOR AND ANY OTHER CODE REQUIREMENTS FOR INSPECTION. REMOVAL AND REPLACEMENT OF ANY FINISHES AND/OR FRAMING DAMAGED BY THE FINISH REMOVAL PROCESS OR AS REQUIRED FOR CORRECTIVE ACTION SHALL BE AT THE CONTRACTOR'S EXPENSE, NOT THE OWNER, ENGINEER NOR STRUCTURAL OBSERVER.
   4.1 BASE ISOLATOR ANCHORAGE PRIOR TO ISOLATOR INSTALLATION.
   4.2 BASE ISOLATORS BEFORE ERECTION.

ABBREVIATIONS:

&	AND	COORD	COORDINATE	FDN	FOUNDATION	KB	KNEE BRACE	PL	PLATE	TB	TRACK SWITCH BEARING POINT
AB	ANCHOR BOLT	CONC	CONCRETE	FF	FINISH FLOOR	LEV	LONG LEG VERTICAL	PLCS	PLACES	THD	THREAD
AHU	AIR HANDLING UNIT	CONN	CONNECTION	FIN	FINISH	LONGIT	LONGITUDINAL	PROJ	PROJECTION	T & B	TOP AND BOTTOM
ARCH	ARCHITECTURAL	CONST	CONSTRUCTION	FL(S)	FLANGE(S)	LP	LOW POINT	REQD	REQUIRED	TG	TOP OF
BM	BEAM	CONT	CONTINUOUS	FLR	FLOOR	LWC	LIGHT WEIGHT CONCRETE	REINF	REINFORCING	TOC	TOP OF CONCRETE
BOS	BOTTOM OF STEEL	DBA	DEFORMED BAR ANCHOR	FRMG	FRAMING	MAX	MAXIMUM	RM	ROOM	TOF	TOP OF FOOTING
BOF	BOTTOM OF FOOTING	DET	DETAIL	FS	FAR SIDE	MB	MACHINE BOLT	SC	STUB COLUMN	TOS	TOP OF STEEL
BOT	BOTTOM	DIA	DIAMETER	FTG	FOOTING	MECH	MECHANICAL	SCHED	SCHEDULE	TOW	TOP OF WALL
BRCG	BRACING	DWG	DRAWING	FOS	FACE OF STUD	MIN	MINIMUM	SECT	SECTION	TYP	TYPICAL
BS	BOTH SIDES	DWLS	DOWELS	GA	GAGE	MISC	MISCELLANEOUS	SLV	SHORT LEG VERTICAL	UNO	UNLESS NOTED OTHERWISE
CANT	CANTILEVER	(E)	EXISTING	HC	HANGER COLUMN	NF	NEAR FACE	SIM	SIMILAR	VERT	VERTICAL
CIP	CAST IN PLACE	EA	EACH	HDR	HEADER	NS	NEAR SIDE	SMS	SHEET METAL SCREWS	WWF	WELDED WIRE FABRIC
℄	CENTERLINE	EJ	EXPANSION JOINT	HORIZ	HORIZONTAL	NTS	NOT TO SCALE	SPA	SPACES	WD	WOOD
CLR	CLEAR	EL	ELEVATION	HS	HEADED STUD	NWC	NORMAL WEIGHT CONCRETE	SPECS	SPECIFICATIONS	WP	WORK POINT
CJ	CONTROL JOINT	ELEV	ELEVATION	HSB	HIGH STRENGTH BOLTS	OC	ON CENTER	SQ	SQUARE		
CP	COMPLETE PENETRATION	EQ	EQUAL OR EQUIPMENT	IE	INVERT ELEVATION	OFI	OWNER FURNISHED AND INSTALLED	STD	STANDARD		
CMU	CONCRETE MASONRY UNITS	EW	EACH WAY	INFO	INFORMATION	OPNG	OPENING	STIFF	STIFFENER		
COL	COLUMN	EXP	EXPANSION	INTERMED	INTERMEDIATE	PJ	POUR JOINT	STL	STEEL		
		EXT	EXTERIOR, EXTERNAL	JT	JOINT	PL	PLATE	SYMM	SYMMETRY, SYMMETRICAL		

