
**DAMPING DEVICES FOR EARTHQUAKE
PROTECTION OF RESIDENTIAL STRUCTURES**

Damped Sway Foundation System (DSFS)

by

Randolph Langenbach

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Damped Sway Foundation System

Background

Buildings exposed to earthquakes are subjected to lateral oscillations that impose lateral inertia forces. Those inertia forces in turn cause the building to deform laterally. If the lateral deformations in a building are very small, it may be that no damage will occur. Vertical oscillations occur also, but these typically do not cause much distress for most buildings. For buildings located in the vicinity of a major earthquake, the lateral deformations are usually large, and significant amounts of damage are common. For buildings that have little earthquake resistance, collapse or partial collapse is a threat, even for small buildings.

Objective

The objective of the Damped Sway Foundation System (DSFS) is to create an economical foundation system for small residential and commercial buildings that is capable of reducing the earthquake demand forces and deformations in the structure itself. The idea was conceived specifically for application to small residential buildings, but it is equally applicable for other types of occupancies.

Applicability

The DSFS is ideally suited for application to small free-standing buildings. The DSFS is specifically applicable to buildings of relatively light weight wood frame or steel frame construction. The DSFS is applicable for buildings as tall as three stories and possibly more, pending further research. There is no real limitation of the foot-print size of a building with DSFS, but, to allow room for the sway space, the building must be free standing with approximately 6 inches to 12 inches (15 mm to 30 mm) of clearance from adjacent structures.

Method

Seismic isolation was originally conceived as a means of laterally disconnecting a building from the ground. Indeed, if a building is resting on a frictionless surface, it will not realize any lateral force during an earthquake. However, if a building is resting on a frictionless surface, it would go sailing down the street on a windy day. As a practical matter, therefore, the ideal foundation system for isolating earthquake motion must provide sufficient lateral resistance to handle lateral wind forces, as well as vertical gravity forces.

The DSFS includes steel elements that carry vertical gravity loads. The elements also provide the flexure to facilitate lateral isolation of the building. In addition, fluid viscous dampers are included in the DSFS to reduce lateral drift in the steel elements.

The development of the DSFS has involved substantially more than the mere installation of dampers with steel elements. The developers of this system have identified the soil, steel element, damper and building parameters that need to be considered in a DSFS design to facilitate tuning the system so that the system as a whole responds favorably in the event of earthquakes of varying intensities and shaking characteristics. Computer programs have been developed to establish the damper and steel elements characteristics required to achieve the desired tuned response of the system.

Fail safe sway limiting provisions are also included as part of the DSFS. In the unlikely event that the dampers are overwhelmed by particularly severe ground motion, the sway limiters will gently stop the building. The sway limiters also serve to satisfy any regulatory official's concern over the departure from the normal strength-based fixed-to-ground foundation design.

Functionality

The steel elements, which are easily deflected laterally, effectively isolate the building from lateral earthquake ground motion. This substantially reduces the lateral forces imparted to the building. Therefore the lateral deformation in the building, and damage, are reduced significantly. The dampers are a necessary and integral part of the system. They serve to reduce the lateral deformation in the steel elements while also reducing the lateral force imparted to the building. The use of dampers is the most effective way to reduce lateral deformation without increasing the forces in the building superstructure.

