

The 10 Largest Base-Isolated Buildings in the World



1. Adana Integrated Health Campus, Adana, Turkey, 430,000 square meters. The campus was developed as a public-private partnership between ADN PPP Sağlık Yatırım A.Ş., a joint venture of four firms, and the Turkish Ministry of Health. The campus will have a total capacity of 1,550 beds housed in three hospitals: the 1,300-bed main hospital, a 150-bed physical-therapy and rehabilitation hospital and a 100-bed high-security criminal psychiatric hospital. The campus is supported by 1,512 base isolators. The complex was designed by HWP, and built by Rönesans Sağlık Yatırım. The structural engineer was Ulker Engineering Ltd. It was completed in May, 2017.

Photo Courtesy Ronesans

By Scott Lewis

Base isolation is a method for moderating the effects of earthquakes on buildings. Isolator devices (either elastic or sliding) are installed between the foundation and the building superstructure. The accompanying slide show looks at the ten largest base-isolated buildings in the world, measured by total floor area.

“The use of base isolation as seismic protection for buildings, bridges and industrial facilities continues to grow, but has done so more robustly internationally than in the U.S.,” says Ronald Hamburger, Senior Principal with Simpson Gumpertz & Heger, a leading seismic engineering firm.

Not surprisingly, Japan, the most seismically active country, employs it most extensively, with 4,100 base-isolated commercial and institutional buildings as of December 2015, according to the Japan Society of Seismic Isolation. “Japan looks at base isolation as a primary option,” says Konrad Eriksen, President of Dynamic Isolation Systems Inc., a leading designer and manufacturer of isolators. “In the Japanese residential market, prospective condo owners will pay a premium for a base-isolated building compared to a conventional building,” says Gordon Wray,

associate principal at Degenkolb Engineers, another prominent seismic engineering firm.

Turkey, another very seismically active country, is also firmly committed to base-isolation methodology. Notably, it has embarked on a \$13.6-billion program to build numerous large modern hospitals, most of which will be base-isolated. In addition, major bridges and viaducts have also been protected in this fashion.

One notable project under construction in Turkey is the Ikitelli Integrated Health Campus in Istanbul. The 2,330-bed main hospital building there is expected to contain 2,000 isolators. It is a public-private partnership being developed by Istanbul PPP Sağlık Yatırım A.Ş. When completed, it is expected to be the largest base-isolated building in the world.

Other countries pushing base isolation include China, New Zealand, Chile, Peru, Colombia and Ecuador. In contrast, “in the U.S., seismic isolation is used relatively infrequently,” according to Hamburger. “In recent years, the inaccurate perception that other structural systems, including energy-dissipated moment frames, or buckling-restrained braced frames, can provide similar protection at lower first cost has slowed the growth of this technology in the U.S.”

“In the U.S., seismic resilience is taken for granted because of the recent infrequency of earthquakes and several decades of good building codes,” says Wray. “Modern buildings have performed well in recent earthquakes (few collapses), although we have not yet experienced a code-level earthquake in a densely populated area in 23 years. I believe that many building owners have an expectation of operational performance, when typical code buildings are designed only to protect life-safety.”

Seismic-isolation technologies fall into two categories: elastomeric and sliding systems. Elastomeric isolation systems consist of natural rubber; natural rubber with lead cores to dissipate energy; and high-damping rubber, consisting of blends of natural and synthetic compounds. Sliding systems generally include flat sliders, typically used in combination with elastomeric bearings and friction pendulum devices. Within the friction pendulum category there are a series of different designs, including the original system that employed a single curved dish and sliding

■ Continued on page 5

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California Sub-Bid Request Ads

DESILVA GATES CONSTRUCTION

11555 Dublin Boulevard • P.O. Box 2909
Dublin, CA 94568-2909
(925) 829-9220 / FAX (925) 803-4263
Estimator: VICTOR LE
Website: www.desilvagates.com
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DeSilva Gates Construction (DGC)
is preparing a bid as a Prime Contractor for the
project listed below:

**DANVILLE VARIOUS STREETS & ROADS
PRESERVATION PROJECT**
Contract No. C-584,
Federal Aid Project No. STPL-5434(021)
Disadvantaged Business Enterprise Goal
Assigned is 5%

OWNER:

TOWN OF DANVILLE –

510 La Gonda Way, Danville, CA 94526

BID DATE: AUGUST 1, 2017 @ 2:00 P.M.

