
CONNECTIONS

The EERI Oral History Series

**Clarkson W.
Pinkham**

Stanley Scott
Interviewer

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Earthquake Engineering Research Institute

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The EERI Oral History Series

This is the thirteenth volume in the Earthquake Engineering Research Institute's *Connections: The EERI Oral History Series*. The *Connection* series was initiated to preserve the recollections of some of those who have had pioneering careers in the field of earthquake engineering. Significant, even revolutionary, changes have occurred in earthquake engineering since individuals first began thinking in modern, scientific ways about how to protect construction and society from earthquakes. The *Connections* series helps document this important history.

Connections is a vehicle for transmitting the fascinating accounts of individuals who were present at the beginning of important developments in the field, documenting sometimes little-known facts, and recording their impressions, judgments, and experiences from a personal standpoint. These reminiscences are themselves a vital contribution to our understanding of where our current state of knowledge came from and how the overall goal of reducing earthquake losses has been advanced. The Earthquake Engineering Research Institute, founded in 1948 as a nonprofit organization to provide an institutional base for the then-young field of earthquake engineering, is proud to help tell the story of the development of earthquake engineering through the *Connections* series. EERI has grown from a few dozen individuals in a field that lacked any significant research funding to an organization with nearly 3,000 members. It is still devoted to its original goal of investigating the effects of destructive earthquakes and publishing the results through its reconnaissance report series. EERI brings researchers and practitioners together to exchange information at its annual meetings, and via a now-extensive calendar of conferences and workshops, also provides a forum through which individuals and organizations of various disciplinary backgrounds can work together for increased seismic safety.

The EERI oral history program was initiated by Stanley Scott (1921-2002) in 1984. The first nine volumes were published during his lifetime, and manuscripts and interview transcripts he left to EERI are resulting in the publication of other volumes for which he is being posthumously credited. In addition, the Oral History Committee is

including further interviewees within the program's scope, following the Committee's charge to include subjects who: 1) have made an outstanding career-long contribution to earthquake engineering, 2) have valuable first-person accounts to offer concerning the history of earthquake engineering, and 3) whose backgrounds, considering the series as a whole, appropriately span the various disciplines that are included in the field of earthquake engineering.

Scott's work, which he began in 1984, summed to hundreds of hours of taped interview sessions and thousands of pages of transcripts. Were it not for him, valuable facts and recollections would already have been lost.

Scott was a research political scientist at the Institute of Governmental Studies at the University of California at Berkeley. He was active in developing seismic safety policy for many years, and was a member of the California Seismic Safety Commission from 1975 to 1993. Partly for that work, he received the Alfred E. Alquist Award from the Earthquake Safety Foundation in 1990.

Scott received assistance in formulating his oral history plans from Willa Baum, Director of the University of California at Berkeley Regional Oral History Office, a division of the Bancroft Library. The Regional Oral History Office approved an unfunded interview project on earthquake engineering and seismic safety, and Scott was encouraged to proceed. Scott continued the oral history project following his retirement from the University in 1989. For a time, some expenses were paid from a small grant from the National Science Foundation, but Scott did most of the work pro bono. This work included not only the obvious effort of preparing for and conducting the interviews themselves, but also the more time-consuming task of transcribing, reviewing, and editing transcripts.

The *Connections* oral history series presents a selection of senior earthquake engineers who were present at the beginning of the modern era of earthquake engineering. The term "earthquake engineering" as used here has the same meaning as in the name of EERI—the broadly construed set of disciplines, including geosciences and social sciences as well as engineering itself, that together form a related body of knowledge and a collection of individuals that revolve around the subject of earthquakes. The events described in these oral histories span many kinds of activities: research, design projects, public policy and broad social aspects, and education, as well as interesting personal aspects of the subjects' lives.

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Foreword

This oral history volume is the completion of the interview sessions Stanley Scott (1921-2002) conducted with Clarkson (“Pinkie”) Pinkham in the 1990s. Except for minor updating by Pinkham, editing and addition of footnote information by myself, and inclusion of photographs, this work is essentially as it was left by Scott in manuscript form prior to his death in 2002. In finalizing this volume, Pinkham said he found the interview sessions with Scott a very enjoyable experience, and bringing this work to completion has likewise been a work of pleasure for me.

Gail Shea, consulting editor to EERI, carefully reviewed the entire manuscript and prepared the index, as she has on previous *Connections* volumes, and Eloise Gilland, the Editorial and Publications Manager of EERI, also assisted in seeing this publication through to completion.

Robert Reitherman
Chair, EERI Oral History Committee
February 2006



Personal Introduction

As a young practicing engineer, the one engineer you were directed to for research data on light-gauge steel decks and later on concrete frames was Pinky, also known as Clarkson W. Pinkham. My first encounter was undoubtedly at a meeting of the Structural Engineers Association of Southern California (SEAOSC) at Rodger Young Auditorium in the later 1950s, where monthly meetings were held. During that era, practicing structural engineers, building department engineers, product suppliers, contractors, and researchers freely exchanged information and discussed design problems and concepts. As a young engineer, one could not ask for a better training program, a nostalgic era now missed when compared to the present. Meetings at Rodger Young Auditorium ceased after the 1971 San Fernando earthquake since the building was of unreinforced masonry with a high roof clear-spanning to the exterior walls, and structural engineers began to weigh the consequences of collapse of this building during their meetings.