SYMBOLS & LEGENDS:

- DENOTES CAST-IN-PLACE CONCRETE IN SECTIONS
- DENOTES CMU WALL IN SECTIONS
- DETAIL NUMBER / SHEET WHERE OCCURS
- DETAIL DESIGNATION / SHEET WHERE OCCURS / SHEET REFERENCED FROM
- ELEVATION /SECTION NUMBER / SHEET WHERE OCCURS

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PROJECT

PROJECT ADDRESS:
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STATUS

MAY 14, 2008

ISSUE

MARK	DATE	DESCRIPTION

PROJECT NO:	60004333.4000
DRAWN BY:	M. RAMIREZ
CHECK BY:	J. LIVERMORE

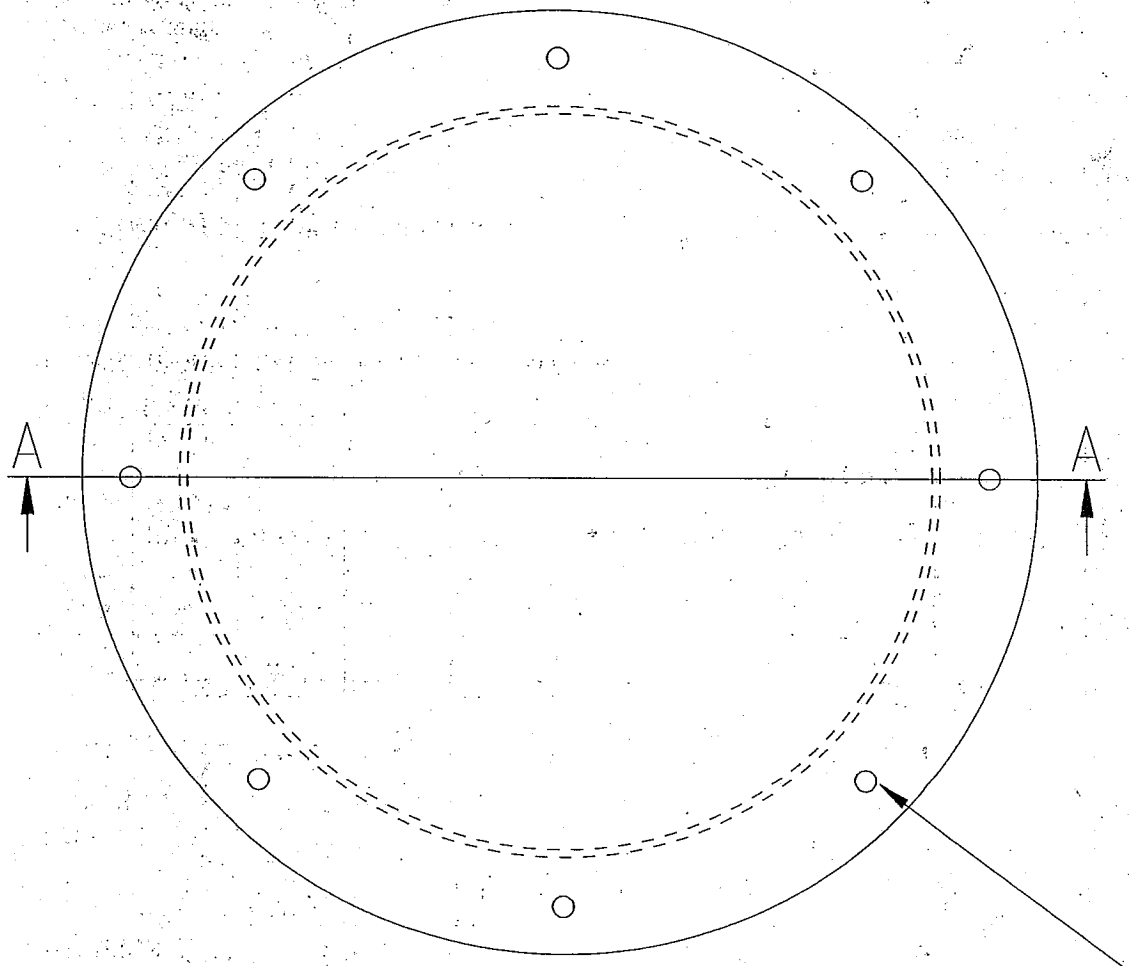
KEY PLAN

SHEET TITLE

GENERAL NOTES, SYMBOLS AND ABBREVIATIONS

S-001

Top View



8 x 28Ø holes
on 1130 PCD for
1 inch A325 Bolts

Title	Proposed RB Inland Empire	
Dwg No	87 100 AA	
Designed	TREVOR KELLY	
Drawn	C.GANNON	5/Aug/08
Checked		
Approved		
Scale	1 : 10	

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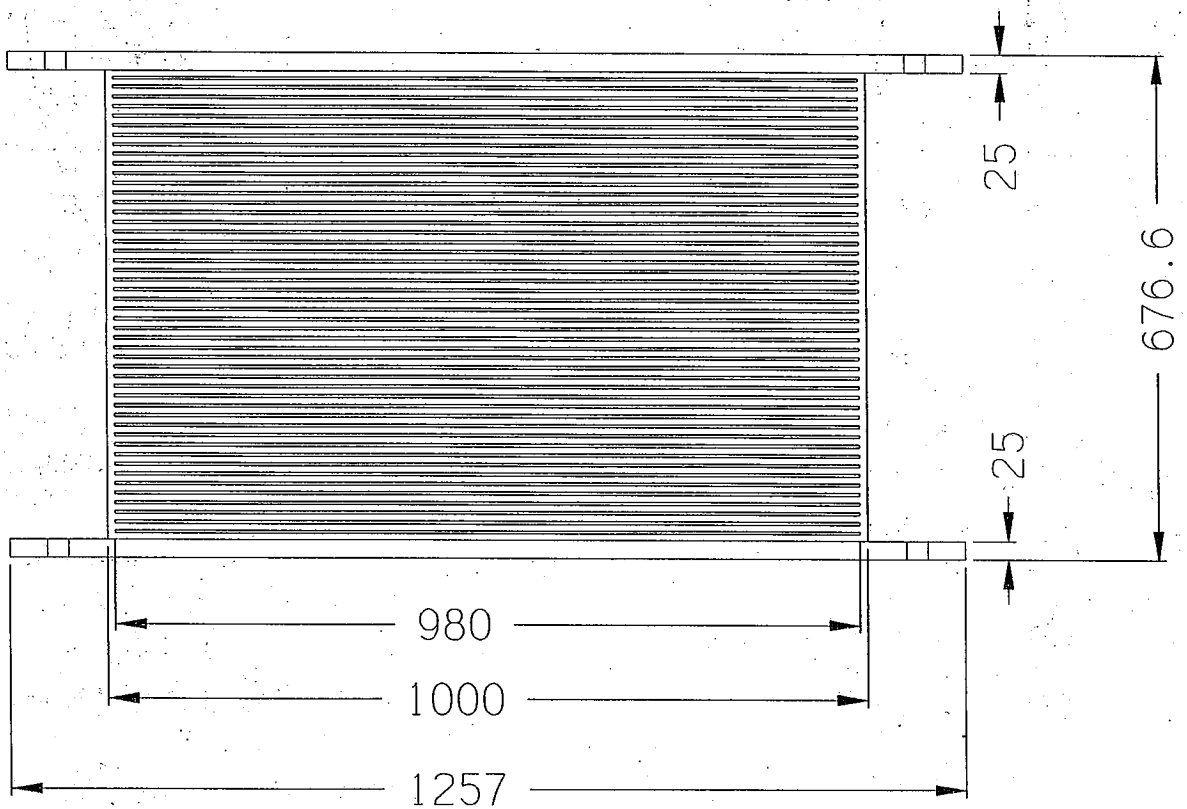
Section A-A