DGC is soliciting quotations from certified Disadvantaged Business Enterprises, for the following types of work and supplies/materials including but not limited to: **ADJUST IRON, BRIDGE DECK REPAIR AND JOINT SEAL, CLEARING AND GRUBBING, ELECTRICAL, PAVING FABRIC, MINOR CONCRETE, PCC PAVING, ROADSIDE SIGNS, STRIPING, WATER POLLUTION CONTROL PROGRAM AND LEAD COMPLIANCE PLAN, SUBDRAIN PIPE, TRUCKING, WATER TRUCKS, STREET SWEEPING, CLASS 2 AGGREGATE BASE MATERIAL, HOT MIX ASPHALT (TYPE A) MATERIAL.**

Plans and specifications may be reviewed at our offices located at 11555 Dublin Boulevard, Dublin, CA or 7700 College Town Drive, Sacramento, CA, or at your local Builders Exchange, or reviewed and downloaded from the ftp site at <ftp://ftp%25desilvagates.com:f7pa55wd@pub.desilvagates.com> (if prompted the username is [ftp@desilvagates.com](ftp://ftp%25desilvagates.com) and password is [f7pa55wd](ftp://ftp%25desilvagates.com)) or from the Owner's site.

Fax your bid to (925) 803-4263 to the attention of Estimator Victor Le. If you have questions for the Estimator, call at (925) 829-9220. When submitting any public works bid please include your DUNS number and DIR number. For questions regarding registration for DIR use the link at: www.dir.ca.gov/Public-Works/Public-Works.html

If you need DBE support services and assistance in obtaining bonding, lines of credit, insurance, necessary equipment, materials and/or supplies or related assistance or services, for this project call the Estimator at (925) 829-9220, or contact your local Small Business Development Center Network (<http://californiasbdc.org>) or contact the California Southwest Transportation Resource Center (www.transportation.gov/osdbu/SB-TRCs). DGC is willing to breakout portions of work to increase the expectation of meeting the DBE goal.

At our discretion, 100% Payment and 100% Performance bonds may be required as a subcontract condition. This will be a PREVAILING WAGE JOB. DGC is an equal opportunity employer.

SUKUT CONSTRUCTION

Is requesting quotes from qualified DBE Subcontractors, Suppliers, and Service Providers for the following (but not limited to) work:

**Clear & Grub, PCC Flatwork,
Fencing/Gates, Electrical, Export Dirt,
Purchase Class 2 Aggregate Base, Striping,
Asphalt Paving, Hydromulch**

AIRFIELD SAFETY GRADING AND

ACCESS CONTROL GATES

Santa Ynez Airport

900 Airport Road, Santa Ynez, CA

County of Santa Barbara

Project No. 8763-AIP16

BID DATE August 2, 2017 @ 2:00 p.m.

Sub & Vendor Scopes and Bids Due Prior

Sukut Construction, LLC

4010 W. Chandler Avenue, Santa Ana, CA 92704

Contact: Matt Bahnsen

Phone: (714) 540-5351 • Fax: (714) 545-2003 • Email: estimating@sukut.com

Plans/specs are available for viewing at our office by appointment or via ftp, or may be obtained from Owner. Subcontractors must be prepared to furnish 100% performance and payment bonds and possess current insurance and workers' comp coverage. Sukut Construction will assist Qualified Subcontractors in obtaining bonds, insurance, and/or lines of credit. Please contact Sukut Construction for assistance in responding to this solicitation. Subcontractors/Vendors will be required to sign Sukut's Standard Subcontract/Purchase Order. Copies are available for examination.

Sukut Construction's listing of a Subcontractor in its bid to the agency is not to be construed as an acceptance of all of the Subcontractor's conditions or exceptions included with Subcontractor's price quotes. Quotations must be valid for the same duration as specified by Owner for contract award.

Sukut Construction, LLC
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Proven Management, Inc.

