seismic safety element

SEISMIC SAFETY ELEMENT

INTRODUCTION:

Southern California geologic and seismic history has been one of long and continued activity. The proximity of known major faults and the experience of many residents within the recent past verify this fact. Two major events within the Los Angeles Basin have called attention to the potential destruction that earthquakes can unleash. The first, the Long Beach earthquake, occurred in 1933. Reaction to it brought about an incorporation of seismic design standards into the building code for the first time. In 1971, the San Fernando earthquake caused appreciable damage within major portions of the Los Angeles Metropolitan area.

The experience of these two major events has produced a high level of seismic hazard awareness on the part of both citizens and public officials of the likelihood of future occurrences. Both major earthquakes have also underscored the need for effective planning to mitigate against the effects of seismic occurrences.

It is apparent that seismic activity brings a potential for loss of life, damage to property, and economic and social disruption. Yet the task of identifying this potential is complicated by the fact that earthquakes and their resultant effects are unpredictable and infrequent. Because existing and expanded development in Montebello will be exposed to potential seismic hazards, it will be necessary to identify, delineate, and evaluate these hazards within the limits of present technology. A policy and implementation program can then be effected.

To gain the necessary technical background data required to formulate a Seismic Safety Element, the City of Montebello contracted with the Envicom Corporation to prepare a Technical Report. The scope of this report includes the identification and analysis of seismic hazards within Montebello. While the Technical Report augments the Seismic Safety Element, it is drawn upon freely for specific information as contained in the element.

Adopted MCC May 27, 1975

PURPOSE:

To comply with California State Law Government Code Section 65302(f) as follows:

> "A seismic safety element consisting of an identification and appraisal of seismic hazards such as susceptibility to surface ruptures from faulting, to ground shaking, to ground failures, or to the effects of seismically induced waves such as tsunamis and seiches.

The seismic safety element shall also include an appraisal of mudslides, landslides, and slope stability as necessary geologic hazards that must be considered simultaneously with other hazards such as possible surface ruptures from faulting, ground shaking, ground failure, and seismically induced waves."

DEFINITIONS:

Alluvium:

A general term for all sediment such as sand and gravel deposited in river beds, flood plains, lakes, and fans at the foot of mountain slopes and estuaries.

Earthquake:

Perceptible trembling to violent shaking of the ground produced by sudden displacement of rocks below and at the earth's surface.

Fault:

A fracture or fracture zone along which there has been movement (slippage) of the two sides relative to one another and parallel to the fracture.

Active Fault:

A fault that has moved in recent geologic time and which is likely to move again the relatively near future. For planning purposes, this period extends back on the order of 10,000 years and forward 100 years or more.

Inactive Fault:

A fault which shows no evidence of movement in recent geologic time and no evidence of potential movement in the relatively near future.

Ground Failure:

A situation in which the ground does not hold together. Examples are landsliding, mudslides, and liquefaction.

Intensity:

A qualitative measure of an earthquake's destructiveness, based on observed damage or effects. (See Modified Mercalli scale Chart 1.)

Landsliding:

The perceptible downward sliding or falling of a relatively dry mass of earth, rock, or mixture of the two.

Liquefaction:

A sudden decrease of shearing resistance of a non-cohesive soil caused by collapse of the soil structure associated with sudden but temporary increase of water pressure in the soil voids; more generally, a "quicksand" condition results from an upward flow of water through sand.

Magnitude:

A quantitative measure of the total energy release of an earthquake based on a logarithmic scale. (See Richter scale Chart 1.)

Seiches/Tsunamis:

Earthquake-generated water waves; seiches occurring in enclosed or restricted bodies of water, the tsunamis occurring on the high seas. Neither hazard significant in Montebello.

Seismic Risk:

The degree of probability of earthquake impacts, including injury and loss of life, property damage, social and economic disruptions, as estimated from the history and records of past earthquakes. The varying degrees of seismic risk are illustrated in Figure 1. A further discussion is provided under "CONSTRAINTS."

