

SYNOPSIS OF PANEL DISCUSSIONS ON  
SEISMIC MATTERS OTHER THAN STRUCTURAL DESIGN

H. M. Engle, Moderator

Panelists:

H. Bertling (Chile), Professor of Structural and Civil Engineering, University of Chile, Santiago.

M. Rodriguez C. (Mexico), Professor of Applied Mechanics, University of Mexico, Mexico City.

J. E. Ramirez, S.J., (Colombia), Seismologist and Director, Instituto Geofisicos de los Andes Colombianos, Bogota.

H. Kawasumi (Japan), Professor of Seismology, Earthquake Research Institute, University of Tokyo, Tokyo.

Y. Otsuki (Japan), Shimazu Construction Company, Tokyo.

Don Butler (Japan), Civil and Structural Engineer, Baker, Butler, and Triplett, Tokyo.

Miss Nuriye Pinar (Turkey), Geologist and member of the Turkish Parliament, Ankara.

G. E. Morris (United States), Superintendent, Department of Building and Safety, City of Los Angeles, California.

H. M. Engle (United States), Consulting Structural Engineer, San Rafael, California.

Question: What is your program for correcting life hazards in existing buildings?

Morris: The first ordinance Los Angeles had, regulating the design of buildings with respect to earthquakes was adopted in 1934, and with a thorough system of checking plans and inspection of buildings we do not worry a great deal about the new buildings. But we were considerably worried about the old buildings. Some of them date back maybe a hundred years and were not designed for earthquakes. We also know that it was economically impossible to have those buildings removed or replaced. So we provide as much safety as we can within reasonable and practical limits.

In earthquakes, most of the deaths are caused by appendages, parapet walls, and architectural projections on the buildings, which fall onto the sidewalk. Most earthquakes do not completely demolish a building. Counting the number of people that are on the streets in Los Angeles, say in the middle of the day, we could possibly have four or five hundred thousand casualties if we

## PANEL DISCUSSIONS

had an earthquake at that time equal to the San Francisco Earthquake of 1906. And that would apply to any city of Los Angeles' size (pop. 2,500,000). So, as a practical measure, we put through a retroactive ordinance. That means we can go back to the old buildings and remove all hazardous architectural projections and parapet walls, or have them rebuilt so they will stand an earthquake. They have to be designed for 100% gravity.

Now, a retroactive ordinance is a very difficult thing to sell any group of people or any legislative body, so we knew we had to sell it to the people who paid the bills, the people who own the buildings. It took seven or eight years to sell the idea. I kept pointing out that if you had four hundred thousand casualties you might as well give your business back to the Indians, so they finally agreed.

In seven years of experience, we have corrected all 5000 buildings in the congested area of Los Angeles. We have not had one single court case. We have been able to sell and talk the owners into doing this work. We haven't finished the job yet, but in the not too distant future we will be able to say "come to Los Angeles and enjoy the earthquakes."

Engle: I can testify that the work that has been done in Los Angeles as a precautionary measure is really an outstanding accomplishment. It is the most extensive accomplishment of that kind that I know of in the country. After the Long Beach earthquake of 1933, the city of Palo Alto instituted a survey and corrected obvious hazards on most of their downtown buildings. The city of San Francisco, when John Leonard was building inspector, also started a survey similar to that initiated by Mr. Morris, and they did get a considerable amount of correction, but the effort died for lack of funds. Even after the 1952 Bakersfield earthquakes, towns such as Santa Rosa, California, seriously considered a program of corrective measures but that did not actually come to pass.

Bertling: Private owners in Chile sometimes take measures for improving their buildings, but it is not required by law.

Rodriguez: We have no requirements in Mexico.

Butler: Tokyo does not have an ordinance which requires that obvious hazards be removed. The Building Research Institute has a program for vibration testing of older buildings which, in the opinion of the owner or of public officials, has become so aged or so poor construction that they offer hazards to life and property. A large program of this type was carried out on fire-damaged buildings after World War II. It was found by vibration tests, coupled with structural static testing, that certain fire-ravaged floors needed repairs.