My next encounter with Pinky was related to design information on metal decking used for floor support and diaphragm values for the first steel building over the Los Angeles height limit designed by our office, Brandow and Johnston, in the late 1950s. Test data had been prepared by Pinky's office, S.B. Barnes Associates, in the early 1950s, and Pinky was the source of information for use of this material and its limitations. Shortly thereafter, our offices teamed up on a major highrise building across from the La Brea Tar Pits in Los Angeles, California. The S.B. Barnes office did the substructure, foundations, and shoring within the asphaltic sands, and our firm did the superstructure. Their expertise in coping with this soil was based on their experience at the new Art Museum across the street. Such arrangements were not uncommon during that period, since firms were not large and design procedures were performed by hand calculations. For such projects, one-third of a design office could be involved in preparation of documents, which usually took over a year from concept to start of construction—much more time than the present computer generation of documents.

The next milestone was the Seismology Committee of the Structural Engineers Association of California, starting with the 1973 Second Edition to the SEAOC Blue Book.

This edition set the standard for the state-of-the-art seismic provisions dealing primarily with changes for reinforced concrete walls and ductile frames. This was an issue in which I was particularly interested. Pinky was then the past chair of this committee and was concurrently acting in an advisory capacity for the American Concrete Institute on the seismic provisions for reinforced concrete walls and frames in their ACI-318 standard. He did such a good job that he remained chairman of the seismic subcommittee of ACI for a number of years. Changes to the codes made under his direction at that time remain basically unchanged.

As a result of, and prior to the 1971 San Fernando earthquake, the Seismology Committee was developing new criteria for seismic design. The dynamics of the building, story drift between floors, the importance factor for critical facilities, and soils effects came into effect. Pinky's input at these meetings was extremely important, because he was also involved in other professional technical group studies of these issues. And his experience and insights gave a broader perspective to what was being written into the Blue Book. During this era, Pinky was quite involved with ACI, AISI/AISC, and ASCE to develop proper seismic criteria for concrete and steel materials. Pinky and I both served on an AISI/AISC advisory committee on steel ductile frame requirements being developed by Egor Popov at U.C. Berkeley. Concurrently, I was involved with the Structural Division Executive Committee of ASCE, and thus we could coordinate the seismic effort of all of these committees in our Seismology Committee meetings in SEAOSC and SEAOC. This was an exciting era, and the precepts of structural engineering for seismic design in California became incorporated into national building codes.

When one goes into Pinky's office, you can easily be overwhelmed by the stacks of journals and technical publications that have informed his work and ongoing committee correspondence. On his shelves are many obscure test results of important work now forgotten, or early publications now obsolete. In most cases, Pinky knows where to find them all and is willing to discuss the problem at hand.

As load factor design and metric equivalents came into practice, Pinky became quite vocal in support of their use and benefit. Such use was met with minimal response by engineers in general, but with new changes, such as in ASCE-7 for seismic provisions in national codes and ASCE-31 for existing buildings, the concept of strength design is now wholly accepted. Pinky's other work

included AISI standards, ASCE 3 for design of composite slabs, and criteria for shear studs now universally used for composite design of steel beams.

Pinky has, throughout his career, believed that the principals of a firm must be directly involved in many areas. He has directed design in his office, done or participated in testing of material systems, and most of all presented this information to his fellow engineers. Pinky has used his experience, testing knowledge, and what he has learned from others during committee meetings in numerous professional technical societies to develop usable and practical code specifications. He is one I can still call on for information on structural materials and systems that may be obscure or questionable in present standards, or being proposed for new uses.

This EERI oral history presents Pinky's distinguished career in structural engineering, testing, design, and the use of a variety of materials for design of building components.

Donald R. Strand
Brandow & Johnston Associates
Los Angeles, California
March 2005

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Clarkson W. Pinkham

Background and Education

My father's last duties for the City of Los Angeles were to start up and manage the original Los Angeles City parapet correction program, which required seismic retrofitting or removal of these hazards.

Parents and Grandparents

Scott: Start by giving a little of your family background, particularly something on your parents and grandparents.

Pinkham: My father was Walter H. Pinkham. In 1906, at the time of the San Francisco earthquake, he was studying mining engineering at U.C. Berkeley. Right about that time the floor fell out of the mining business, and it never really did recover after that for many years. So after he graduated in 1908, he did not pursue mining as a profession. For a long time he worked at various jobs. My father was born in Los Angeles, my grandparents having come out here from Iowa about a year or so before he was born.

My father's parents came from Quaker families. My grandfather, Clarkson Pinkham, was born near Augusta, Maine. As a

young man, he moved with his father, who acquired a farm near Muscatine, Iowa. He owned and developed a number of properties in Iowa and Illinois. He moved to Los Angeles in 1883 and was in the business of property development. As my grandfather died in 1897, I don't know the specifics of his profession, but I do know that he was a developer of property in the downtown Los Angeles area. For many years after his death, the family continued my grandfather's work and formed a family corporation. They developed property and actually farmed in the Wilmington area and near Lancaster, here in southern California. But the business finally collapsed with the Depression.

When the family corporation was still operating, my father worked for some of the local steel companies, and then after World War I, he worked for the City of Los Angeles.

Through almost all of the 1920s, he was with the City of Los Angeles Sewer Department. Then when the Depression came along, things got pretty bad.