Economics

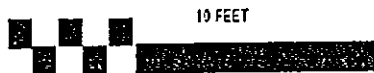
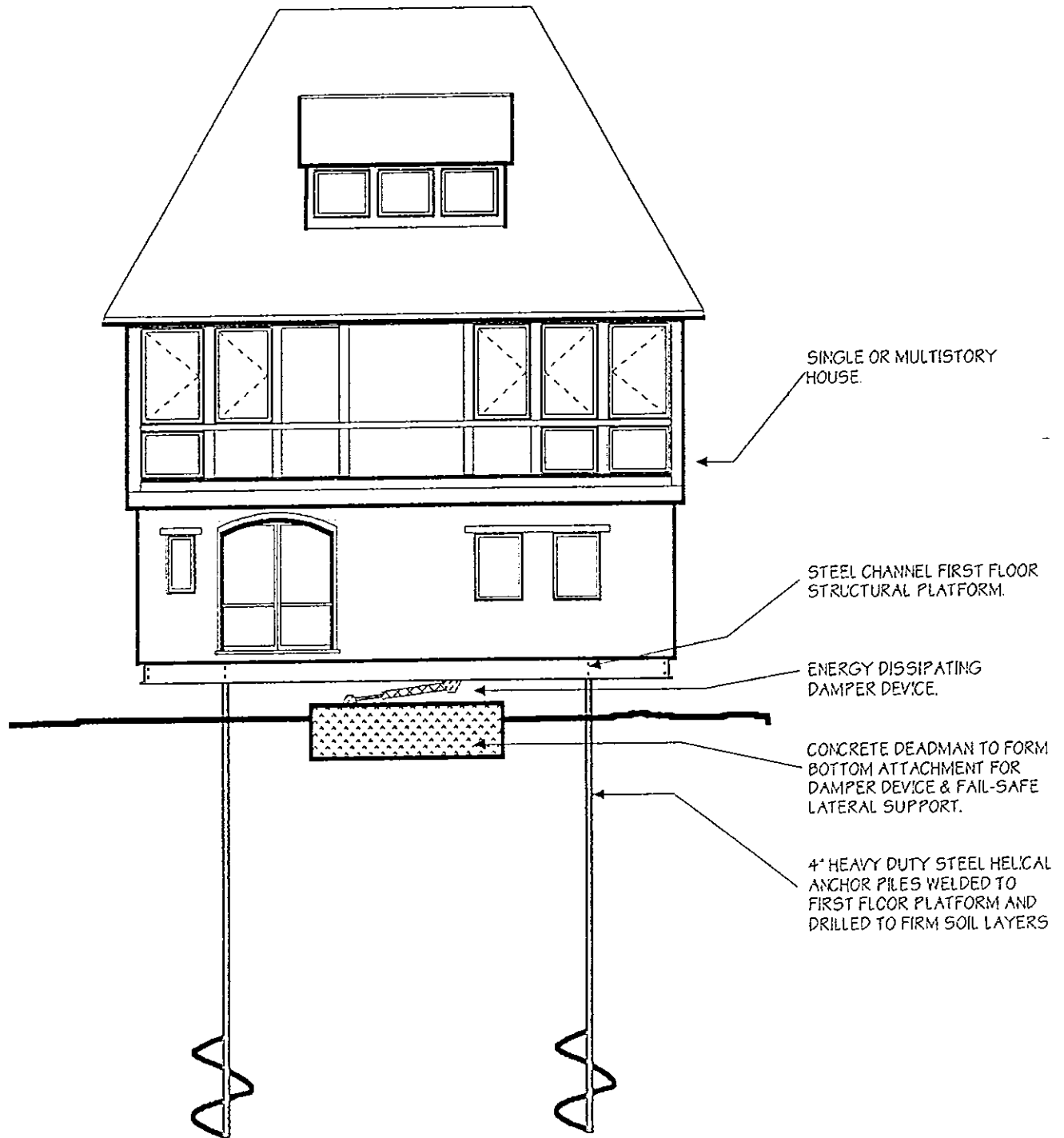
Bottom line cost is always important. Thus, although the greatest value of the DSFS is realized through life-cycle cost, initial construction cost was a main goal in this development.

Use of the system can produce considerable initial cost savings, especially for structures where site conditions would require a high cost pier and grade beam foundation. The DSFS requires very little disturbance of the ground. The structure rests on a platform which floats on the steel elements above the ground, with the dampers providing dynamic lateral restraint when an earthquake strikes. The dampers cost between \$8,000 and \$16,000. The cost of a pier and grade beam foundation system can easily be higher than this.

Life-cycle costs typically include initial cost, maintenance, and repair costs following earthquakes. Thus, life-cycle costs using the DSFS are reduced significantly because earthquake damage is reduced.

DAMPED SWAY FOUNDATION SYSTEM (DSFS)

A SEISMIC ENERGY DISSIPATING FOUNDATION SYSTEM FOR SMALL BUILDINGS



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LANGENBACH HOUSE, 7045 CHABOT ROAD, OAKLAND

REV	DATE
1	10/2/14
2	6/20/16
3	6/28/16

RANDOLPH LANGENBACH
 ARCHITECTS
 1500 17th Ave
 Oakland, CA 94612

Langenbach Residence
 7045 Chabot Rd.
 Oakland, Ca.