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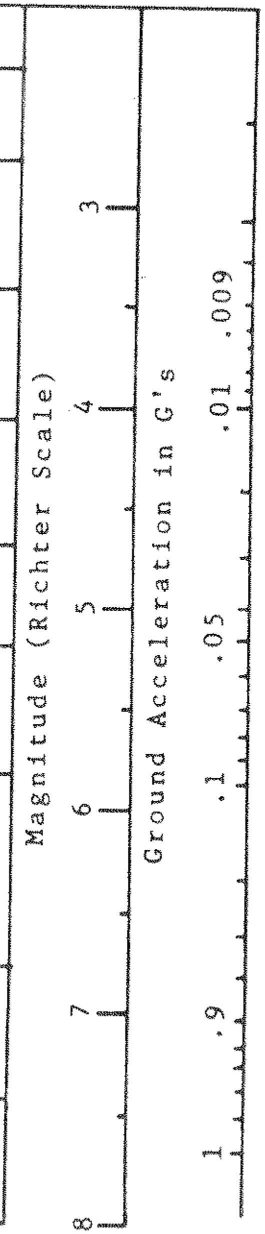
TECHNICAL BACKGROUND:

Because the basis for the Seismic Element rests upon a large amount of technical information, an explanation of both the general effects of earthquakes and certain specific facts of Montebello's geology will be necessary. Only selected information is provided here in

Chart 1

MODIFIED MERCALLI INTENSITY SCALE SHOWING APPROXIMATE RELATIONSHIP WITH GROUND ACCELERATION AND MAGNITUDE (RICHTER) OF SHALLOW LOCAL EARTHQUAKES.

I	Not felt except by very few under especially favorable conditions.
II	Felt only by a few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III	Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibration like passing of truck. Duration estimated.
IV	During the day, felt indoors by many; outdoors by few. At night some awakened. Dishes, windows, doors disturbed; wells make creaking sound. Sensation like heavy truck striking building. Standing motor cars rock noticeably.
V	Felt by nearly everyone; many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster, unstable objects overturned. Disturbance of trees, poles and other tall objects sometimes noticed. Pendulum clocks may stop.
VI	Felt by all; many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight.
VII	Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken; noticed by persons driving motor cars.
VIII	Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motor cars disturbed.
IX	Damage considerable in specially designed structures; well designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken.
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations, ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks.



SOURCE: *Planning Department, San Bernardino County, Informational Paper on the Proposed San Bernardino County Seismic and Safety Element, 1974.*

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SEISMIC SAFETY ELEMENT

DEGREES OF SEISMIC RISK

INCREASING RISK OF DAMAGE

INCREASING EARTHQUAKE MAGNITUDE

	Damage substantially beyond control. Accepted risk of living in a seismically active area.
Level of Risk is Beyond Feasible Mitigation	Damage could be controlled, but will not be for all but the most critical structures. The costs (economic/social/political) exceed the benefits derived from control measures (e.g., abatement of all pre-1933 structures in the city is not considered feasible).
Level of Risk can be Mitigated	It is economically/socially/politically feasible to minimize this level of hazards. All new structures will be constructed to specified standards. Selected existing structures will be rehabilitated to minimize risk of hazard and damage. Hospital and school construction standards, public information programs, and development review are examples of mitigating measures.
Level of Risk is Negligible	Damage, if any, is not of sufficient significance to warrant concern by government.

Figure 1

Adopted MCC May 27, 1975

order to give a general picture of the geology and seismic hazards for Montebello. For a more complete but technical treatment, reference is given to the Technical Report for the Seismic Safety Element, prepared by Envicom Corporation, 1975.

The most widespread effect of an earthquake is ground shaking. This is usually, but not always, the greatest cause of damage. This effect poses the primary seismic risk in Montebello from a major earthquake on either the Newport-Inglewood, Sierra Madre, or the Whittier faults. A great earthquake of nearly 8.0 magnitude on the San Andreas fault would also result in strong ground shaking. (Compare the Modified Mercalli, a qualitative scale, to the Richter, a quantitative scale on Chart 1, and the expected effects of major faults on Montebello on Chart 2.)

