

BENEFIT COST RESULTS

Building 678	US Navy	San Diego, CA
Facility Class: Precast Concrete Tilt-up w/ Flexible Diaphragm		
Project Description: Shear wall retrofit		

A. ECONOMIC PARAMETERS :

Discount Rate:	7	percent
Planning Period:	50	years
Present Value Coefficient:	13.80	

B. SUMMARY OF DAMAGES AND ECONOMIC LOSSES:

	Annual Expected	Annual Avoided	Annual Residual	Present Value of Damages Avoided
Building Damages	\$33,842	\$25,512	\$8,330	\$352,087
Contents Damages	\$8,156	\$6,145	\$2,011	\$84,803
Relocation Expenses	\$4,335	\$3,199	\$1,135	\$44,150
Rental Income Losses	\$0	\$0	\$0	\$0
Value of Lost Services	\$18,169	\$13,691	\$4,477	\$188,951
Total Damages and Losses	\$64,501	\$48,547	\$15,954	\$669,990

PRESENT VALUE OF TOTAL DAMAGES AND ECONOMIC LOSSES AVOIDED: \$669,990

TOTAL COSTS OF THE SEISMIC REHABILITATION PROJECT: \$3,796,000

TOTAL BENEFITS MINUS TOTAL COSTS WITHOUT THE
VALUE OF AVOIDED INJURIES & DEATHS: (\$3,126,010)

BENEFIT COST RATIO WITHOUT THE VALUE OF AVOIDED INJURIES & DEATHS: 0.18

C. VALUE OF INJURIES AND DEATHS:

Value of Avoiding a Minor Injury:	\$1,000
Value of Avoiding a Serious Injury:	\$10,000
Statistical Value of Life:	\$1,700,000

	Annual Expected Number	Annual Avoided Number	Annual Residual Number	Present Value of Damages Avoided
Minor Injuries	6.12E-03	5.51E-03	6.12E-04	\$76
Serious Injuries	8.16E-04	8.08E-04	8.16E-06	\$112
Deaths	2.04E-04	2.04E-04	2.04E-07	\$4,783
			Total Value	\$4,971

PRESENT VALUE OF TOTAL DAMAGES, ECONOMIC LOSSES, DEATHS AND
INJURIES AVOIDED: \$674,961

TOTAL BENEFITS MINUS TOTAL COSTS WITH THE
VALUE OF AVOIDED INJURIES & DEATHS: (\$3,121,039)

BENEFIT COST RATIO WITH THE VALUE OF AVOIDED INJURIES & DEATHS: 0.18

SUMMARY		Run Identification: Final					
Building 678	US Navy	San Diego, CA					
Rehab Project Description:	Shear wall retrofit						
Facility Class:	Precast Concrete Tilt-up w/ Flexible Diaphragm						
Data used for this analysis:							
Building Replacement Value per square foot	\$100.00						
Total Floor Area (square feet):	64,500						
Total Building Replacement Value	\$6,450,000						
Demolition Threshold Damage Percentage:	50%						
Total Contents Value	\$1,612,500						
Cost of Providing Services per day	\$12,579						
Continuity Premium	\$25,000						
Value of lost services per day	\$37,579						
Total Private Monthly Rental Revenue	\$0						
Total Relocation Costs (\$/sq.ft./month):	\$2.00						
Total Seismic Rehabilitation Costs	\$3,796,000						
Average Day Occupancy	130						
Average Night Occupancy	5						
Soil Type	S3						
Data used in this analysis that varies by MMI:							
MMI	VI	VII	VIII	IX	X	XI	XII
PGA (%g)	4-8	8-16	16-32	32-55	55-80	80-100	>100
Mean Damage Function (%)	1	5	11	19	30	47	64
Modified MDF (%)	1	5	11	19	30	47	100
Minor Injury Rate/1000	3.000E-02	3.000E-01	1.380E+00	2.820E+00	1.380E+01	4.543E+01	1.766E+02
Major Injury Rate/1000	4.000E-03	4.000E-02	1.840E-01	3.760E-01	1.840E+00	6.057E+00	2.354E+01
Death Rate/1000	1.000E-03	1.000E-02	4.600E-02	9.400E-02	4.600E-01	1.514E+00	5.886E+00
Content MDF (%)	1	5	11	19	30	47	64
Functional Downtime (days)	1	5	11	19	30	30	30
Days of Relocation Necessary:	0	0	34	99	190	324	366
Building Rehab Effectiveness (%)	72	79	77	72	68	68	77
Contents Rehab Effectiveness (%)	72	79	77	72	68	68	77
Rehab Minor Injury Rate/1000	3.000E-03	3.000E-02	1.380E-01	2.820E-01	1.380E+00	4.543E+00	1.766E+01
Rehab Major Injury Rate/1000	4.000E-05	4.000E-04	1.840E-03	3.760E-03	1.840E-02	6.057E-02	2.354E-01
Rehab Death Rate/1000	1.000E-06	1.000E-05	4.600E-05	9.400E-05	4.600E-04	1.514E-03	5.886E-03
Annual Number of Earthquakes	9.453E-02	3.039E-02	1.039E-02	2.600E-03	6.490E-04	2.345E-04	5.319E-04
SUMMARY OF DAMAGES AND ECONOMIC LOSSES:						Without Value of Life	With Value of Life
PRESENT VALUE OF TOTAL DAMAGES AND ECONOMIC LOSSES AVOIDED:						\$669,990	\$674,961
TOTAL BENEFITS MINUS TOTAL COSTS :						(\$3,126,010)	(\$3,121,039)
Benefit cost ratio :						0.18	0.18