225 3rd Street, Oakland, CA 94607 Phone: 510-671-0000 • Fax: 510-671-1000

Requests proposals/quotes from all qualified and certified Disadvantaged Business Enterprise (DBE) subcontractors, suppliers, and truckers for the following project:

SOUTH SAN FRANCISCO STATION IMPROVEMENTS

CALTRAIN CONTRACT #17-J-C-063

Bids: 05/30/2017 @ 2 PM

SUBCONTRACTING GOAL – DBE- 14%

Demo; Site Clearing; Earthwork; Disposal of Excess Soil & Railroad Ballast; Station Platforms, Sidewalks, Curbs & Gutters; Asphalt Paving; Wheelstops; Station Fence & Railing; Chain Link Fence; Traffic Control; Welded Wire Mesh Fence; Retaining Wall System; Planting/Irrigation;

CIP Concrete, Shotcrete; Rebar; CIDH Piles; OCS Pole Foundations & Guy Anchors; Glass Unit Masonry; Metal Fab; Handrails & Railings; Anti-Graffiti Window Film; Paints/Coatings; Graffiti-Resistant Coating; Station Furnishings; Station Shelters; Wheelchair Lift & Shed; Signs; Plumbing; Mechanical; Fire-Suppression Piping; Electrical; Site Lighting; CCTV System; PA System; Trackwork; Timber Crossties & Switch Ties; Conc Crossties & Rail Fastener Assemblies; Rail; Track Removal & Salvage; Conc Grade Crossings; Thermoite Rail Welding

Bonding, insurance, lines of credit and any technical assistance or information related to the plans & specifications & requirements for the work will be made available to interested SBE certified suppliers & subcontractors. Assistance with obtaining necessary equipment, supplies, materials, or related assistance or services for this project will also be offered to interested SBE certified suppliers, subcontractors, truckers. PMI is signatory to the Operating Engineers, Carpenters, and Laborers Collective Bargaining Agreements.

100% Payment & Performance bonds will be required from a single, Treasury-listed surety company subject to PMI's approval. PMI will pay bond premium up to 1.5%. Subcontractors awarded on any project will be on PMI's standard form for subcontract without any modifications. For questions or assistance required on the above, please call.

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California Sub-Bid Request Ads

Turner

Turner Construction Company, representing the County of Alameda as their Construction Manager at Risk (CMR), formally announces the upcoming bidding opportunity on the project listed below. Bidders are required to meet Project Stabilization/Community Benefit Agreement (PSCBA) requirements and make a good faith effort to meet Enhanced Construction Outreach Program (ECOP) goals. Prospective bidders are encouraged to visit the County of Alameda website for information on certification, ECOP, and PSCBA requirements.

Cherryland Community Center

Approximate Construction Value: Fifteen Million Dollars (\$15,000,000)
 Owner: County of Alameda

The project scope includes ground-up construction of an approximately 17, 500 square-foot multipurpose community center located on two adjoining lots (278 Hampton Road and 17482 Boston Road). The scope also includes improvements to the Meek Estate parking lot, located behind the Community Center site, at the end of Boston Road. This advertisement is for all trade packages associated with the project. The estimate construction start is September, 2017.

This advertisement is for all trades, including:

Trade Package #	Trade Package Name	Trade Package #	Trade Package Name	Trade Package #	Trade Package Name
BP1.00.1	GENERAL CONDITIONS	BP6.20	FINISH CARPENTRY	BP9.60.1	FLOORING
BP1.00.2	FINAL CLEAN	BP7.50	ROOFING, ACCESSORIES, AND WATERPROOFING	BP9.60.2	TERRAZZO
BP2.31	SITE DEMOLITION & EARTHWORK	BP8.10.1	DOORS, FRAMES, HARDWARE	BP10.10.1	TOILET PARTITIONS, TOILET ACCESSORIES, FIRE PROTECTION SPECIALTIES, VISUAL DISPLAY SURFACES, WALL PROTECTION, STAGE CURTAIN
BP2.50	SITE UTILITIES	BP8.10.2	ROLL UP DOORS	BP10.10.3	BOOK DEPOSITORY AND STACK SYSTEM
BP2.74	SITE PAVING	BP8.10.3	OPERABLE PARTITIONS	BP11.04	FOOD SERVICE EQUIPMENT
BP2.75	SITE CONCRETE	BP8.40	GLAZING, EXTERIOR AND INTERIOR	BP12.49	ROLLER SHADES
BP2.90	LANDSCAPE AND IRRIGATION	BP9.20.1	DRYWALL AND INSULATION	BP15.90	PLUMBING
BP3.30	STRUCTURAL EXCAVATION AND CONCRETE	BP9.20.2	PLASTER	BP16.00	ELECTRICAL
BP5.10	STRUCTURAL STEEL	BP9.30	TILE		
BP5.50	MISC. METALS	BP9.90	PAINTING		

Plans and Specifications

Plans, Specifications, Requirements, and other job documents will be available July 10, 2017. Please go to <https://turnemorcal.box.com/s/kx8ab0qc0t38zqic5shsuqy3q9kq5x6n> to access the documents. You will be asked for your own user name and password.