Title	Proposed RB Inland Empire	
Dwg No	87 100 AB	
Designed	TREVOR KELLY	
Drawn	C.GANNON	5/Aug/08
Checked		
Approved		
Scale	1 : 10	

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Rubber - 49 x 8.87mm
Steel Shim - 48 x 4mm

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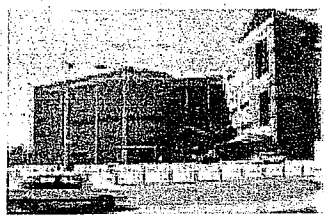
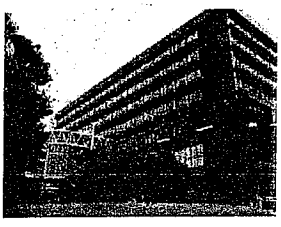
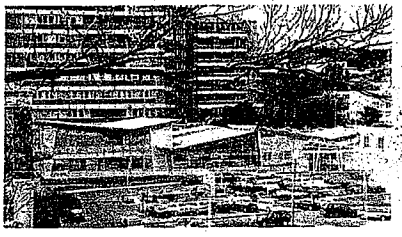
Work Experience: A selection of structures similar to the Inland Empire Transportation Management Building



1998, Wellington, NZL: Te Papa Museum of New Zealand, 50,000 sq mtrs at a weight of 64,000 tonnes: Used 152 LRBs at 1m diameter

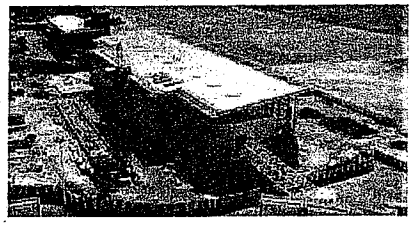


. 2002: Wellington, NZL: Rankin Brown Bldg; 8 storeys at 18,000 tonnes retrofitted with 18 LRBs of 1m diameter.

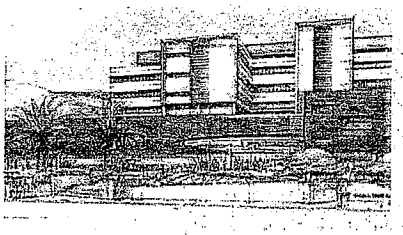


2003: Wellington, NZL: Accident & Emergency building using 24 LRBs of 620mm diameter and 24 sliders.

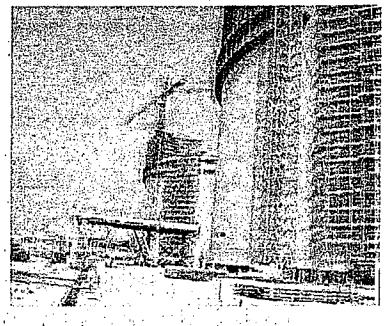
2003,Bhuj, Gujarat, India: 300 bed hospital at 50,000 sq mtrs used 200 LRBs at 500mm diameter and 100 Sliders.



2005, Yerevan, Armenia: Fifty Two LRBs of 750mm diameter supplied for the new Yerevan National Airport



2005 Wellington, NZL: New Hospital of 50,000 sq metres with 135 LRBs of 1m diameter and 150 Sliders.



2005-2006 Guangdong, China: Three LNG tanks installed by Saipem and owned by BP. A total of 1080 HDRB bearings, 360 per 80m diameter tank weighing 144,000 tonnes.

ROBINSON SEISMIC LTD.