Another effect of earthquakes is ground failure. This category includes such hazards as differential settlement and liquefaction, natural landslides, rock falls, and subsidence. Each of these are considered limited hazards in Montebello.

Ground displacement, which is the surface rupture along faults, is not considered a significant hazard because no active or potentially active faults are known to be present within the limits of the City of Montebello.

Within the City of Montebello four geologic/seismic zones were identified and then delineated such that the effects of earthquakes of different magnitudes in each zone might be analyzed. These zones are based primarily on variations in subsurface characteristics and are characterized on Figure 2, as follows:

Zone 1 - Thick alluvium (200-800 feet) underlain by sedimentary rocks.

Zone 2 - Thick alluvium as in Zone 1, including the Gaspur Aquifer.

Zone 3 - Thin alluvium (0-200 feet) underlain by sedimentary rocks.

Zone 4 - Pico Formation of San Pedro Formation rocks exposed at the surface.

The major part of Montebello is underlain by alluvial deposits. With respect to ground shaking, the most significant variation results from the presence of the Gaspur Aquifer (Zone 2). Although this zone is limited in Montebello to a narrow strip along the present course of the Rio Hondo in the eastern part of the city, there is potential hazard here for liquefaction.

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Chart 2

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MAJOR FAULTS IN THE MONTEBELLO AREA
AND THEIR EXPECTED EFFECT ON THE CITY

	Fault	Miles From Montebello (North-South)	Expected Richter Magnitude	Approximate Probability of Occurrence (100-Year Period)
1.	Whittier	6	6.0	Low to Very Low
2.	Newport-Inglewood	9.5 - 14	6.5	Intermediate
3.	Sierra Madre	10 - 14.5	6.5	Intermediate
4.	San Andreas	33	8.5	Probable

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SOURCE: *Envicom Corporation, City of Montebello Technical Report for the Seismic Safety Element, April 1975.*

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FIGURE 2

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The northern part of the alluvial area, designated as Zone 3, thins onto the "bedrock" (Zone 4) of the Montebello hills. Here, in Zone 3, conditions are present that tend to amplify shaking frequencies that will affect low-rise to medium-rise structures. Within Zone 4, the question of slope stability was encountered and an appraisal of slope stability was made by Envicom. The results indicate that under the present "semi-natural" condition, the slopes are fairly stable. However, a modification of the terrain, such as during grading for a development, could create unstable conditions unless appropriate engineering geologic practices are incorporated.

Each of the characteristics of the four zones were projected by computer for a series of expected earthquakes to obtain their responses in terms of shaking and acceleration of the ground or the structure on which it is mounted. The results were tabulated in Chart 3. It is evident that each zone experiences different effects by virtue of their differing physical characteristics and because of this, each zone consequently experiences differing degrees of hazard.

To complete the analysis of earthquake hazards, an evaluation of the probability of earthquake occurrence and magnitude is necessary. Based upon the probability of an occurrence, as illustrated in Chart 2, a determination of the risk involved may be estimated. The risk of potential seismic hazard will be reflected in the policies set forth in this Seismic Element.

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GOALS:

1. Identify and appraise the geologic and seismic hazards within the community.

2. Reduce the loss of life, damage to property, and the economic and social dislocations resulting from future earthquakes.