Pre-Bid Meeting/Job-Walk

INFORMATIONAL Pre-Bid Meetings and Job-Walks:

Jobsite Walk: July 13 from 7:00 a.m. to 7:30 a.m.,
 278 Hampton Road, Hayward.
Pre-Bid Meeting: July 13 from 8:30 a.m. to 10:00 a.m.,
 1401 Lakeside Drive, Rm 1107, Oakland.

Requests for Information

Pre-Bid Requests for Information (RFIs) are due July 19 at 2:00 p.m.

Prequalification

Bidders interested in working with Turner on this project will be required to prequalify before being awarded the work. Submit prequalification packages online at www.turnerconstruction.com/sub-contractors. Non-qualified subcontractors may bid the work, and will have 72 hours to submit an acceptable prequalification package if they are the apparent low bidder. Contractors are encouraged to submit a prequalification package by July 19.

Emailed, faxed, or hand delivered bids are due no later than 10:00 a.m., TUESDAY, July 25, 2017.

EMAIL TO: mguzman@tcco.com

FAX TO: 510-267-0787

HAND DELIVER TO:

Attn: Marlene Guzman

300 Frank H. Ogawa Plaza, Suite 510
 Oakland, CA 94612

Turner requires that subcontractors also comply with Project Stabilization/Community Benefit Agreement (PSCBA) requirements.

Turner has the following goals for the project:

Minority Owned Business Enterprise – 15%, Woman Owned Business Enterprise – 5%,

Local Business Enterprise – 60%, Small Local Business Enterprise – 20%

Please direct all questions to Marlene Guzman at 510-267-8105 or mguzman@tcco.com.



Kiewit

Kiewit Infrastructure West Co.
 4650 Business Center Drive Fairfield, CA 94534
 Attn: Victor Molina • norcal.bids@kiewit.com
 Fax: 707-439-7301

Requests sub-bids from qualified Contract Monitoring Division (CMD) Small and Micro-LBEs and San Francisco Public Utilities Commission (SFPUC) certified Local Business Enterprises (LBE) Subcontractors, Consultants, and/or Suppliers seeking to participate in the SFPUC, Alameda Creek Recapture Project in Sunol, CA.

<http://www.sfgov.org/cmd>

Subcontractors and Suppliers for the following project:

Alameda Creek Recapture Project

Contract No. WD-2825

Project No. CUW35201

Owner: San Francisco Public Utilities Commission

Bid Date: August 10, 2017 @ 2:00 P.M.

Small Business Enterprises and Micro (SBEs)

wanted for the following scopes, including, but not limited to: Aggregates, AC Paving, Concrete, Forming, Clear & Grub, Concrete Supply, Concrete Reinforcement Supply & Install, Demolition, Dewatering, Doors & Windows, Erosion Control, Electrical & Communications, Fencing & Vehicle Gate, Grouting, HVAC, Hydroseeding, Instrumentation & Controls, Landscaping, Metals, Prefabricated Building, Painting & Coatings, Piping & Valves, Pumps, Safety & Security Systems, Structural Steel, Shoring, Signage, Street Sweeping, SWPPP, Thermal & Moisture Protection and Water Truck.

Bonding, insurance and any technical assistance or information related to the plans or specification and requirements for the work will be made available to interested CMD and SFPUC certified, LBE and Small and Micro SB LBE suppliers and subcontractors. Please visit SFPUC website: <http://sfgov.org/cmd/surety-bond-assistance-program-1> for their Bond Assistance Program. Assistance with obtaining necessary equipment, supplies, materials, or services for this project will be offered to interested certified suppliers and subcontractors.

Subcontractor and Supplier Scopes are due

August 4, 2017 and Quotes

NO LATER THAN August 9, 2017 at 5 P.M.

Plans are available for viewing at our office at our address below and through SmartBidNet (SBN).

All subcontractors that are registered in our SBN database will receive an invitation to bid. Please visit <http://www.kiewit.com/districts/northern-california/overview.aspx> to complete the SFPUC Confidentiality Agreement, register your company and to receive bidding information, view plans and specifications.

You can view the plans in our office during regular business hours by appointment.

Performance Bond and Payment Bonds may be required for subcontractors and a suppliers bond for suppliers, where applicable.