Analyst: Goether & Horner Inc

**Building 8, U.S. Coast Guard Support Station,
427 Commercial Street, Boston, MA**

Function	<p>This 196,000 square foot building is used primarily as storage/warehouse space, but also provides detention facilities, medical/dental offices, the CGES retail exchange, Group Boston and First Coast Guard District armories. On average, 50 persons are employed and/or reside in the building.</p>
Structure	<p>This building was constructed in approximately 1910, with 7 stories above grade, 1 story below. The building dimensions are 187'x131, and story height varies from 11' to 13'. Total height is 93'.</p> <p>Diaphragms are cast-in-place concrete. There is a masonry exterior, unreinforced masonry bearing walls and pile foundations. The longitudinal and transverse lateral systems are shear walls.</p>
Seismic Evaluation	<p>This building was considered seismically vulnerable because of inadequate wall-diaphragm ties, numerous wall openings, and unbraced parapets. This building is constructed on S3 soil.</p>
Seismic Rehabilitation	<p>The rehabilitation project infilled wall openings, strengthened diaphragms by tying to walls, installed new roof diaphragms, and braced parapets. Rehabilitation is expected to provide great improvement at the lower magnitude intensities.</p> <p>In 1983, the structural cost of rehabilitation was estimated at \$325,000; total renovation costs, including complete interior renovation, were estimated at \$2.25 million. For the purposes of benefit-cost analysis, \$1.25 million was attributed to seismic work. In addition, relocation costs of \$3.5 million brought the total cost to approximately \$4.8 million.</p>

BENEFIT-COST ANALYSIS OF EIGHT FEDERAL BUILDINGS

Building Mean Damage Functions

The mean damage functions for Building 8, before and after rehabilitation, are shown below. The damage functions were estimated by Larry Reaveley, using ATC-36 data as guidelines. The existing building was characterized as "standard" which means a building with typical seismic performance for this building type. For the rehabilitated building, the building was characterized as "special", which means a building specifically designed to resist seismic forces.

BUILDING MEAN DAMAGE FUNCTIONS

Effective PGA		4-8	8-16	16-32	32-55	55-80	80-100	>100
MMI		VI	VII	VIII	IX	X	XI	XII
Original Building		2.7	9.0	22.6	39.5	64.7	77.1	89.4
With Rehabilitation		1.8	2.7	9.0	22.6	39.5	64.7	77.1

Benefit-Cost Results

The Benefit-Cost ratios for this project are 0.57 without and with the value of life. The number of avoided casualties is so small that it does not significantly affect the Benefit-Cost results.

Given the moderate seismicity of this location, it is somewhat surprising that the Benefit-Cost ratio is as high as 0.57. The reasons for this include the vulnerability of the existing building, and the fact that the rehabilitation project is moderate in cost (33% of the building replacement value).

BENEFIT COST RESULTS

Building #	US Coast Guard	Boston, MA
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Facility Class:	Unreinforced Masonry Bearing Wall
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Project Description:	Infill openings, tie diaphragms to walls, brace parapets, new roof dia
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A. ECONOMIC PARAMETERS :

Discount Rate:	7	percent
Planning Period:	50	years
Present Value Coefficient:	13.80	

B. SUMMARY OF DAMAGES AND ECONOMIC LOSSES:

	Annual Expected	Annual Avoided	Annual Residual	Present Value of Damages Avoided
Building Damages	\$129,696	\$102,883	\$26,813	\$1,419,862
Contents Damages	\$90,164	\$71,889	\$18,276	\$992,121
Relocation Expenses	\$30,456	\$16,660	\$13,796	\$229,917
Rental Income Losses	\$0	\$0	\$0	\$0
Value of Lost Services	\$6,481	\$5,288	\$1,193	\$72,980
Total Damages and Losses	\$256,798	\$196,720	\$60,078	\$2,714,880