Pinar: Turkey does not have retroactive ordinances, but if an old building is to be reconstructed, it must follow the code applicable to new buildings.

Engle: This problem of removing obvious life hazards from existing buildings is one that is not unique to our country. I hope that our visitors from other lands may take back the example of the city of Los Angeles and perhaps see what they could do along that line. Mr. Morris, what are the limitations of retroactive ordinances?

## H. M. ENGLE on Seismic Matters Other Than Structural Design

Morris: The important limitation of a retroactive ordinance is that it has to be practical; it can't be so extreme as to confiscate the building unless the building is a very serious hazard. We know that if we put through an ordinance so severe that all non-conforming buildings would have to be redesigned or demolished, it would be thrown out in the courts. We have other retroactive ordinances under which we demolish buildings at a rate of about 4000 a year in Los Angeles: buildings that are serious fire hazards and have other hazards in them, but only in cases where we can prove that they are extreme fire hazards and very dangerous buildings.

Ramirez: Retroactive ordinances do not exist in Colombia, but after an earthquake an official mission is sent out to examine the damage the earthquake has caused and to determine how many buildings remain standing intact, how many are destroyed beyond repair, and how many can be repaired. So the faults in the seismic regions are thus automatically corrected.

Murphy (from New Zealand, in the audience): Is there any attempt to strengthen existing shear walls and frames as well as the appendages in existing buildings?

Morris: We are confining ourselves entirely to the exterior appendages which endanger the pedestrians on the public ways. Occasionally, by persuasion, we get corrective measures on the frame, but we have no ordinance requiring the strengthening of the building as a whole.

Question: What is the possibility of dispatching or exchanging scientists or engineers between countries for the purpose of getting familiar with the local conditions after an earthquake, so we can understand thoroughly the written reports.

Rodriguez: There is certainly a possibility for such an exchange.

Engle: It would be very valuable if, after a destructive shock in any country, some key personnel from other countries could collaborate in gathering and disseminating data.

Otsuki: In Japan, the financing of such exchanges would present a problem due to the strict currency control. However, it would be possible if handled through governmental channels.

Engle: This idea is very worthwhile. After a shock in our own locality we get together what information we can, but we are very eager to get information from other countries. The suggestion invites further planning by the engineers in the countries represented here.

Question: In Japan seismic walls are receiving a great deal of attention in earthquake resistant design. Will the engineers outline their research program in this matter?

## PANEL DISCUSSIONS

Otsuki: This should be answered by Dr. Muto, but I shall outline the program as it now exists. First, we are trying to get the elastic behavior of seismic walls, including walls continuous in a horizontal direction or in a vertical direction, both with and without openings. Next, we are trying to get the behavior of such walls into the plastic range, to determine the ultimate strength of the structure. Such research is under way in many laboratories in Japan. We are also interested in the rocking problem; that is, the compaction of the soil under compressive load and also uplift on the tension zone.

Butler: Studies on seismic wall frames and also solid walls have been going on in Japan for a long time, ever since Dr. Naito originated his theory of the distribution of lateral forces to such walls. Recently, there has been some attempt photoelastically to find the exact stress distribution in all types of walls under all types of loadings. Also considerable attention is being given to the best method of analyzing the frames of the building which are tied into such walls.

There is still another thing that is being attempted. You are aware of the design method that slices a frame away from the building as a whole and analyzes it individually. We are attempting to find out what mass frame effect has on the reduction of the over-all damage to buildings. In Japan, walls are receiving more theoretical study than actual practical load tests.

Rodriguez: At present there is no such program in Mexico. We were interested in some shear tests of walls recently and obtained some information from the U. S. Corps of Engineers.

Question: Measured ground motion is influenced by the existence of a building or foundation supporting the instrument. What consideration is being given to obtaining the pure ground motion?

Kawasumi: I believe that the motion on the ground floor of a building is not the true earthquake motion of the ground in general, so we must have some observations at a distance from the building.

Question: If the destructive force of an earthquake is proportional to the energy transmitted to the building, why is it that structures on consolidate alluvium suffer greater damage than similar structures on solid rock foundations?