CALCULATIONS FOR

SEISMIC ISOLATION BEARINGS

FOR

INLAND EMPIRE TRANSPORTATION CENTRE
DEPARTMENT OF TRANSPORTATION – DISTRICT 8

TABLE OF CONTENTS

1 INTRODUCTION

Section 1.7 D pf 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 $\varepsilon_{sr} = \dfrac{B^2\theta}{2t_i T_r}$

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:

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

2.2.3 Tensile Rated Load Capacity

For tension loads, the stiffness in tension depends upon the shape of the unit, as in compression, and is approximately the same as the compression stiffness. Therefore, 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:

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

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 $K_r = \frac{G_\gamma A_r}{T_r}$. 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)	199
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) maximum long term load (LT) with zero displacement and (2) short term maximum load (ST) with total maximum design displacement (TM).

Table 3-2: Design Loads

	Vertical Load (kips)
LT = Long term maximum load (D + L) Max	785
ST = Short term maximum load (1.2D + L + E_{MCE}) Max	930
AL = Average isolator test load (D + 0.5L) Average	268

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	0.354"
Number of Layers	49
Total Height	26.654"

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 3-5 : Bearing Properties

Gross Area	1217 in^2
Side Cover	0.394"
Bonded Dimension	38.583"
Bonded Area	1169 in^2
Total Rubber Thickness	17.362"
Bonded Perimeter	121.21"
Shape Factor	27.2
Internal Shim Thickness	0.1575"
Mounting Plate Thickness	0.866"
Shear Modulus (nominal)	57 psi
Yielded Stiffness K_r Nominal	4.07 kip/in
Adjusted for Vertical Stress	3.86 kip/in

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 3-6 Gravity Load Limit State

	LR A
Factor on e_u	0.33
Vertical Load	785 kips
Compressive Strain e_c	0.0027
Elastic Modulus	0.193 ksi
Compressive Shear Strain e_{sc}	0.43

Total Shear Strain	0.43
Strain Limit	2.17
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 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 3-7 Seismic Limit States

	Minimum Load	Maximum Load
Factor on e_u	1.00	1.00
Vertical Load	-50 kips	930 kips
Applied Displacement	26.0"	26.0"
Elastic Modulus		0.193 ksi
Compressive Strain e_c		0.0148
Reduction Factor		0.212
Compressive Shear Strain e_{sc}		2.42
Shear Strain from Disp. e_{sh}		1.50
Total Shear Strain		3.92
Strain Limit		6.50
Tensile Stress	42 psi	-
Cavitation Limit (=3G)	127 psi	-
Status	OK	OK

3.7 Vertical Stiffness

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

Table 3-8 Vertical Stiffness

E	0.193 ksi
A	1169 in^2
$1+2ks^2$	1290
e_c	250
e_{cm}	133.5
K_{vj}	445,909
K_v	9,100

3.8 Buckling Strength

Table 4.7 lists the calculations for buckling strength. The factor of safety is slightly less than the required value of 1.00 but the equation for buckling load is known to be conservative, particularly the reduction factor.

Table 3-9 Buckling Load Calculations

	LR A
Moment of Inertia	108,778 in4
Height Free to Buckle	24.92"
Effective Buckling Modulus	106.6 ksi
Constant T	16,646,898
Constant R	101.4
Constant Q	0.126
P_{cr} at Zero Displacement	5162 kips
Factored Displacement	26.0"
Reduction Factor	0.212
Reduced P_{cr}	1096
Factor of Safety	1.18