He tried a number of things, but finally worked with the Metropolitan Water District as a designer, which he did for about ten years. Then he went back to work for the City, for the Department of Building and Safety. My father's last duties for the City of Los Angeles were to start up and manage the original Los Angeles City parapet correction program, which required seismic retrofitting or removal of these hazards. That began around 1947, and he carried that on until he retired in 1955, when he went back to his first love—developing properties. Thus, he switched off entirely from structural engineering. We occasionally asked him if he would like to take a look at a building

for us, but no, he was too busy. He died in 1972.

My father's mother, Mary Furnas, was born near Dayton, Ohio. Her family was part of a large migration of Quakers who had moved from South Carolina around 1800–1810 and settled in the area around Dayton.

Scott: Do you know some of the story on that migration?

Pinkham: There were Quakers in North Carolina, South Carolina, and Georgia, who had first come there in the 1700s, before the southern plantation system really developed.

Scott: Had those southern Quaker settlements spun off from the Quaker settlements in Pennsylvania, or did they come directly from England?

Pinkham: They mostly came directly from England—although one of the families in my ancestry, a Pearson family, moved to South Carolina from Philadelphia. But the Furnas family came directly from England. By the early 1800s, however, the Quakers in the south, who did not believe in slavery, saw that they could not compete with the slave owners, so most of those in South Carolina and Georgia left. My grandmother's people were part of that migration of Quakers who had decided to go someplace where they would not have that kind of competition. Some Quakers did, however, stay in North Carolina, around Greensboro, for example. By the time of the Civil War, my grandmother's family had moved to Louisa County, Iowa, just south of Muscatine. She and my grandfather, Clarkson Pinkham, were married in 1867 and continued to increase their family after moving to Los Angeles.

My mother's maiden name was Dorothy Burdorf. She was born to a family of German immigrants, one of many who established the German "colony" of Anaheim, California—Anaheim is, of course, a German name. Some of them came to California by way of the Isthmus of Panama, and some came across country.

My mother's father was Heinrich Burdorf, who came to this country from Germany in 1867. He married Dorothea Wöhler in absentia, while she was still in Germany. When Heinrich came over in 1867, she was only a small girl. The families knew each other in Germany. After being married in absentia, she came to San Francisco with her brother in 1876, and my grandparents repeated their marriage vows.

My mother and father met while going to the University of California at Berkeley and were in school there at the time of the 1906 earthquake. My father was part of the military group at school and served guard duty in Golden Gate Park after the earthquake.

Early Years

Scott: Say something about your birth and your early years, up through high school.

Pinkham: I was born on November 25, 1919. My family lived in Los Angeles on 30th Street, near Grand Avenue, not far from the present campus of the University of Southern California (USC) and Exhibition Park. I first went to school in 1924 at Jefferson Elementary School, directly across Jefferson Street from the USC campus. The school is still there, but not the old buildings. In 1928 my family moved west, near the intersection of La Brea and Mansfield avenues, and from the fourth

through sixth grades I went to Wilshire Crest Elementary School on Olympic Boulevard, two blocks from home. One of the old school buildings is still there.

I attended the seventh through ninth grades at John Burroughs Junior High School, near Highland Avenue. In 1934 I entered Los Angeles High School, located on Olympic and Rimpau boulevards. I arranged my courses to qualify for college entrance and participated in the Army ROTC program.

Scott: So quite early, at least by the time you started high school, you knew that you wanted to go to college?

Pinkham: Oh, yes. Then I graduated from high school in the winter class of 1937. I wanted to enter a university on a regular schedule the following year, so I had a little time available after my high school graduation. During that time, I worked as an apprentice at a typewriter repair shop near Hollywood and Vine. I finally decided I wanted to go to Berkeley, where my parents had gone.

U.C. Berkeley and World War II

Pinkham: I really did not have the vaguest idea which way I wanted to go in engineering. I had interests in a number of areas. For a time, I considered electrical engineering, electronics, etc., but then I went for a very general program. I mentioned that my father had gone through Berkeley in mining engineering, but there was a big depression in mining after the 1906 earthquake. So he never got into that field as a career. In any case, I got the idea that it was not essential to decide on a specific major, but that I should get the broadest exposure to all

kinds of engineering. That is why I took sanitary engineering.

In August 1937, I entered the University of California at Berkeley with a major in civil engineering, specializing in sanitary engineering. The courses offered in sanitary engineering were the same as all the other engineering courses, except for transportation. The only courses I did not take were one in the method of least squares and a geodesy class, though I got involved in both of those subjects during World War II.

Scott: You stayed with the sanitary engineering program throughout your education at Berkeley?

Pinkham: Yes, because it was broader. In addition to all the regular classes in structural and civil engineering, I also had all the work in sanitary. And of course at that time, Berkeley did not really have a structural department per se—structural engineering was sort of spread between all the other engineering groups. In fact, I was planning to actually carry the program for five years. Supposedly, I was in the class of 1941, but of course, World War II came along. It took me ten years or more from the time I started until I finally completed my undergraduate studies.

Scott: How did that all come about?