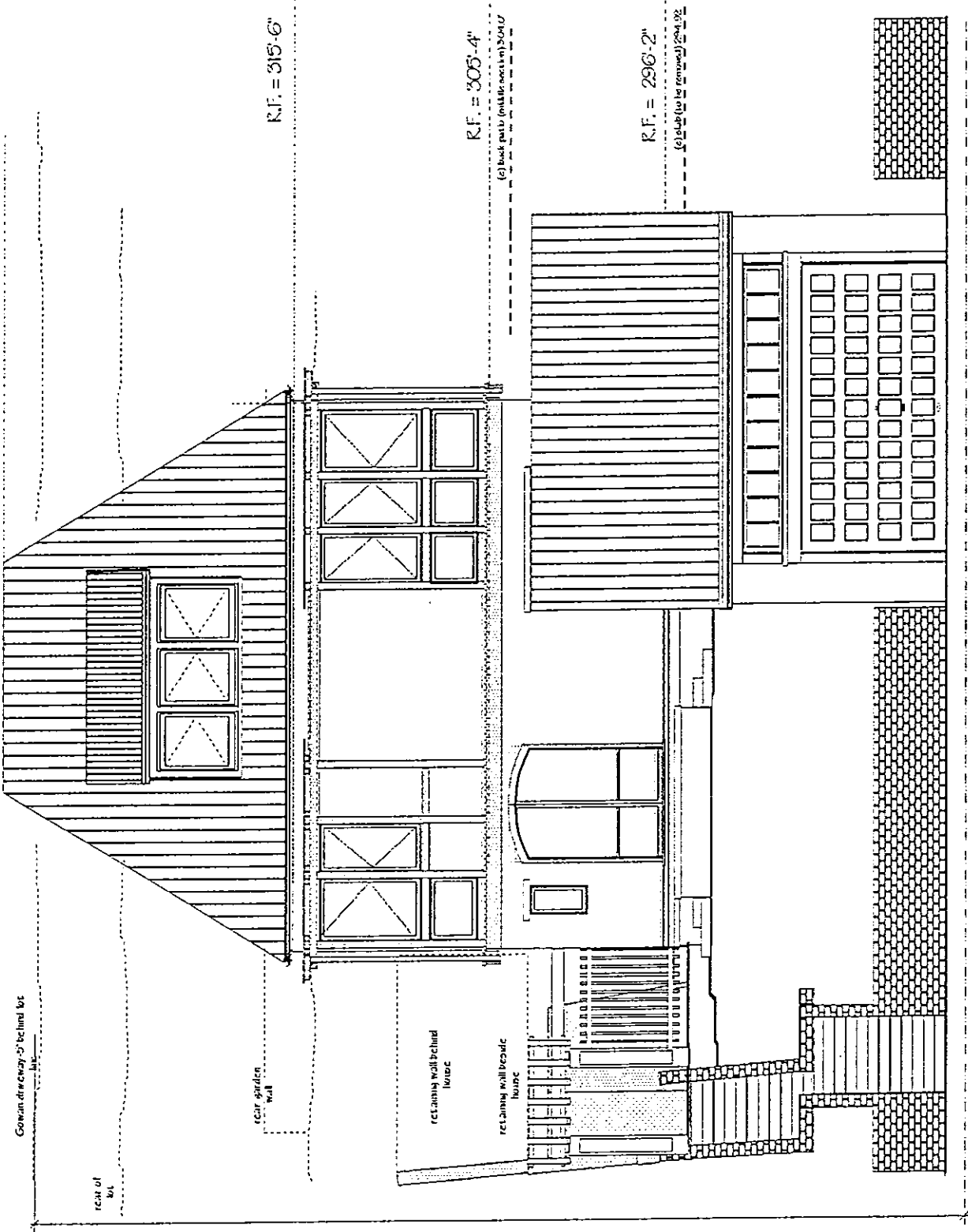
COVER
 DATE: 2/22/16
 DRAWN BY: [blank]
 CHECKED BY: [blank]

RIDGE = 330'-8"

R.F. = 315'-6"

R.F. = 305'-4"

R.F. = 296'-2"



SOUTH ELEVATION (FRONT)