PRESENT VALUE OF TOTAL DAMAGES AND ECONOMIC LOSSES AVOIDED:	\$2,714,880
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TOTAL COSTS OF THE SEISMIC REHABILITATION PROJECT:	\$4,778,000
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TOTAL BENEFITS MINUS TOTAL COSTS WITHOUT THE VALUE OF AVOIDED INJURIES & DEATHS:	(\$2,063,120)
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BENEFIT COST RATIO WITHOUT THE VALUE OF AVOIDED INJURIES & DEATHS:	0.57
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C. VALUE OF INJURIES AND DEATHS:

Value of Avoiding a Minor Injury:	\$1,000
Value of Avoiding a Serious Injury:	\$10,000
Statistical Value of Life:	\$1,700,000

	Annual Expected Number	Annual Avoided Number	Annual Residual Number	Present Value of Damages Avoided
Minor Injuries	1.96E-02	1.77E-02	1.96E-03	\$244
Serious Injuries	3.58E-03	3.55E-03	3.58E-05	\$490
Deaths	1.18E-03	1.17E-03	1.18E-06	\$27,561
Total Value				\$28,294

PRESENT VALUE OF TOTAL DAMAGES, ECONOMIC LOSSES, DEATHS AND INJURIES AVOIDED:	\$2,743,174
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TOTAL BENEFITS MINUS TOTAL COSTS WITH THE VALUE OF AVOIDED INJURIES & DEATHS:	(\$2,034,826)
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BENEFIT COST RATIO WITH THE VALUE OF AVOIDED INJURIES & DEATHS:	0.57
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SUMMARY		Run Identification: Final					
Building 8	US Coast Guard	Boston, MA					
Rehab Project Description:	infill openings, tie diaphragms to walls, brace parapets, new roof diaphragm						
Facility Class:	Unreinforced Masonry Bearing Wall						
Data used for this analysis:							
Building Replacement Value per square foot			\$75.00				
Total Floor Area (square feet):			196,000				
Total Building Replacement Value			\$14,700,000				
Demolition Threshold Damage Percentage:			50%				
Total Contents Value			\$10,407,600				
Cost of Providing Services per day			\$7,888				
Continuity Premium			\$0				
Value of lost services per day			\$7,888				
Total Private Monthly Rental Revenue			\$0				
Total Relocation Costs (\$/sq.ft./month):			\$2.00				
Total Seismic Rehabilitation Costs			\$4,778,000				
Average Day Occupancy			200				
Average Night Occupancy			10				
Soil Type			S3				
Data used in this analysis that varies by MMI:							
MMI	VI	VII	VIII	IX	X	XI	XII
PGA (%g)	4-8	8-16	16-32	32-55	55-80	80-100	>100
Mean Damage Function (%)	9	23	40	65	77	89	100
Modified MDF (%)	9	23	40	100	100	100	100
Minor Injury Rate/1000	1.020E+00	6.240E+00	2.460E+01	1.843E+02	2.769E+02	3.450E+02	4.000E+02
Major Injury Rate/1000	1.360E-01	8.320E-01	3.280E+00	2.457E+01	3.691E+01	2.020E+02	4.000E+02
Death Rate/1000	3.400E-02	2.080E-01	8.200E-01	6.143E+00	9.229E+00	9.550E+01	2.000E+02
Content MDF (%)	9	23	40	65	77	89	100
Functional Downtime (days)	9	23	30	30	30	30	30
Days of Relocation Necessary:	0	131	266	365	365	365	365
Building Rehab Effectiveness (%)	100	60	43	60	35	23	11
Contents Rehab Effectiveness (%)	100	60	43	60	35	23	11
Rehab Minor Injury Rate/1000	1.020E-01	6.240E-01	2.460E+00	1.843E+01	2.769E+01	3.450E+01	4.000E+01
Rehab Major Injury Rate/1000	1.360E-03	8.320E-03	3.280E-02	2.457E-01	3.691E-01	2.020E+00	4.000E+00
Rehab Death Rate/1000	3.400E-05	2.080E-04	8.200E-04	6.143E-03	9.229E-03	9.550E-02	2.000E-01
Annual Number of Earthquakes	5.315E-02	1.125E-02	2.495E-03	4.000E-04	7.180E-05	2.148E-05	3.313E-05
SUMMARY OF DAMAGES AND ECONOMIC LOSSES:						Without Value of Life	With Value of Life
PRESENT VALUE OF TOTAL DAMAGES AND ECONOMIC LOSSES AVOIDED:						\$2,714,880	\$2,743,174
TOTAL BENEFITS MINUS TOTAL COSTS :						(\$2,063,120)	(\$2,034,826)
Benefit cost ratio :						0.57	0.57

Analysis: Goetter & Homer Inc.