Pinkham: I was in the Naval ROTC at Berkeley and obtained my commission in the Naval Reserve in the summer of 1941. Even before the war started, I got my orders to report for active duty. I went up to see Dean Charles Derleth of the Engineering School. He thought I was being drafted and wanted to know how he could get me out to finish up the year. But I

said, “No, I have got my orders.” So he shook my hand and said he’d see me after the war, which he did. During the war, they came up with what they called the Bachelor of Applied Science. So after being in the Navy for two years, I got a certificate that said I had graduated with a bachelor’s degree. But I had not finished all the courses—I still had one year left to go. I returned to Berkeley after the war in 1946, studied for one full year, and finally received the Bachelor of Science degree in sanitary.

Scott: When did you meet your wife?

Pinkham: During the fall semester of 1941, prior to getting my orders to report to the Navy, I met my future wife, EmmaLu Hull. We had met initially at a dancing school in Los Angeles in 1935. (Neither of us actually remember meeting.) She had just started studying music at U.C. Berkeley after two years at Occidental College in Eagle Rock, a suburb of Los Angeles. As I was no longer studying since being called to active duty by the Navy on Treasure Island, I had ample time to interrupt her studies. We were married in Berkeley on May 8, 1942. EmmaLu’s parents were Bert Hull and Wilma (Bill) Reed. He was a claims manager for the Los Angeles office of an insurance firm. EmmaLu died in 2003.

World War II effectively put our family life on hold, as I was gone most of the time in the Pacific theaters of war. We did finally develop a family, all of whom went to U.C. Berkeley.

Nancy Pinkham was born in 1947. She has been an elementary school teacher in Arcadia. She married John Ballance, an electrical power engineer with Edison International. They had two children, Dennis Ballance and Stephanie Baltz.

Timothy Hull Pinkham was born in 1949. He was a defense analyst for the federal government in Washington D.C. He married Marian Chung, a doctor of internal medicine. They had two children, Rebecca and Daniel. Timothy died in 2005.

Anthony Hull Pinkham was born in 1955. He is a technical writer of computer programming in Mountain View.

Wartime Service

We had no casualties, except for one person who was killed when we were on Okinawa and had a kamikaze pilot hit the ship.

Scott: Talk a little about your wartime experience, which actually started a little before direct U.S. involvement in hostilities.

Pinkham: My active duty started on Treasure Island in San Francisco Bay, in October 1941. More or less immediately after the 1939 World's Fair closed, the island was taken over by the Navy. Some of the fair's buildings were still on the site when I started there. I was assigned to a mine-sweeping school whose headquarters were on the riverboat *Delta Queen*, anchored alongside a dock. I lived off-base, staying at the fraternity where I had lived during my university days. In essence, I had a regular job going to the mine-sweeping school every day. My stay at the mine-sweeping school was very short, however, as I was soon taken out for other duties.

The Navy was converting some of the fair's buildings over to Navy use. The public works officer in charge of contracts for doing the conversion chose me as his assistant. For the next five months or so, I assisted him in the process of assuring that the contracts for the conversion were properly performed.

Getting the *Pathfinder* Ready

Pinkham: I stayed on the same assignment from December 7 (Pearl Harbor) to May of 1942, when I got orders to report to the USS *Pathfinder*, a ship being built in Seattle. It was originally designed for the U.S. Coast and Geodetic Survey for work in Alaska that involved deep sea sounding, but when the war came along, they decided to switch it over. When I went to Seattle, however, the ship was not finished yet, so we had four or five months in Seattle before a full contingent came on board. The identification reference number of the USS *Pathfinder* was AGS-1, which referred to Geodetic Survey ships.

Scott: Describe the ship's organizational structure after it was fully manned.

Pinkham: The captain and executive officer were Naval Reserve officers. Underneath them were the Coast and Geodetic Survey officers, who were in charge of the survey work. The survey work was not done by the Hydrographic Office. Instead, all the Coast and Geodetic Survey officers were commissioned for Navy duty. They retained their ranks in the Survey, but were actually part of the Navy. So some five to eight Survey officers were on the ship—the number varying from time to time.

I was the only young Naval Reserve officer assigned to the ship who actually had an engineering background. All the others had studied commercial art, business administration, etc. I have no idea how the Navy chose the young officers for Survey duty. The candidate's past experience obviously was not a criterion.

Once we had everybody on board, we started off under orders to go to Honolulu, but when

we got offshore, we found that the drive shaft squeaked—it made a hell of a racket. Our superiors were contacted and informed that we had to “do something about the drive shaft noise.” Trying to use sonar and hearing this big squeal did not go well together.

We stopped off at Alameda and were there in dry dock for about three months while they tried to remedy the squeal. In Alameda we were trained to draw charts, which was the particular kind of operation we would be doing in our survey work: we were to draw charts of areas for which there were no charts.

Scott: Charts of the bottom, or of the shores?

Pinkham: The bottom and also the shores. There was one island in the Solomon group for which the latest existing chart was made by James Cook.

Scott: The eighteenth-century British sea captain and explorer? That was a long time ago.

Pinkham: Yes, it was. Eventually they got the drive shaft fixed, and we took off for Hawaii. Then on the way to Hawaii, we found that there were more problems than just the drive shaft squeal. The ship had been built for Alaska, and they had not thought about the fact that it would be going into the Tropics instead, where the water outside the ship would be significantly warmer. We found that it was impossible for anyone to work in the engine room, particularly the boiler room. There were places where the ambient temperatures reached around 165 degrees. To read gauges and what-not, they had people going down there for five minutes at a time, which was all they could stand. When we got to Pearl Harbor we had to undergo additional work to deal with that

problem; they installed a heck of a lot of blowers to exchange air a lot better. So we spent a while in Pearl Harbor before finally setting off to do some work.