OBJECTIVES:

1. To promote consideration of seismic standards and criteria for existing structural hazards.

2. To develop land use standards and development regulations related to the level of seismic hazards.

3. To establish a seismic hazards review procedure.

Chart 3

MONTEBELLO GENERAL PLAN PROGRAM

SEISMIC SAFETY ELEMENT

GENERALIZED CHARACTERISTICS OF EXPECTED EARTHQUAKES
BY ZONES WITHIN MONTEBELLO

Magnitude of Earthquakes

Zone	Newport/Inglewood or Sierra Madre Faults 5.2	5.6	6.5	San Andreas Fault 8.5
1	a = 0.05 T = 0.2 t = 4-6	a = 0.19 T = 0.2-0.4 t = 6-10	a = 0.30 T = 0.3-0.5 t = 15-20	a = 0.23 T = 0.3-0.5 t = 30-40
2	a = 0.5 T = 0.2 t = 4-6	a = 0.19 T = 0.3-0.5 t = 8-12	a = 0.30 T = 0.4-0.6 t = 20-25	a = 0.23 T = 0.4-0.6 t = 40-50
3.	a = 0.09 T = 0.3 t = 4-6	a = 0.30 T = 0.2 t = 6-10	a = 0.45 T = 0.2-0.4 t = 15-20	a = 0.33 T = 0.2-0.4 t = 30-40
4.	a = 0.03 T = 0.3 t = 3-4	a = 0.12 T = 0.3-0.4 t = 5-8	a = 0.13 T = 0.6-1.0 t = 10-15	a = 0.14 T = 0.4-0.7 t = 30-40

The Whittier Fault is not included because ground shaking from the earthquakes shown should equal that from the Whittier Fault.

a = maximum ground acceleration expressed as a decimal fraction of the acceleration of gravity.

T = predominant period of shaking in seconds.

t = duration of "strong" shaking in seconds.

SOURCE: *Envicom Corporation, City of Montebello Technical Report for the Seismic Safety Element, April 1975.*

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4. To assure consistency of all elements of the General Plan with the Seismic Safety Element.

5. To define and coordinate a disaster preparedness program in conjunction with other General Plan Elements.

6. To provide for a periodic review of the Seismic Safety Element to reflect new information or improved technology to reduce the hazard of seismic activity.

CONSTRAINTS:

The major constraint to be dealt with in the Seismic Safety Element concerns seismic risk. The degree of earthquake risk that the community is willing to accept is critical to the development of policy and implementation of the element. Because a perfectly hazard-free environment does not exist, certain types and degrees of risk are always present. The acceptability of this risk also varies and we find that citizens may be willing to accept relatively unregulated risks in the selection of their homes but not in selection and location of hospitals and public buildings. An example of structure use and the probability of occurrence of earthquakes of specific magnitudes is given in Chart 4. These magnitudes can provide standards for levels of acceptable risk that the community is willing to assign to different uses. Although these levels may provide a basis, other factors such as general geology, characteristics of the site, and structural specifications must also be considered.

The basic problem in the determination of seismic risk is that it cannot be quantified. While the fields of geology, seismology, and engineering are steadily growing in their knowledge of the mechanics of seismic processes, the great complexity of many geologic/seismic factors related to earthquakes does not currently permit accurate predictable measurements concerning where, when, and how large an earthquake might occur. We thus find that risk is basically a subjective determination based on a variety of components which are integrated to comprise the total risk. These components include the general geology of the area, the geological characteristics of the specific site, the land use, and the structural specifications of the site. Each of these four components may be dealt with more or less independently to derive the estimated total risk of a specific project or location based upon its specific characteristics.

The derived total risk, developed through the procedure of risk analysis of the four components, may be applied to existing

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Chart 4

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STRUCTURE USE AND THE PROBABILITY OF OCCURRENCE
FOR POTENTIALLY DAMAGING EARTHQUAKES OF SPECIFIC MAGNITUDES

Use	Approximate Recurrence Interval (years)	Fault (Source of Earthquake)			
		Newport-Inglewood	Sierra Madre	Whittier	San Andreas
Limited occupancy (warehouses, automated manufacturing facilities, etc.)	50-100	5.2	--*	4.5	8.5
Normal occupancy (residences, narmally occupied, factories, etc.)	100-200	5.6	6.0	5.2	8.5
Critical facilities (hospitals, fire and police stations, schools, critical utilities, etc.)	200-500	6.5	6.5	6.0	8.5

*Seismic history of the Sierra Madre Fault suggests that smaller earthquakes will probably not occur on this fault.