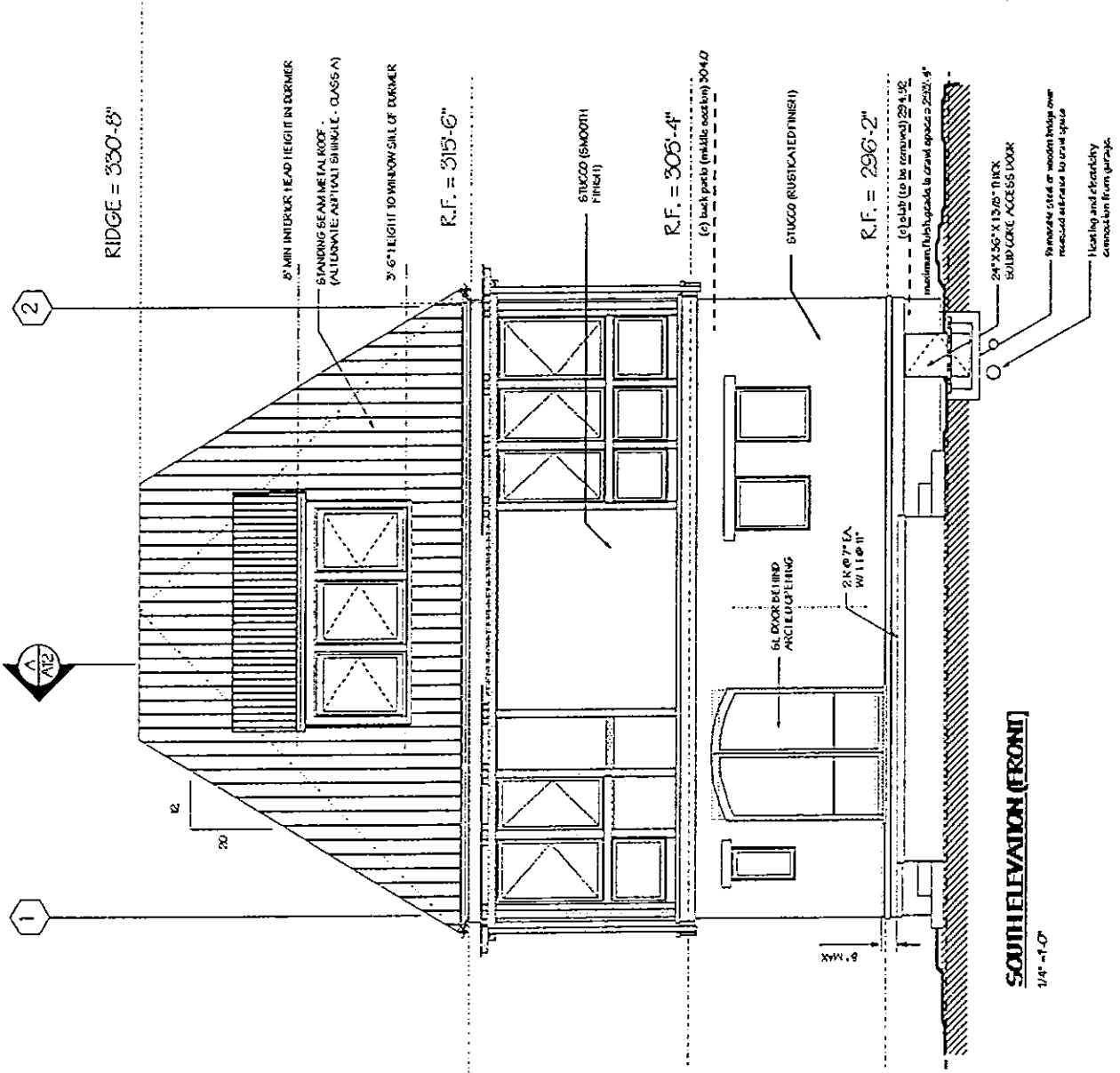
1/4" = 1'-0"

REV	DATE
1	4/22/14
2	6/27/15
3	6/10/16

GENE ST. ONGE
 & ASSOCIATES
 Engineering, Planning &
 Architecture
 Randolph
 Langenbach
 844 Fremont Ave.
 Oakland, CA 94612

Langenbach Residence
 7045 Chabot Rd.
 Oakland, Ca.