State Prevailing Wages apply.

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DIR # 100001147





California Sub-Bid Request Ads

nibbi

Project Name: Mission Bay Block 3E – DIV 1-48
Location: San Francisco, California
Pre-Bid Mtg: August 3, 2017 @10:30am
Bid Date: August 17, 2017 @2:00 PM

Nibbi Brothers has been selected as the General Contractor for the Mission Bay Block 3E project in San Francisco. We are in receipt of the bid documents and are currently requesting bids from qualified subcontractors including those certified with the Office of Community Investment and Infrastructure (OCII) for DIV 1-48. The Office of Community Investment and Infrastructure (OCII) participation goal has been established for this project 50% SBE/LBE goal with first consideration for San Francisco-based MBEs, WBEs and SBEs located in zip code areas 94124, 94134 and 94107 followed by all areas in San Francisco. The Mission Bay Block 3E program goal is to provide a safe and healthy home for families and veterans. In addition, Nibbi Brothers is committed to supporting this goal by achieving a minimum of 5% Disable Veteran Business Enterprise (DVBE) participation. All bidders should visit <https://calprocure.ca.gov/pages/PublicSearch/supplier-search.aspx> to search for DVBE's and solicit their participation in some capacity with your specific scope of work. Your proposed DVBE participation in your bid will be evaluated along with the bid and scope inclusions. The project consists of new construction of 101 affordable housing units in San Francisco with a total of 123,701 gross square-feet. The 4-story type V over 1-story type I housing project is to provide a safe and healthy home to support spaces for families and veterans. The building is organized into three wings surrounding a large landscaped multi-use courtyard. The project will also include a main lobby, activity rooms, administrative offices, storage, bike parking and an on-grade parking garage with 25 spaces.

To obtain bid documents through Building Connected, please contact **Kristin Medwick**, Senior Precon and Estimating Coordinator, kristinm@nibbi.com.

For specific questions regarding this project please contact **Elizabeth Crockett**, Preconstruction Manager, elizabethc@nibbi.com.



GOLDEN GATE CONSTRUCTORS

5225 Hellyer Avenue, Suite #220
 San Jose, CA 95138
 Phone (408) 574-1400 Fax (408) 365-9548
 Contact: Bob Williams
 Email: estimating@graniterock.com

REQUESTING SUB-QUOTES FROM
 QUALIFIED LBE SUBCONTRACTORS/
 SUPPLIERS/TRUCKERS FOR:

**Terminal 1 Boarding Area B Project –
 Bid Package 4.1 –**

**Trade Package TP#31 Site Demolition,
 Earthwork & Paving**

**Owner: City and County of San Francisco
 c/o Austin – Webcor, a Joint Venture
 BID DATE: July 27, 2017 @ 2:00 PM**

Items of work include but are not limited to: Temporary Erosion Control Installation, Maintenance and Removal. Pavement, Slab and Footing Demolition. QC/QA Testing, Sawcutting, Water Truck Rental, Street Sweeper Rental, Trucking, Survey, Traffic Control, Shuttle Services, Striping Removal & New Striping Installation. MBGR, Misc Metals, Fixed and Removable Bollards, Class II Contaminated Material Off Haul Including Dump Fees, Soil Stabilization Fabric. Haul and Dispose of Asphalt Concrete Containing Petromat, Haul and Dispose of California Hazardous Material at Class I Landfill, Haul and Dispose of Non Hazardous Materials at Landfill.

Plans, specifications and bid documents (including the Project Labor Agreement, LBE forms, and local hire requirements) may be downloaded from the project's BuildingConnected site. Please send a request to view these documents to estimating@graniterock.com so that we may email you the link. 100% performance and payment bonds will be required from a qualified surety company for the full amount of the subcontract price. Subcontractors are encouraged to contact GGC Estimating with questions regarding bonding assistance, obtaining lines of credit, insurance, equipment, materials and/or supplies, or with any questions you may have. Subcontractors must possess a current contractor's license, DIR number, insurance and worker's compensation coverage. Subcontractors will be required to enter into our standard contract. This will be a prevailing wage job. GGC intends to work cooperatively with all qualified firms seeking work on this project.