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

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

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

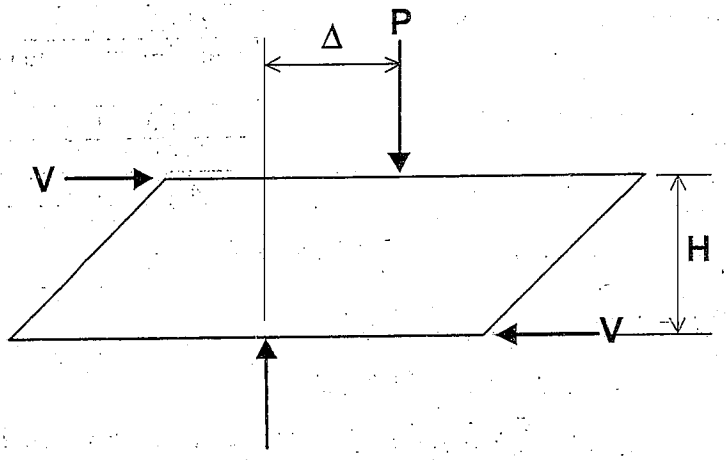


Figure 4-2 Equivalent Column Forces

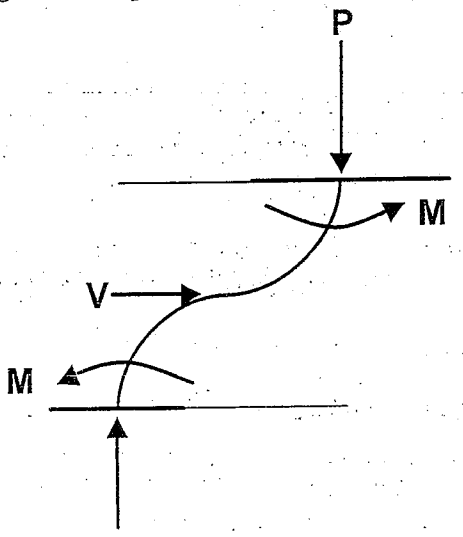


Table 4-1 Design Actions

Bearing Dimensions	
Bearing Diameter	38.58"
Bearing Height	26.65"
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	930 kips
D – E	-50 kips
Lateral Loads and Displacements	
Maximum Displacement	26"
Maximum Force	99 kips
Design Actions	
Shear Force	99 kips
Primary Moment, VH	2639 kip-in
Secondary Moment, PΔ (Max)	24,180 kip-in
Secondary Moment, PΔ (Min)	-1300 kip-in
Design Moment = (VH + PΔ)/2 (Max)	13,409 kip-in
Design Moment = (VH + PΔ)/2 (Min)	669 kip-in
Design Conditions	
(1) Earthquake Load Down	
Shear Force	99 kips
Vertical Load	930 kips
Bending Moment	13,409 kip-in
(2) Earthquake Load Up	
Shear Force	99 kips
Vertical Load	-50 kips
Bending Moment	669 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