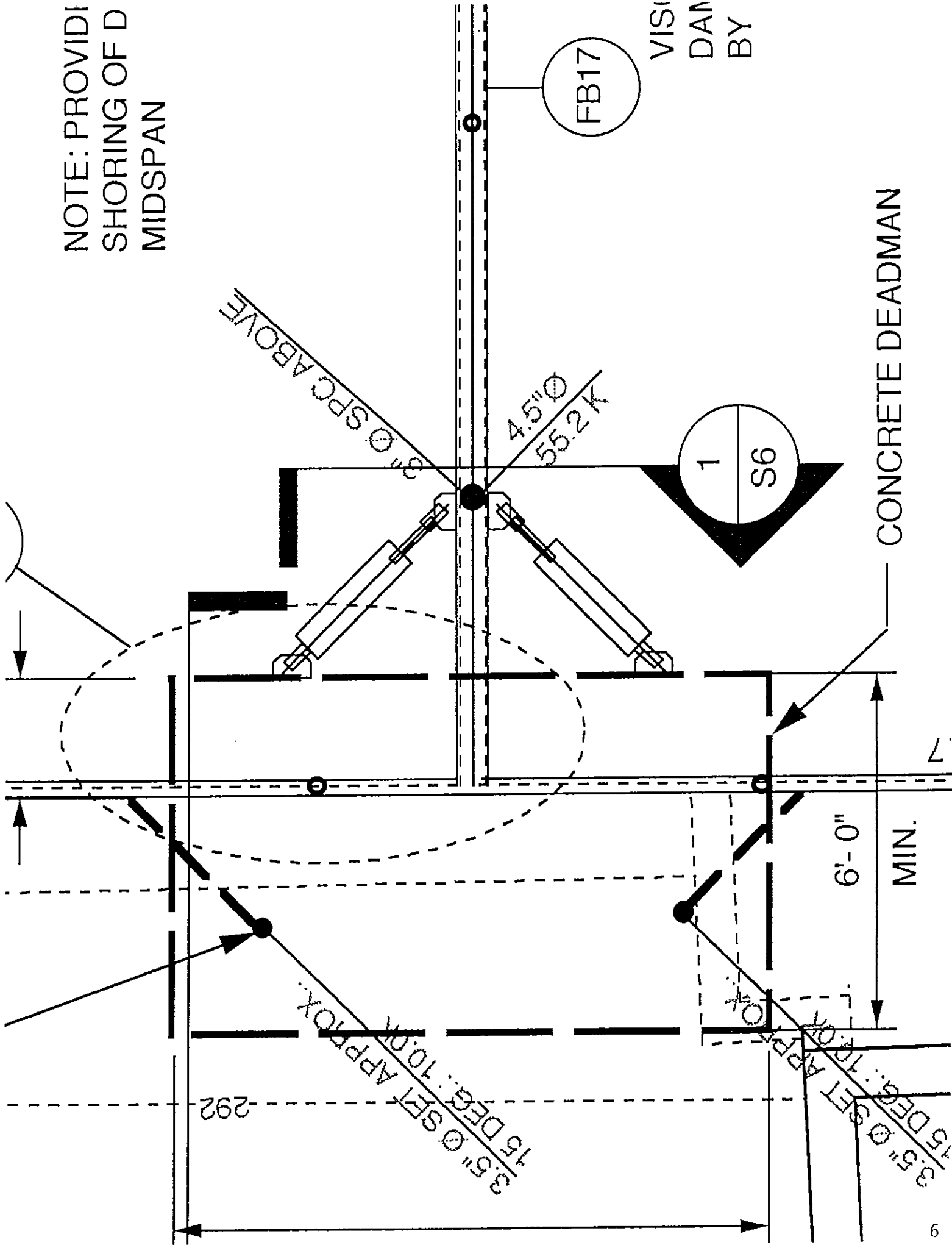
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