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Kiewit

Kiewit Infrastructure West Co.
 4650 Business Center Drive Fairfield, CA 94534
 Attn: Victor Molina • norcal.bids@kiewit.com
 Fax: 707-439-7301

Requests sub-bids from qualified Subcontractor and/or Supplier seeking to participate in the City of Fremont Warm Springs BART West Access Bridge and Plaza Project in Warm Springs, CA.

http://www.alamedact.org/app_pages/view/8080

Subcontractors and Suppliers for the following project:

**Warm Springs BART
 West Access Bridge and Plaza Project
 Owner: City of Fremont
 Bid Date: August 1, 2017 @ 2:00 P.M.**

Local Business Enterprises (LBEs)

wanted for the following scopes, including, but not limited to: Aggregates, AC Paving, Bird Control Devices, Cast in Place Concrete, Precast Concrete, Minor Concrete, Concrete Pumping, Concrete Ready-mix, Concrete Reinforcement Supply & Install, Concrete Forms, Concrete Accessories, Concrete Washouts, Canopy, CIDH, CCTV, Clear & Grub, Demolition, Dewatering, Elevators & Escalators, Elastomeric Bearing Pads, Earthwork, Erosion Control, Electrical, Falsework, Fencing & Gates, Fire Alarm & Detection System, Fire Suppression, Firestopping, Finishes, Non-Shrink Grouting, HVAC, Hydroseeding, Instrumentation and Controls, Joint Protection, Landscaping, Masonry, Metal Doors and Access Doors, Metals, Metal Decking, Metal Wall Panels, Modified Bitumen Roofing, Lime Treatment, Openings, Pavement Markings, Painting and Anti-Graffiti Coating, Piling, Piping, Plumbing, Quality Control, Safety Specialties, Site Furnishings, Structural Steel, Station Identification Pylons, Sheet Metal & Flashing, Shoring, Signage, Site Clearing, Street Sweeping, SWPPP, Synthetic Turf, Tiling, Thermal & Moisture Protection, Trucking & Hauling, Vibration Monitoring, Utility Structures, Waterstops, Wayfinding System, Wire-Mesh Barrier Screens and Water Truck.

Bonding, insurance, and any technical assistance or information related to the plans or specification and requirements for the work will be made available to interested Alameda County Transportation Commission (CTC) certified LBE/SLBE/VSLBE business suppliers and subcontractors. Assistance with obtaining necessary equipment, supplies, materials, or services for this project will be offered to interested certified suppliers and subcontractors.

Subcontractor and Supplier Quotes

are due NO LATER THAN July 31, 2017 at 5 PM.

Plans are available for viewing at our office at our address below and through SmartBidNet (SBN).

All subcontractors that are registered in our SBN database will receive an invitation to bid. Please visit <http://www.kiewit.com/districts/northern-california/overview.aspx> to register your company to be able to receive bidding information, view plans and specifications.

You can view the plans in our office during regular business hours by appointment.

Performance Bond and Payment Bonds may be required for subcontractors and a suppliers bond for suppliers.

Prevailing Wages apply.

**An Equal Opportunity Employer
 CA Lic. 433176
 DIR # 1000001147**

CAHILL CONTRACTORS, LLC

Colby Smith at estimating@cahill-sf.com
 (415) 677-0611

CAHILL CONTRACTORS, LLC requests bids from Certified SBE Subcontractors and Suppliers for the following TRADES ONLY:

Special Inspections

PARCEL O - SELECT TRADES
 455 Fell Street, San Francisco, CA 94102

This is a CMD project with construction workforce and prevailing wage requirements.

BID DATE: 8/1/17 @ 3PM

BID DOCUMENTS:

Please contact Colby for access to documents on BuildingConnected.

The 10 Largest Base-Isolated Buildings in the World



2. Apple Park, Cupertino, California, 260,128 square meters. Apple's new corporate headquarters is a four-story, ring-shaped building, with a circumference of 1,512 sq ft. It houses 12,000 employees and opened in April 2017. It was designed by Foster and Partners. In addition to the four floors above ground, it also includes three stories below ground. The building sits on top of 700 base isolators. Each isolator is 7 ft in diameter and weighs about 15,000 lbs. The isolators were customized for low friction, according to the lead structural engineer, John Worley. Construction of the entire Apple Campus 2, including the headquarters building as well as a 1,000-seat auditorium (the Steve Jobs Theater), a wellness-fitness center, two R&D buildings, a visitor center and parking structures, totaled \$5 billion. The building's inner part is a 30-acre park, featuring fruit trees, winding paths and a pond.