SOURCE: Envicom Corporation, City of Montebello Technical Report for the Seismic Safety Element, April 1975.

structural hazards, particularly to pre-1933 structures, as well as to future development. Within the scope of the state requirement that levels of acceptable and unacceptable risks be determined, risk analysis would provide the method for making such determinations.

In the reduction of seismic risk, higher costs often result. (Chart 5.) Additional costs such as reports prepared by specialists (geologist, soils engineer), lower densities, added building requirements, and relocation studies may be considered unnecessary by many. Yet the major goal of the Seismic Safety Element is a committment to the reduction of seismic risk to the public at large. This commitment will be met to the extent possible as described in the policies and action program of this plan.

POLICIES AND ACTION PROGRAM:

1. To define acceptable and unacceptable seismic risks in the framework of a feasible implementation program to reduce unacceptable seismic risks.

2. To identify and evaluate structural hazards of existing buildings that may constitute unacceptable seismic hazards.

3. To seek reduction of unacceptable structural hazards on a voluntary basis and through other appropriate means.

4. To incorporate a seismic hazard review procedure in the evaluation of new developments.

5. To emphasize seismic hazards as part of the city's disaster preparedness plans.

6. To promote public awareness of potential seismic risk, hazards, and mitigating measures.

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A SCALE OF RISKS AND COSTS OF MITIGATION

	Level of Risk to Public	Kinds of Structures	Extra Project Cost Probably Required to Reduce Risk to an Acceptable Level
Failure of a single structure may affect substantial populations.	Extremely High	Structures whose continued functioning is critical, or whose failure might be catastrophic: nuclear reactors, large dams, power inter-tie systems, plants, manufacturing explosives.	No set percentage (whatever is required for maximum attainable safety)
	Slightly Lower Than Above	Structure whose use is critically needed after a disaster: important utility centers, hospitals, fire, police and emergency communication facilities, and critical transportation elements, such as bridges and overpasses; also smaller dams.	20 to 25 percent of project cost
Failure of a single structure will affect primarily only the occupants.	Possible High Risk to Occupants	Structures of high occupancy, or whose use after a disaster will be particularly convenient: schools, churches, theaters, large hotels and other high-rise buildings housing large numbers of people, civic buildings such as fire stations, secondary utility structures, extremely large commercial enterprises, most roads, alternate or non-critical bridge and overpasses.	10 to 15 percent of project cost
	An "Ordinary" Level of Risk*	The vast majority of structures: most commercial and industrial buildings, small hotels and apartment buildings, and single-family residences.	1 to 2 percent of project cost, in most cases (2 to 10 percent of project cost, in a minority of cases)

*"Ordinary" risk: Resist minor earthquakes without damage; resist moderate earthquakes without structural damage, but with some non-structural damage; resist major earthquakes of the intensity of severity of the strongest experienced in California, without collapse, but with some structural as well as non-structural damage.

SOURCE: Adapted by Tri-Cities; from Scale of Acceptable Risks of the Structural Engineers Association of California.

SOURCES/REFERENCES:

1. California Council on Intergovernmental Relations; Seismic Safety Element Guidelines, September 1973.

2. California Council on Intergovernmental Relations; Seismic Safety Element Interim Guidelines, July, 1972.

3. California Division of Mines and Geology; Urban Geology, Master Plan for California, Bulletin 198, 1973.

4. Claremont, City of. Seismic Safety Element, July, 1974.

5. Envicom Corporation, Technical Report for the Seismic Safety Element - City of Montebello, April, 1975.

6. Los Angeles County; General Plan - Seismic Safety Element (Proposed), October, 1974.

7. San Bernardino County, Informational Paper on the Proposed San Bernardino County Seismic and Safety Element, 1974.

8. Tri-Cities Advisory Committee on Seismic Safety. (El Cerrito, Richmond, and San Pablo), The Seismic Safety Study for the General Plan. September, 1973.

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