Scott: I presume you operated under the auspices of the U.S. Navy?

Pinkham: Yes, AGS-1 was a Geodetic Survey ship that operated under the Navy command in Honolulu. In the Pacific, the headquarters was in Honolulu with Admiral Chester Nimitz in command, and then there were different area interests that came under him. There was the Third Fleet area under Admiral William Halsey, another one was down in Australia more or less under the purview of General Douglas MacArthur, and so forth. But as far as the Navy was concerned, all of them operated under Nimitz.

Survey Voyages in the Pacific

Pinkham: We were supposed to be joined by another survey ship called the USS *Oceanographer*, which was a converted yacht built in the 1890s, but they never made it out to the South Pacific. So until the end of the war, they had a number of very small ships that were doing that kind of survey work; but the *Pathfinder* was the only one in the South and Eastern Pacific, and it was roaming all over the place.

Scott: You went all over doing that mapping work, making charts for the ships to use in navigation? That was a pretty crucial activity.

Pinkham: Yes, it was something they really needed. We had a printing press on board and made our own charts, which were passed out to the fleet. We could do it right on board—there was no need to go back to Washington for that.

The *Pathfinder* made two survey voyages during the war. We spent two years in the South Pacific covering many areas. We went to the Ellice Islands, to Funafuti, which is an island without much ground but with a very large atoll—a protected anchorage. The Navy needed to know where the bottom was and what it was like, particularly if they ever needed to get a large number of ships in the atoll.¹

After that, we spent a little time in Samoa and New Caledonia, and then went on to various islands in the New Hebrides group. From there, we went to the Solomon Islands while military activity was still going pretty hot around the islands of Tulagi and Guadalcanal. We would have to run the ship up a little creek and hide it under trees so the enemy would not see it. The ship was attacked a few times, but we did not get hit.

We did quite extensive survey work on many of the islands there, starting with Tulagi and the little islands Gavutu and Tanambogo, which were essentially wiped out—there was nothing left after the attack. So we did not have to survey them. We spent quite a bit of time on Guadalcanal, the Russell Islands, and some of the other islands, all the way up to Bougainville, the northernmost of the Solomon Islands. We spent almost a year on that work. Then we did some additional work in New Caledonia and the adjacent Loyalty Islands. After two years, we were given a week or two down in Sydney, Australia, for a little rest and relaxation before going back into the midst of it.

1. The Ellice Islands have now been renamed the independent state of Tuvalu of the Commonwealth of Nations.

Scott: You just sailed the ship down to Sydney for a short break?

Pinkham: Yes. That was during the first voyage, which was roughly 1942–1943. Toward the end of 1943, they apparently decided we had enough time out there, so we went all the way back to the States. We docked not far from the Ferry Building in San Francisco, where we were resupplied and got a whole new crew, captain, and executive officer.

On the second voyage, we sailed more or less into the mid-Pacific, to Kwajalein, Guam, Ulithi, and on to the Philippines. We charted the “Pathfinder Reef” about 350 miles north of Guam. There was no dry land at all, but the reef came within about forty feet of the surface of the water, so we had to go there and find out for sure how deep the water was. Planes flying over could see it, and they wanted to know whether it might be a hazard to navigation. The water turned out to be deep enough for navigation but shallow enough that it was a source of large waves.

There was a bay on the east shore of Luzon (Casiguran Bay), which had the potential to provide anchorage for a very large fleet and to actually be land-locked. It is east of all the mountains and is totally isolated from Manila. Very few people were there—only some small villages. We did survey work there, laying out anchorages and producing charts for the Navy’s potential use.

Part of the Coast and Geodetic Survey’s work required what they called a “wire drag”: two boats about half-a-mile apart, dragging a long wire cable with buoys between them. The cable was kept taut enough so that it would drag

right at a given level as they moved slowly through the water. That was done to make completely sure there were no small pinnacles of rock jutting up that might be a hazard to a ship. On the charts, we colored areas a separate shade once they had been wire-dragged.

Scott: You covered a lot of areas in the Pacific Ocean where the main action was. You mentioned having a few attacks on the ship.

Pinkham: Yes. A number of times we used a small boat—a sub chaser or something like that—and put some of the survey people on it to go into the areas that were still in contention. We wanted to find out whether an invasion force could get in. We had to go in during the night or with a screen of marines so that we could perform our work. We had no casualties, except for one person who was killed at Okinawa when a kamikaze pilot hit the ship. We picked up casualties, but that was the only incident involving the ship’s own personnel. We had a doctor on board all the time, with a staff and good facilities.

Personnel, Rank, and Protocol Problems

Scott: How did the Coast and Geodetic Survey people fit in to that wartime Navy work? I guess they were doing what was really their business anyway, whether done in wartime or peacetime.

Pinkham: Yes, and they knew their business. The head Coast and Geodetic Survey officer was eventually Admiral William Gibson. Before he retired he moved up to a top-notch position in the Coast and Geodetic Survey. About fifteen years after the war, I ran into him

at the University of Southern California and we became reacquainted. I saw him for years after that, and we became kind of close. He lived in Piedmont, adjacent to Oakland, and as I used to go up there quite frequently, I would stop by to see him.