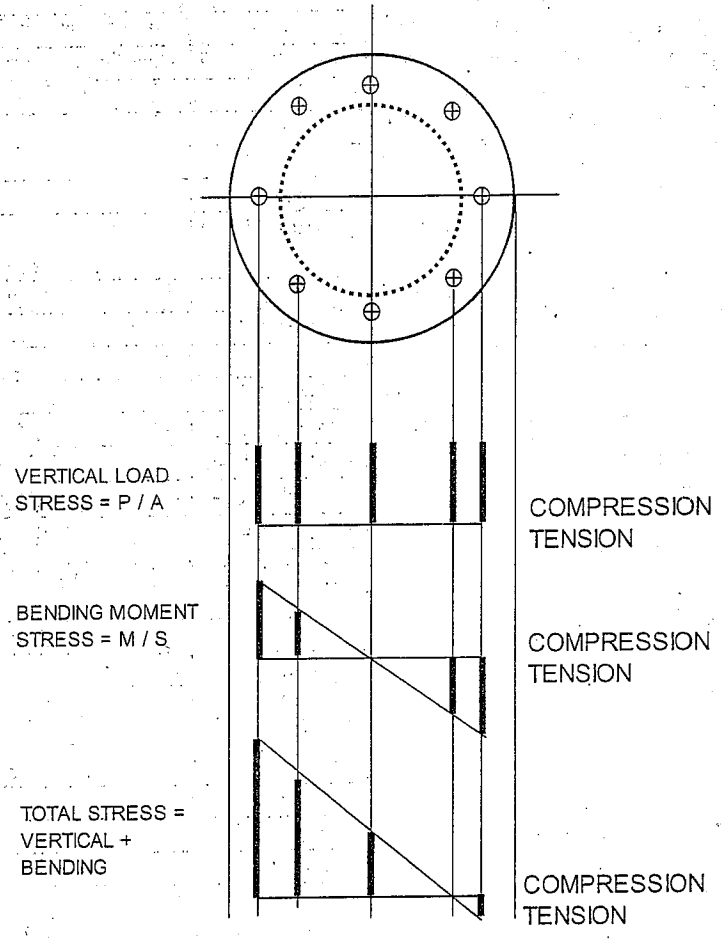


Table 4-2 lists connection design calculations for the bolted connection of the mounting plate. The procedure is:

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	12.38 kips
Load Case 1	
P/A per bolt	-116.25 kips
M/S per bolt	154.10 kips
Tension per Bolt	37.85 kips
Shear Stress	15.76 ksi
Allowable Shear Stress	22.67 ksi
Shear Stress Ratio	0.70
Tensile Stress	48.19 ksi
Allowable Tensile Stress	48.48 ksi
Tensile Stress Ratio	0.99
Status	OK
Load Case 2	
P/A per bolt	6.25 kips
M/S per bolt	7.69 kips
Tension per Bolt	13.94 kips
Shear Stress	15.76 ksi
Allowable Shear Stress	22.67 ksi
Shear Stress Ratio	0.70
Tensile Stress	17.75 ksi
Allowable Tensile Stress	48.48 ksi
Tensile Stress Ratio	0.21
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