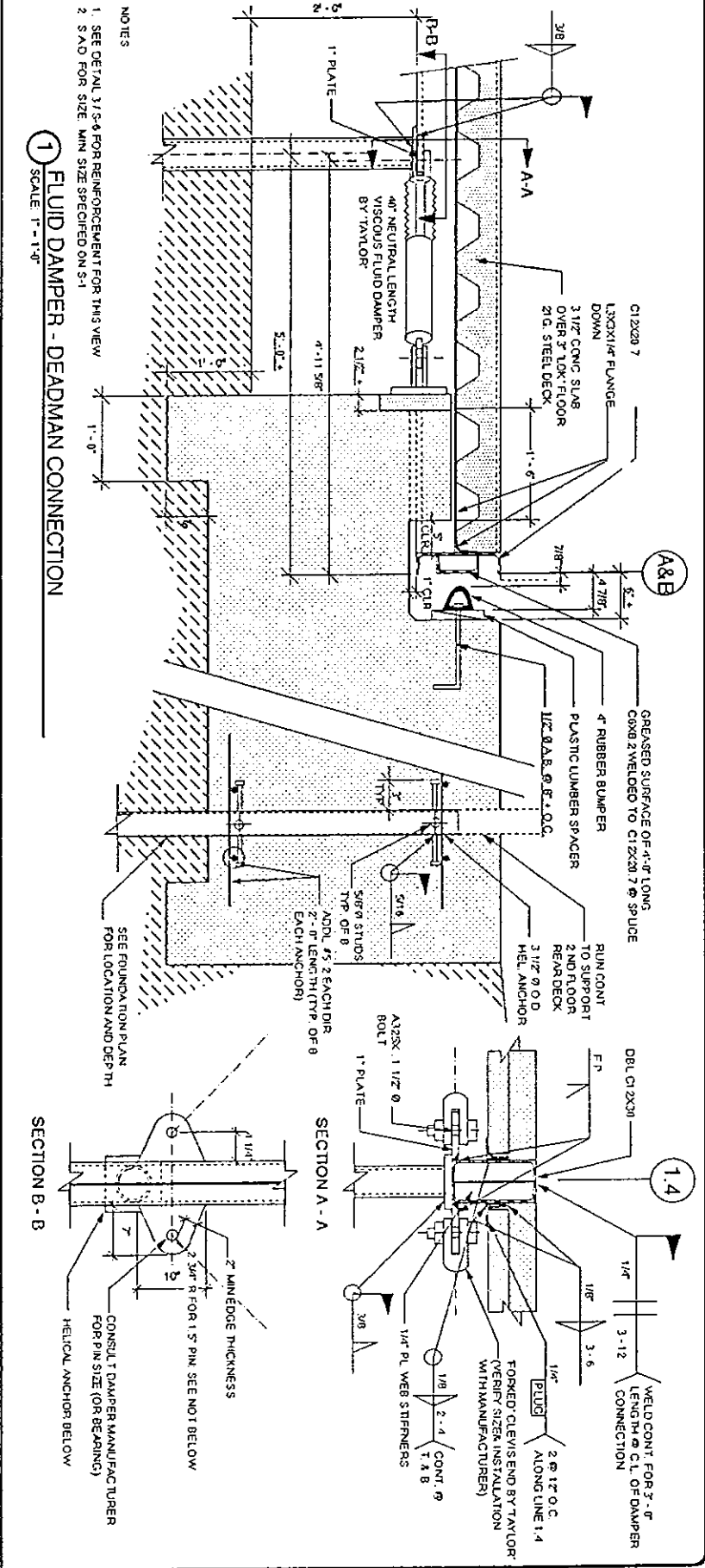