Scott: The ship's organization must have been very different with both Navy people and Coast and Geodetic Survey people on board. How did the rank and seniority protocol work?

Pinkham: It was interesting. The typical officer layout on most ships looks like a triangle with the base at the bottom. At the top is the skipper, two officers are immediately below him, and so on. The lower the rank, the more of them there are. But having those Coast and Geodetic Survey officers on board, most of them with pretty high ranks, sort of inverted the triangle. We would have one ensign, about three junior grade lieutenants, maybe ten lieutenants, and even more lieutenant commanders.

It was backwards, and on a small ship that created some problems. You had to keep the ship going all the time, of course, but those involved in the survey work might be extremely busy for maybe a month and then have nothing to do for three months, in between survey jobs.

What do you do with everybody? There were all these people on board not doing anything. It griped some of the lonely ensigns who had to take all the watches while the Survey officers sat around doing nothing. It was kind of a morale problem that really never got resolved.

We had one fellow on board, a meteorologist, who was a totally useless person for that job. We had radio silence, so he could not send out any of his observations to anybody. And every-

body on board ship knew what the weather was like without him telling them. He was just not in his element. After the war, in the 1950s, that meteorologist actually wound up in the Coast and Geodetic Survey, working with Fritz Mathiessen on the strong motion instrumentation program. But on the survey ship in wartime, there was nothing for him to do. He was just one of the people who had to be assigned to the ship. He wound up helping blow up coral heads. So the whole business of personnel structure was unique. And nobody, including those on top, knew what to make of it.

Okinawa and the End of the War

Pinkham: The survey work kept going all the way to the conclusion of the war, when we were working around Okinawa; that was quite a sight toward the end. After the war in Europe had concluded, they sent all of the existing mainline battleships out to Okinawa. There must have been six or seven of them all in a line just off southern Okinawa, all firing their 16-inch guns at the Japanese. Seeing them there dead in the water, just firing away, was quite a sight. I think that was the only time that so many battleships had been gathered together in one place.

When we first went to Okinawa, it was still very much in contention. But toward the end, it was kind of quiet. I mentioned the kamikaze hit, which didn't really cause any damage to the ship, and what it did do we could not quite understand. A steel hatch on a gun platform, which rose up about one-and-a-half feet above the deck, was used for passing ammunition up from the compartment below to some 40-millimeter guns up above. The hatch had a seal

around it and was watertight when closed and dogged. Somehow the plane hit that hatch lid and sheared off the bolts. It did not even damage the lip with the water seal but just broke the bolts and lifted the lid off. All we had to do was get new bolts and a new lid.

The casualty was the one person who happened to be on watch at the time, a kid who had come on board the day before. He had been with us such a short time that nobody knew him, and we did not even realize that he was missing for a day or so. He just vanished. We felt sort of bad about not even knowing him.

Scott: I guess the kamikaze hit just knocked him right off the ship.

Pinkham: Yes, that is what happened. Then the skipper decided he wanted to get the hatch lid fixed, so we sailed forty or fifty miles to a little group of islands called Kerama Retto, where all the ships that had been damaged waited their turn to get fixed up. Some of the ships there had only half of their bodies left—I don't know how they stayed afloat. Then we pulled in with just one little hatch lid to be repaired and felt sort of silly. But they did it in one afternoon and we got out of there.

Scott: When was that?

Pinkham: In the spring of 1945. As it got toward summer, the kamikaze activity became a little quieter. About that time there was a

switch from the Army flying sky cover to the Marines doing it. As soon as the Marines took over, the kamikazes seemed to disappear. I have no idea if there was any cause and effect relationship, but both seemed to happen at the same time.

In August, there were two rather heavy typhoons. When the first one hit, I was still on the ship. When the second one came, I was on the shore base waiting to be shipped out on the USS *Texas*, which was heading back to Honolulu. I had accumulated enough points to return.

Scott: That was about the time the atomic bombs were dropped, which ended the war.

Pinkham: Yes, those things all happened quite close together, and I am not sure of the exact sequence. Shortly after the second typhoon, I went to Pearl Harbor and shifted to another ship—which I think was the *Nevada* after it had been fixed up following its Pearl Harbor experience. That part of the return was a slow one because they wanted to enter San Pedro, California on Navy Day, so we crept along at about two knots all the way across from Honolulu. Naturally, none of us on board cared much about the Navy Day event. Anyway, I got out in December 1945, with still another year to finish at Berkeley. I was able to get there in time for the spring semester, which began in February 1946.

Joining S.B. Barnes Associates

*Then before I knew it I was hired,
although I didn't really ask for a job.*

Pinkham: After completing my studies at Berkeley in February 1947, I started looking for work, not having any particular idea where to go, and it just happened that I walked into the office of Stephenson B. Barnes. At that time, he was on Third Street in Los Angeles, adjacent to the downtown area. Bob Kadow stopped by to talk to my dad, who mentioned that I was looking for a job. Bob, who was with the Barnes firm, said, “Well, send him down.”