Rendering Courtesy Wikimedia Commons



3. Tokyo Skytree East Tower, Tokyo, 229,237 square meters. This mixed-use complex includes an office tower, mall and entertainment complex. An eight-story podium contains a shopping center, planetarium and theater serving millions of tourists visiting the observatories on the adjacent Tokyo Skytree tower. The office tower rises to 31 stories. The complex was designed by Nikken Sekkei and built by Obayashi Corp. It was completed in 2012.

Photo Courtesy Obayashi Corp.

Continued from page 1

element; a double pendulum, in which two curved dish surfaces are employed; and a triple pendulum employing three such surfaces. "The triple pendulum system reduces the size of the isolator while increasing its effectiveness," says Farzad Naeim, a prominent structural engineer and former president of the Earthquake Engineering Research Institute.

Elastomeric bearings were first used on bridges in the 1950s and were found to be an improvement over mechanical bearings, which suffered from corrosion, according to Eriksen. Friction pendulum bearings were developed in the late 1980s. "Friction pendulum bearings dominate applications in the U.S., in some other important markets like Turkey, and most applications in certain types of structures worldwide (offshore oil platforms, LNG tanks, large bridges, hospitals)," says Michael Constantinou, professor of civil, structural and environmental engineering at the State University of New York at Buffalo.

"Elastomeric systems perform best in large buildings, which have large axial loads," explains Wray. "Sliding systems perform well for both large and small axial loads (large and small buildings). The behavior of sliding systems under high-frequency vertical acceleration continues to be studied."

Deformation in a building during a large earthquake is inevitable. "Using conventional lateral force resisting systems, the deformation is distributed up the height of the building among many beams, columns, connections, braces, or shear walls," comments Wray. In comparison, "using base isolation, (nearly) all of the building deformation is concentrated at the isolation plane, limiting damage up the height of the building. The magnitude of the displacement can be predicted

with more certainty than the individual deformations among hundreds or thousands of individual components of a lateral system."

"Of all the seismic protection technologies presently available, seismic isolation offers the most effective protection against damage or loss of function following strong shaking," says Hamburger. "Other structural technologies allow transmission of the motion into the structure, where its energy is dissipated either through damage to the structural elements, or through more benign energy dissipation mechanisms. Regardless, structures employing these other technologies experience greater motion and as a result more damage than do isolated structures."

The evolution and spread of base isolation is influenced by many players. "Governments have played a role in funding research to develop these technologies, including National Science Foundation-funded centers such as the Pacific Earthquake Engineering Research center at UC Berkeley and the Multidisciplinary Center for Earthquake Engineering Research at the State University of New York at Buffalo," says Constantinou. "Insurance agencies (and owners) have not yet taken into consideration the reduced risk of damage for a seismically isolated structure. This may change following the work of the U.S. Resiliency Council on rating building performance."

The USRC membership includes all the major professional organizations in earthquake and structural engineering, structural engineering firms, architectural firms, contractors, and hardware and software suppliers. The USRC rating system rates buildings from one to five stars for each of three criteria: safety, damage and recovery. "While many lateral systems can provide high ratings for safety, base-isolated buildings provide the greatest opportunity to achieve high

ratings for damage and recovery," says Wray.

"The USRC will certify raters and review ratings after they are submitted, similar to the USGBC's LEED ratings for sustainability," says Ronald Mayes, USRC executive director and co-founder. "The rating is a different way of specifying what an owner's performance expectations are for a building. I think it will become a powerful tool." The rating system launched in December, 2015. One building has been rated so far, with 18 more in process, according to Mayes.

"The structural engineering community in the past has done a poor job of communicating what a code-designed building delivers, as attested by the performance of modern buildings in the 2011 Christchurch New Zealand earthquake, where more than 50% of the modern buildings in the central business district delivered life-safety performance but had to be demolished after the earthquake," adds Mayes.

"The Insurance industry has done little to encourage the use of seismic isolation, and it could be said that offering an earthquake mitigation alternative to developing earthquake-resistant structures, actually provides a disincentive," says Hamburger. "The primary insurance benefit the owner of a seismically isolated structure obtains is through an ability to purchase greatly reduced levels of protection. Some owners have chosen to use base isolation as their earthquake insurance of choice, as any damage that may occur is well below current deductibles. In addition, base isolation provides business continuity, something that is very difficult to cover with insurance."

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www.enr.com/articles/42366-the-10-largest-base-isolated-buildings-in-the-world

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