SOUTH ELEVATION (FRONT)
 1/4" = 1'-0"

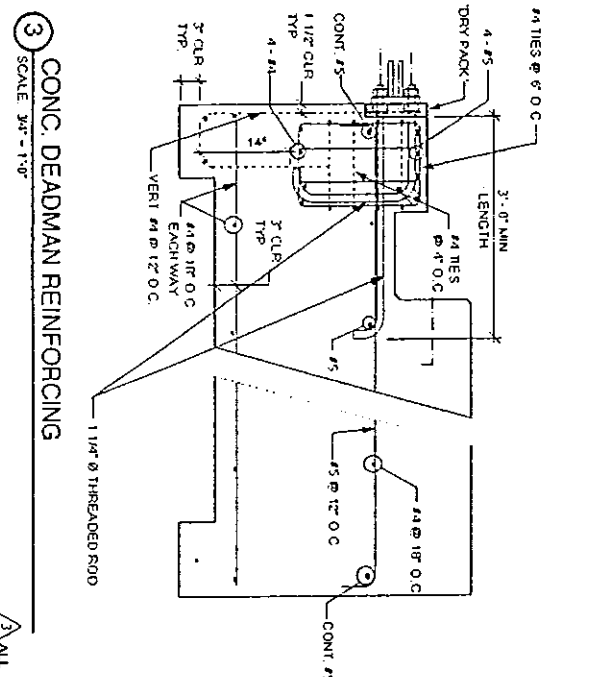
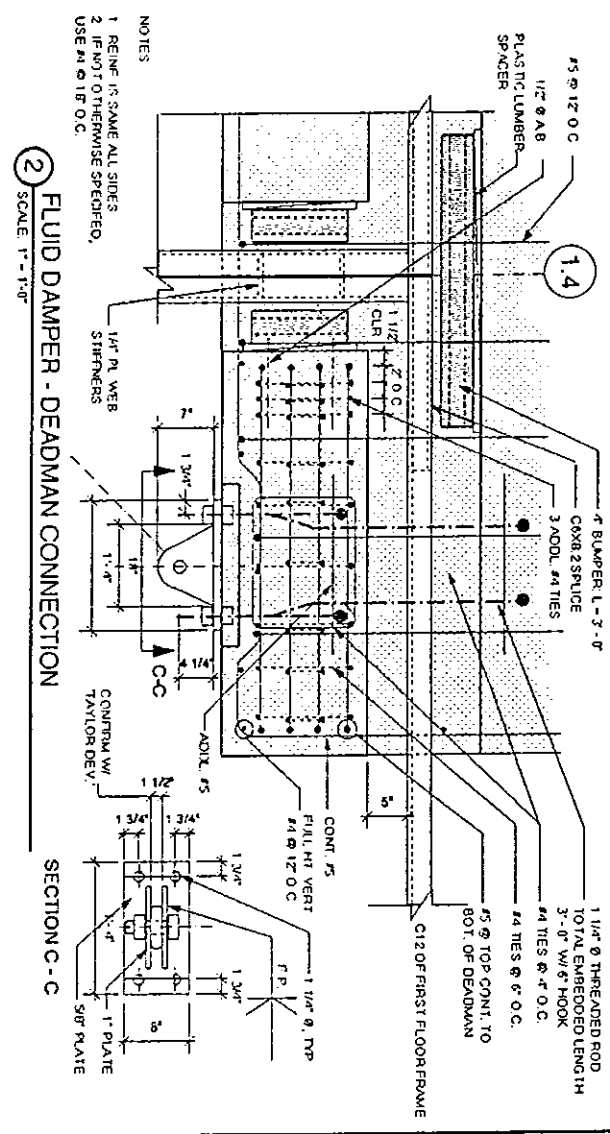
NOTE: The grade elevation under the hood can be adjusted +/- 1' for economy of cost and fill. All floor levels should be adjusted accordingly.

NOTE: PROVIDE SHORING OF DEADMAN MIDSPAN





REV	DATE
3	06-25-95 by CC



REV	DATE
3	06-25-95 by CC

- NOTES
1. REINFC IS SAME ALL SIDES
 2. IF NOT OTHERWISE SPECIFIED, USE #1 @ 18\"/>

1. SEE DETAIL 3154 FOR REINFORCEMENT FOR THIS VIEW

2. S.A.D FOR SIZE, MIN SIZE SPECIFIED ON S-1

1.1/4\"/>

1.1/4\"/>

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Langenbach Residence

7045 Chabot Rd.
Oakland, CA

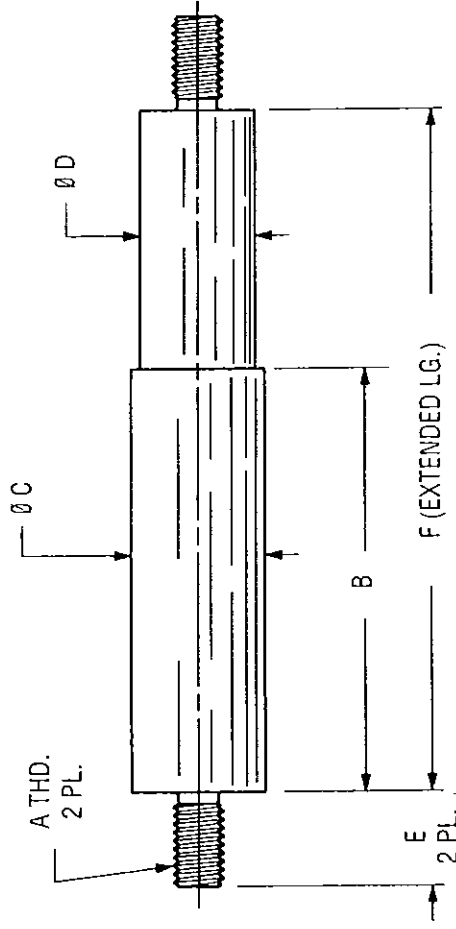
ENGINEER
GENE ST. ONGE & ASSOCIATES
Engineering, Planning & Design
1934 Park Blvd.
Oakland, CA 94606