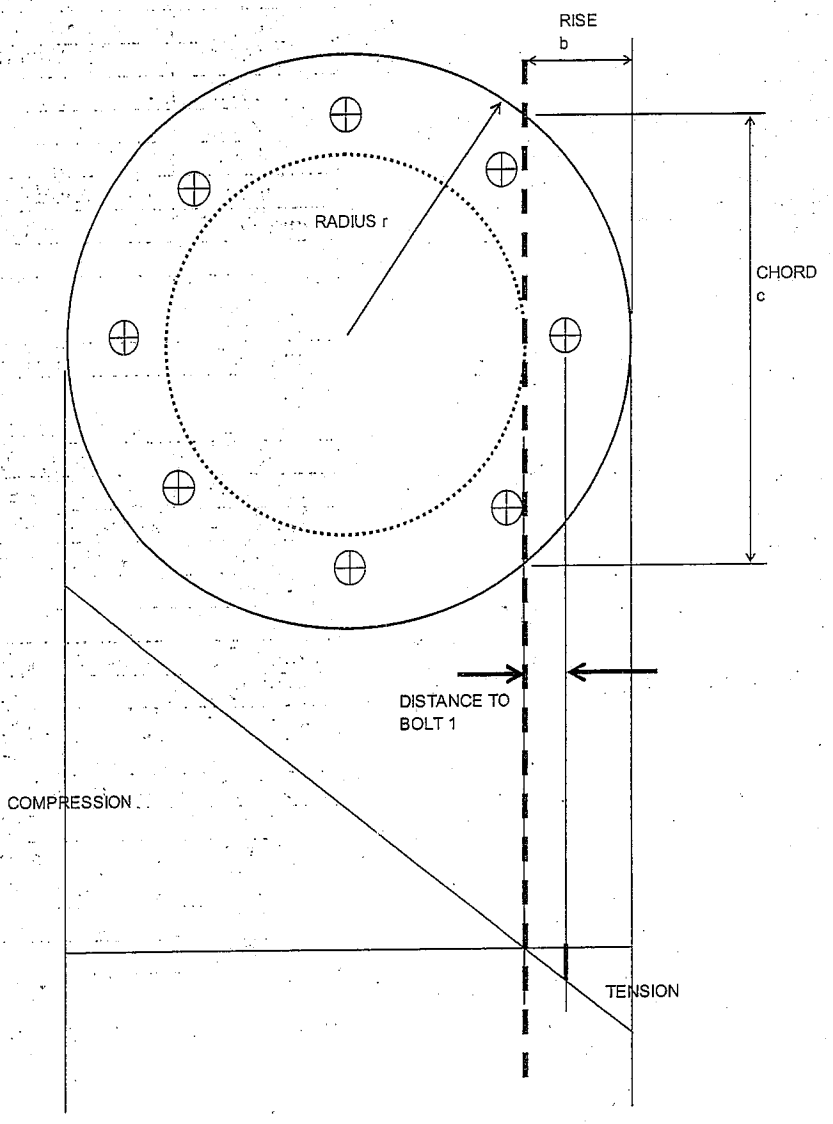


Table 4-3 Mounting Plate Design

Rise, b	5.5"
Radius, r	24.8"
Chord, c	31.0"
Distance to Bolt 1	2.96"
Number of Bolts in Outstand	1
Load Case 1	
Bolt Tension	37.87 kips
Plate Moment	112 kip-in
Section Width	31.01"
Section Depth	0.87"
Section Modulus	3.88 in^3
Bending Stress	28.88 ksi
Load Case 2	
Bolt Tension	13.94 kips
Plate Moment	41 kip-in
Section Width	31.01"
Section Depth	0.87"
Section Modulus	3.88 in^3
Bending Stress	10.64 ksi
Maximum Stress	28.88 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 1.66 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 had 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.

(6) The wind load displacement is based on an assumption that the shear modulus for strains less than 25% is 1.5 times the shear modulus at strains of 50% or higher. This provides an effective stiffness of 1.5 x 3.86 = 5.79 kip/in and a displacement of 10.4 / 5.79 = 1.86" under the 10.4 kip wind load.

(7) The effective stiffness of the natural rubber material is assumed constant between shear strain levels of 75% (at DD) and 132% (at DM) and so the effective stiffness is the same at both displacements.

(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)	 0.43 3.92	 2.17 6.50	 F.S. 5.05 F.S. 1.66
Vertical Load on Isolator LT loads (D + L) ST loads (1.2D + L + E)	(2)	 785 kip 930 kip	 3910 kip 1910 kip	 Capacity at zero displacement Capacity at 26" displacement
Tension on Isolator	(3)	-50 kip	-204 kip	F.S. 4.08
Total Maximum Displacement (TM)	(4)	26.0"	30.6" 30.6"	Capacity at 930 kip load Capacity at -50 kip load
Axial Compressive Stiffness	(5)	> 9,000 kips/in	9,100 kip/in	
Deflection under 10.4 kip wind load	(6)	< 2.20"	1.84"	
Effective Stiffness at DD (13.0") Effective Stiffness at DM (22.90")	(7)	3.80 3.80	3.86 3.86	
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 75% (at DD) and 132% (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 17.362" rubber thickness = 2.60" at failure. Stiffness is the failure load of 204 kips divided by 2.60".

[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
-	-	30.6"	-	3910	1910	-	3.23	3.86	4.37	3.23	3.86	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	120	135	100	120	135

Direct Net Tension Force Capacity Without Failure (kips)	Tension Displacement at Tension Capacity Load (ins) and Stiffness (k/in)	Lateral Deflection at 11 kips Lateral Load	Minimum Compression Stiffness of Isolator (kips/in)
204 kips	2.60" at Failure K = 78 kip/in	1.80"	9,100

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	3.86	4.37	-	-	-	-	-	-	3.23	3.86	4.37	42.0	50.2	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	3.86	4.37	-	-	-	-	-	-	3.23	3.86	4.37	74.0	88.4	100.0