Kawasumi: I can only say that the underground condition is very much related to the destruction of buildings. But as to the first point of the question, that the energy absorbed in the building is related to soil conditions, I do not understand.

Butler: I think the energy transmitted to the building depends on the period of the building and it cannot be generalized as a whole. Perhaps if you took one specific building and drew an explicit case between alluvium and diluvium and the dissipation of energy in that specific building, the statement could be true, but it cannot be generalized therefrom.

## H. M. ENGLE on Seismic Matters Other Than Structural Design

Ramirez: We have always observed that structures on loose alluvial ground are the most affected by earth vibrations. The energy in alluvial ground is absorbed in breaking the ground and this may weaken the foundations of the structure and cause failure.

Bertling: The ground motion in soft soils is large compared to that of rock. It is important to define the surface waves resulting from primary waves in the bedrock. The overburden is a very severe amplifier of the bedrock motion. It is possible also that in soft soils there are different relative settling, and this contributes also to the greater damage observed.

Question: Why do we hear an earthquake several seconds before we feel it?

Kawasumi: If you had an impersonal instrument that recorded the start of sound and the start of motion of the ground, I am certain the times would coincide.

Ramirez: Probably persons hear the rumblings of the earthquake and do not feel the earthquake as responsively; hence they think they heard the shock before they felt it.

Pinar: The felt earthquake jar and the audible sound must come at the same time.

Question: What is the interest in an exchange of correspondence between conferees and others interested, leading to a supplement to the proceedings of this conference?

Otsuki: That would be quite valuable for the future development of engineering seismology because all questions cannot be answered here. Copies of questions and answers could be sent to EERI for assembly and distribution to the members of the conference later.

Engle: I think this idea could have a great value.

Butler: I would like to see the idea extended to have an interchange of building plans and design analyses and construction specifications. The engineer who is responsible for implementing codes and applying research developments would profit by actual examples of building plans. The design forces, their distribution, the stresses induced, the details of connections, all could be explained.

Engle: I see that Mr. Butler's idea has hit a responsive note. We have here the scientific mind and practical designer of buildings. There is a tendency in published literature to get into the rather abstruse vein. Somebody has to translate this data into practical structures. The interchange of information would be very valuable. For instance, Dr. Naito after 1923 made available to engineers in this country the details and design of some of those buildings that he designed before 1923 and which survived the shock so successfully. I hope that EERI might be able to implement something along the line suggested.

Question: What are the regulations regarding earthquake resistant design in your country; do you have them; if so, what may they be?

## PANEL DISCUSSIONS

Pinar: The regulations concerning buildings to be built in earthquake regions of Turkey emanate from the Ministry of Public Works and are intended as a uniform code for the Republic of Turkey. A provisional code was promulgated in 1942, followed by a permanent code in 1946, which has been revised in 1948 and in 1955.

The code specifies both a coefficient C which is proportional to the weight, with a proportion of the live load included. The seismic forces are quite low: In areas which are subject to the most severe earthquakes (first degree, they are noted in the code) the coefficients run 2% for hard rock, 3% for hard clay, 4% for all others. But these are added to half the specified wind forces. In second degree areas, the corresponding factors are 1%, 2%, and 3%, respectively. One of the interesting features of the Turkish code is that these seismic coefficients are specified, not by the bearing value of the soil, but by the actual geologic condition underneath the site. The code allows certain specified soil pressures for different types of foundation materials, the same as most other codes.

The lateral force computations are made for the more severe condition of either full wind or the specified earthquake forces combined with half the wind.

The code has special requirements for cantilever elements of three times normal loading, and for retaining walls the natural slope angle of the ground must be increased by six degrees in the most seismically active areas and three degrees in all other areas.

The code stresses the hazard to buildings due to land slip caused by earthquake. There have been very serious results from land slips in Turkey, and there is legislation which requires the movement of whole population areas out of a zone which is known to be hazardous. This is done on a statute passed for specific cases, upon which the population is moved to another area and land acquired on eminent domain and the owner receives a new lot for the old lot he had to abandon.

Allowable stress increase for seismic conditions is 50% for reinforced concrete.