OWNER'S REP
Randolph Langenbach
8448 Harwood Ave.
Oakland, CA 94618

S-6
d 9 sheets

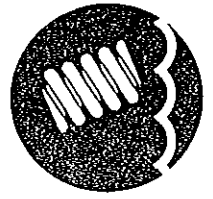
Linear Fluid Viscous Seismic Dampers

- Three compact sizes fit most building and bridge structures
- Linear damping coefficient to customer specifications
- Stainless Steel construction
- Non-flammable inert silicone damping fluid
- Zero-maintenance construction



Engineering Data

Model	Max. Force lbs.	Stroke in.	Weight lbs.	A Thread in.	B in.	C in.	D in.	E in.	F in.
3x4	10 KIP	4	20	1"-8 UNC	11.9	3.0	2.5	2.0	17.5
4x5	20 KIP	5	40	1½"-8 UN	12.7	4.0	3.4	2.5	20.5
5x5	30 KIP	5	90	1¾"-8 UN	14.1	5.0	4.4	3.0	22.5

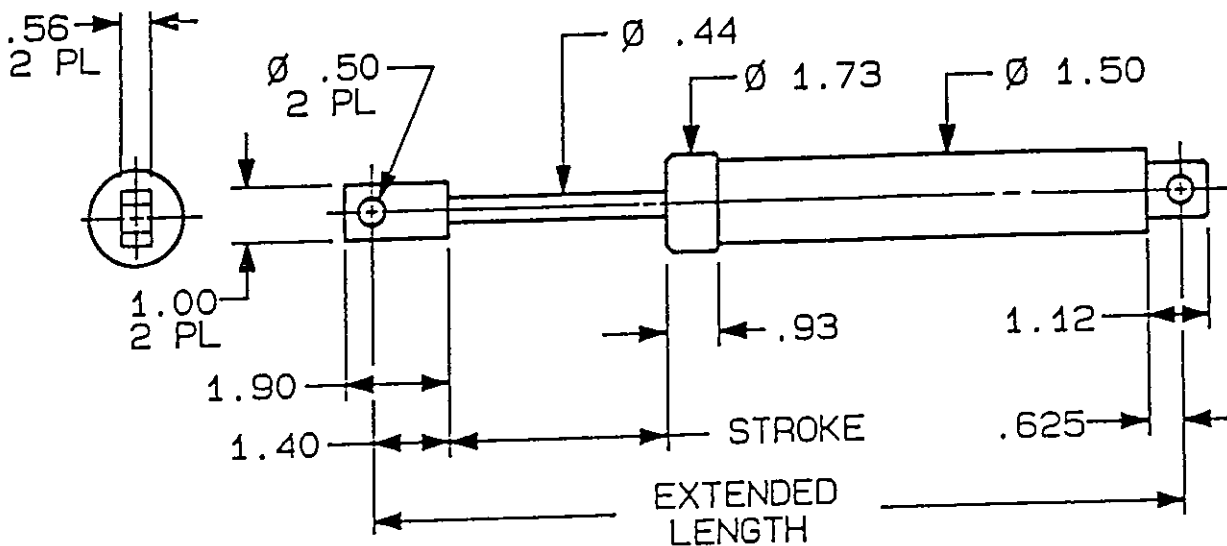


taylor devices inc.

90 Taylor Drive P.O. Box 748 • North Tonawanda, NY 14120-0748 • Phone: 716-694-0800 Fax: 716-695-6015
 Please call or fax us for additional information

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
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MODEL	STROKE (IN)	EXTENDED LG. (IN)	MAX DAMP. FORCE (LB)	MAX VEL. (IN/SEC)
1.5X2	2	9.71	2000	600
1.5X4	4	14.72	2000	600
1.5X6	6	19.76	2000	600
1.5X8	8	24.80	2000	600

CONTRACT NO.



taylor devices inc.
PHONE 694-0800 NORTH TONAWANDA, N.Y.

PREPARED	
ENGINEER	
CHECKER	
STRESS	
WEIGHTS	
MATERIAL	
MFG ENGR.	
ENGR. APVD.	
PRGM. ENGR.	
QUALITY	

1.5 D-SERIES LINEAR DAMPERS

SIZE	FSCM. NO.	DWG. NO.	REV.
A	06742		
SCALE		SHEET	

ENGINEERING SUPPLY COMPANY 503R10