So I walked into the Barnes office, and there were so many Cal graduates in the place that I immediately felt comfortable and began conversing with them. Bob Kadow was older than I, but had also graduated from Berkeley. Albin Johnson, John Holstein, and John Hoeft were the other Berkeley graduates in the office that I knew, all within a year of my class. So I stayed about two or three hours just talking with them. Then before I knew it, I was hired even though I didn't really ask for a job. I just started working all of a sudden—that was in April 1947. I had not had any specific intent of getting into a structural office.

When I first started looking for a job, I was looking in all the areas of civil engineering. My mind was open to anything. I

mentioned having purposely taken sanitary engineering, so as to have as broad an experience in civil work as I could get. But I did not look specifically for work in sanitary engineering—I just looked to see where employment was available.

Scott: Talk a little about your early days on the job. What was it like?

Pinkham: It was actually a very good practice, particularly for learning the profession. I did quite a bit of drafting at first, and I did not do any design at the outset, which was fine with me because I wanted to learn what they were doing. I probably started getting into design work in 1948.

Things sort of slowed down for a while, with most everybody out on loan, but I had a job testing steel deck diaphragms that was just beginning about that time. That original job was for H.H. Robertson. It was in 1949 that we actually ran the first tests. That same type of work is still going on.

Scott: The Barnes firm has been associated with that steel deck testing for a long time, hasn't it? You got into testing work right at the beginning of your career, and it is still going on some fifty years later. Has testing occupied much of your time and energy?

Pinkham: No, it never really did, and it still only takes twenty to twenty-five percent of my time. Our principal work is still with buildings—with architectural clients, industrial clients, and whatever they come up with. We have worked with a number of our clients for years.

The testing still goes on, however, and they still come up with new ideas and new systems. The

testing is done without the full array of potential variables and without vibratory earthquake motions. Instead, they get only the information they need for design. It is just not feasible to go “whole hog” with it. To test everything conceivable—every variation possible—in order to arrive at an answer. You would have to ignore money and time. The size of the job and the monetary considerations rule that out.

Scott: So the trick is to narrow the testing down to what is really relevant, necessary, and usable.

Pinkham: Yes. We hope, however, that the testing has created a better situation for designers than they would have without it. I can discuss diaphragm testing in some detail after saying more about the Barnes firm and my recollections of Steve.

S.B. Barnes Associates

Pinkham: When I first came to the Barnes organization (a partnership), there was Steve Barnes and his two partners, Mark Deering and Bob Kadow. Mark Deering had been Steve's classmate at Purdue. When Steve started up his business in 1934, he invited Mark to join him. Later he took in Bob Kadow, who had gone to U.C. Berkeley, and the three of them worked together during World War II. Bob Kadow's primary interest was actually in survey work, and he eventually did survey and field supervision and kept away from structural design.

So originally there were just these three engineers. Other people were working with them, but they were the three principals at the time. John Hoeft joined them in 1942. After World War II, Al Johnson and I joined the firm. Then

Bob Spracklen came about eight years later. So for many years we were a firm of seven principals, two of whom graduated from Purdue, and all the rest who graduated from Berkeley, although Bob Spracklen mostly studied at UCLA.

The three original partners each had their own tasks and their own directions, and that sort of set the pattern. Steve was interested in all types of design. Mark Deering was really not too advanced in design work; he was a good assistant, a good person to look at plans and see that they were properly put together, but he was not the type of person to be the lead engineer. Bob Kadow's interests were totally different. He was primarily interested in survey work, layout of site development, field supervision, and things like that. So initially, the firm comprised those three different people with their different interests and skills. Then, when we three younger fellows first came in—John Hoeft, Al Johnson, and I—we were more or less assigned to do different kinds of tasks. So we each tended to go in our own direction. Al Johnson primarily did the school work and dealt with the people in the Schoolhouse Section; that was the bureau in the Office of Architecture and Construction, now called the Division of the State Architect, which was responsible for administering the Field Act. John Hoeft worked primarily on small commercial projects. I got stuck with some of the larger jobs, which involved a number of people as well as the business of setting up testing research projects to help clients get approvals from the code agencies. Al did some of that too, so we had a little bit of switchover now and then.

Scott: Say a word or two about the shift from partnership to corporation.

Pinkham: In 1959 the organization was incorporated, and all seven of us were fully active. Steve was very thoughtful in trying to plan for the future, so he slowly brought the four of us along, and eventually it got to the point where he decided to ease up on his own activities. Steve retired from the firm in 1985. Deering (1973), Kadow (1975), Hoeft (1987), Barnes (1989) and Johnson (2003) have died, so we are down to two principals—Bob Spraklen and me.

Joint Venture of Taylor and Barnes

Pinkham: I should mention that there has been a separate firm besides S.B. Barnes Associates for many years. In the 1930s, Steve Barnes was a consultant to Taylor and Taylor, Architects. A joint venture of Taylor and Barnes was set up to perform joint tasks on many industrial and commercial jobs. In 1950, the joint venture was changed to Van Dyke and Barnes. James Van Dyke was initially chief architect for Taylor and Taylor, and the joint venture of Van Dyke and Barnes kept going until James Van Dyke retired in 1991.

In 1950, the year of its formation, Van Dyke and Barnes did a major joint venture job on the site of the Douglas Aircraft Company plant in Torrance, California. The total force for that project was roughly 100 or more people. That was not, however, the normal thing for us—in fact, it was the only time we did anything like that.

Scott: You mean you never did another joint venture project that big?