Question: In Japan, who is in general charge or supervision of the work? Who does the inspection and in what detail and with what frequency? To what extent does a design engineer have control over construction?

Otsuki: Supervision of work is supposed to be done by qualified architects or engineers. Inspection is supposed to be done by qualified architects, but generally it is handed over to the chief structural engineer. The final inspections should be done by the building officials. As a rule, the inspection is done when the soil bearing tests or pile driving tests are conducted; next, when the bars are installed or when the steel frame is erected. Materials are inspected and tested by qualified testing laboratories. Concrete cylinders are made whenever concrete is placed.

## H. M. ENGLE on Seismic Matters Other Than Structural Design

Question: Should engineers designing for earthquake resistance work closely with fire insurance engineers?

Engle: If you are designing a building for this area and you plan to carry earthquake insurance, it behooves you to contact the earthquake department of the fire rating bureaus and find out what you are up against. Nothing is mandatory about those requirements, but at least you will be forewarned as to what you might have to do to take advantage of the lowest rates.

Question: Is there conceivably a proper seismic and structural orientation for certain buildings in this area where the faults tend to run north and south?

Ramirez: Sometimes we don't know where the faults are, or where the earth is going to break, or in what direction, so I think it is a hard problem to select any preferred orientation.

Engle: In any area there are numerous faults, and they don't all run parallel to the more prominent ones.

Kawasumi: I think that the prevailing faults will not influence the orientation or vibration of a building.

Question: What earthquake provisions are in the building code in Mexico City?

Rodriguez: We have a code in Mexico City for that particular area and it provides for the design of structures for seismic forces. The seismic coefficients vary from 0.1 to 0.025. But the building code does not say anything as to how the building must be designed and the structural engineer is left very much to his own judgment.

Question: How is it possible to obtain copies in English of the Japanese design standards and design proceedings?

Otsuki: The Tokyo building code is available in English through the Architectural Institute of Japan.

Question: Would you mention some of the items of non-structural damage which might be costly to an insurance company which a structural engineer might consider?

Engle: Anything that looks like a crack after an earthquake is costly to an insurance company. Just repainting a floor of a sizeable fire-resistant building after patching cracks may cost as much as \$10,000, or possibly more. So superficial damage may be very important to an insurance company, and anything the structural engineer can do to minimize it is correspondingly important.

## PANEL DISCUSSIONS

Question: Is it possible to evaluate the effect on insurance premiums of various design assumptions, that is the 20% quake factor, 2%, or what have you?

Engle: It can be done and has been done for over twenty five years. The insurance premium you pay has a direct relation to the degree of lateral force resistance that goes into a building.

Question: Does the fact that a known fault extends in a specific direction determine that earthquake shocks from this fault will always be in one general major direction?

Butler: While the Tokyo area is influenced mainly by the Sagami Fault which runs through Sagami Bay, there are also many minor faults and different soil conditions in the area, so that it would not be safe to assume unidirectional earthquake motions.

Morris: We noticed some buildings that were not designed for earthquake, but apparently were oriented in a favorable direction, and were not damaged at all in the Long Beach Earthquake of 1933, where other buildings in that area were damaged.

It is also true in the Los Angeles area that some of the taller buildings not specifically designed to resist earthquake were damaged in a certain pattern in 1933 and again in 1952. The Bakersfield earthquake which originated over a hundred miles away produced an almost similar pattern of damage. It is more the balance of the building and the strength of the building rather than the direction from which the shock happens to come that influences the damage.

Engle: We do know from experience that a damageable building will be redamaged in succeeding shocks, sometimes a number of times. In Santa Barbara, there are buildings in existence that have been damaged to my knowledge at least three times, possibly four.

Question: What is the effectiveness of earthquake resistant designs compared to the buildings which did not have such provisions?

Butler: Speaking for the Japanese delegation, we have prepared answers to this and several related questions which I will present at this time.

Generally speaking, buildings not designed to resist earthquakes have been badly damaged; in fact, almost total losses. With seismic design but with poor construction, it is very hard to distinguish between poorly constructed and poorly designed buildings, after they are down. The Daiwa building collapsed in Fukui and the adjacent building, although smaller, was undamaged. Both were designed by the same architect and engineer and built by the same contractor.

With seismic design and good construction, experience in the past has generally been satisfactory. We are skeptical about some of the newly built structures, although they are built in accordance with the present seismic code

## H. M. ENGLE on Seismic Matters Other Than Structural Design

and constructed in full accordance with the design. These buildings are framed structures with full glazing outside. The tendency toward full glazing is more limited in Japan than here in the United States. Of course, the deformation rate of the structure should limit the amount of that type of fenestration.

As to which type of structure fares best, generally, reinforced concrete structures with a good balance of shear walls and with a good honest attention to construction have shown the best overall resistance to earthquakes.

On the effect of the type of soil, Dr. Kawasumi covered this in his statistical review of damage to various types of structures. I might add that a recent survey has been made of reinforced concrete structures which seemingly came through the 1923 earthquake in rather fine shape although built upon alluvial soil. In those structures that were damaged the recent survey revealed that the degree of damage was considerable, contrary to the general findings of damage trends in that type of structure in the downtown area.

Have we been able to correlate design practices and code requirements with earthquake damage or lack of damage? The Japanese code follows very well the statistical studies of damage. It is up to the local prefectural official to implement the provisions of the code. This is done rather inconsistently in the smaller cities, but in the larger cities the officials bear down pretty hard on owners, particularly in regard to public buildings.

Do we feel that present code requirements under present design practices are now adequate, inadequate, or too severe? With the present tendency toward flexibility, they are probably inadequate. With regard to safety without regard to economy, they are fully adequate.

Question: What glazing provisions must be made in the newer type of tall building, steel frame, non-masonry walls? Do you pay much attention to special glazing provisions, or do you just assume that it is of no particular importance if the glass breaks out?

Otsuki: The structural engineers are worrying about this problem; most of our architects would not pay any attention.

Engle: This business of glass coming out of a tall building interests me personally, because fifteen years ago I was on Montgomery Street in San Francisco when several panes of glass were broken out of a building across the street. From twenty stories up, some of those pieces of glass whistled uncomfortably close to my head. Glass breaking from a tall building could present a considerable life hazard to people on the street.

Question: Is anything done in Colombia to observe, record, and disseminate data on actual damage from earthquakes?

Ramirez: The Geophysical Institute of the Colombian Andes has as its duty the study of earthquake damage. Besides study teams, we send out questionnaire cards to the post offices of the towns and to the mayors of cities. Information is studied at the Institute and for the larger earthquakes the data is reported through the publication of the Institute.

## PANEL DISCUSSIONS

We also have in Bogota a Center of Housing under the auspices of the organization of the American Nations, formerly the Pan American Union. The Center has professors and students from all of the American nations and they are devoted, among other things, to the study of the seismic problem.

Question: What has been the experience in your country as to the value of inspection and supervision during construction, insofar as earthquake resistance is concerned?

Bertling: The inspection in Chile is very poor; it is not performed adequately. Especially, the quality of materials is not adequately inspected. We have official controls only for steel and cement. The quality of concrete aggregates is not controlled, nor is brick. Control of construction is even poorer than the control of materials. It gives no safety for the owners.

Engle: In Chile, then, it is left to the individual builder, the architect, and the engineer as to what extent the construction practices are safeguarded.

Rodriguez: In Mexico, samples of concrete are sent to the laboratories for testing, but as to brick there is no control. Supervision is done mainly by the engineer in charge and on large jobs the supervision is good; on small jobs there is no supervision at all.

Question: Who conducts seismological research in your country?

Kawasumi: Earthquake observations in Japan are carried out by the Central Meteorological Observatory. It has about 100 stations around the country and the Earthquake Research Institute has about 10 stations for earthquake observation. Five of the latter are permanent and the rest temporary. The universities also have seismological stations.

Engle: It is time for the panel to close. We are extremely fortunate in having these representatives from other lands with whom we may exchange ideas and obtain information that will be mutually profitable. It has certainly been a great pleasure to me personally and I am sure to everyone in the audience and all members of EERI to have the privilege of discussing these matters with this panel this afternoon.