Pinkham: That's right. Most of the people we had on the joint venture job for Douglas Aircraft Company were people hired for that particular job. A few of us went there and headed up a new group, and we expanded to suit the job. But we did not particularly care for the large size of the operation, and we also kept our normal activities in the office, where we still had our normal contingent of approximately fifteen people.

Staying Small: Our Basic Philosophy

Pinkham: I think Steve Barnes in particular wanted to keep the firm rather on the small side so the principals could be in closer touch with the actual jobs going on, rather than assigning things to subordinates.

Scott: Despite using the joint venture firm for a considerably larger job on that one occasion, I take it that throughout its history the Barnes organization has held pretty steadily to its policy of staying small?

Pinkham: Yes, it is something of a philosophical approach that the firm built up over the years. It was also Steve's work style. He wanted us as principals to keep our hands on the jobs—and in general most of us agreed with that.

Scott: That is quite different from some other engineering firms, isn't it?

Pinkham: Yes, you can see large differences in the approaches of the various firms. For instance, Skidmore, Owings & Merrill LLP (SOM)—at least in their Chicago office—form design teams for a job. The whole team, including all of the architects and all of the consultants, work together in one spot. So that is an entirely different type of approach.

In the SOM office in Chicago, they provide the full service, forming a team for a specific job that includes all disciplines. They bring all these people together in an area to work on the job. The members of a team would actually physically move in order to work together on the same floor and in the same area. They would shift people around so they could do this. That arrangement is a little different from the way most offices do things. I think it has some merit, if you have the people. But it's a matter of how you set up to do what you want to do.

Scott: At the Barnes firm, you have done things in quite another way—and you have managed to stay about the size you wanted to.

Pinkham: Yes, roughly the same size, although we did get somewhat larger when we were working on the Los Angeles Airport. I would say that we got up to about twenty at that time.

Scott: What are some of the implications of your firm's philosophy?

Pinkham: The good side is that it allows the principals to stay close to the jobs they are working on. If the principals have fewer jobs to supervise, they work more closely with the designers and can watch them more closely. But our approach also has something of a downside in that it does not produce a standard type of output from the firm. Each of the two principals has his own style. That can be a drawback, as it limits our ability to sell our services as a firm.

So a client is not dealing with a cohesive unit, but primarily with the individual or individuals who are supervising the job. You could look upon us as two structural engineers who have

decided to have a common staff. To some extent, then, each of us sets his own way of doing things. There is not a firm-wide standard. If we were a much larger firm, some kind of standard would have to be set.

Scott: Do the two of you each do a lot of repeat business?

Pinkham: Yes, we do almost all repeat business. Or sometimes a firm we've worked with splits up and some people from that office form another firm that also works with us. We have done very little actual salesmanship for our work. It is from word-of-mouth that we get our jobs—other people talk about us and our work.

Scott: How do you handle the firm's finances—the income?

Pinkham: It is all one central pool. It has more or less had to be that way, inasmuch as I have been doing a lot of professional work with the specification and code groups, which does not bring money into the firm. But the arrangement works so long as it is acceptable to the others; they know that I can give them the most current information. So in that sense it benefits everybody in the firm, but does not pay well.

Scott: Also, you get the firm's name around by doing this, so that probably helps.

Pinkham: Yes.

One Advantage of Being a Small Firm

Pinkham: Let me mention building specifications (not design specifications) as an example of why we keep our firm small. The specifications are a verbal document describing required materials, properties, and so on. They

are an essential part of a building's construction documents, along with the drawings. On a very large job, the engineer would probably hire a spec writer to generate the specifications and would not be intimately involved in them, although that engineer would review the specifications before the job goes out. In some of the larger firms, however, the specifications don't normally get the kind of review you really would like to see.

Scott: So you think being in a small firm helps with this?

Pinkham: Yes, it helps to a certain extent. In fact, that was part of Steve Barnes's reasoning as to why he did not want to be in a larger firm. He wanted to have a feel for all the jobs that were going through the firm. And for the most part we have held to that. At least one of our senior people is pretty knowledgeable about each and every job we do.

It is quite a problem to do a really good job on a set of structural engineering specs, and there are even more problems with mechanical and electrical specifications. One difficulty is the tendency to write standardized specifications. On federal jobs, for example, the design engineer is given a standard write-up, which he then modifies to fit the job; but there is a significant problem with working from such standardized write-ups. Many parts of the specifications—particularly on major structures—can be quite lengthy and sophisticated. Often things can be overlooked and not modified properly.

When bids come in to perform a certain process, bidders often propose doing it in a whole bunch of different ways that meet different

specifications. So writing anything ahead of time, other than a so-called performance specification, may be difficult. Performance specifications outline how you want the thing to perform and let bidders come in and show how they can do it. That is more or less what is done with aircraft. They write the aircraft performance capabilities they want and then let bidders come in and show how their proposal can do the job.

Scott: So to sum up, specification writing is one area where the small firm has an advantage, because some senior engineer in the firm will be intimately knowledgeable about every project?

Pinkham: Yes.

Downside: The Gap Below the Principals

Pinkham: Our approach does, however, create a bit of a problem in the firm's continuity. When we do get young people who have gained experience with us, they have had the tendency to go off and form their own firms rather than stay with us and join us as principals. Thus we have a gap between our principals and the people who work for us. It is not the same now as it was back in the earlier days when we had seven principals. So our pattern of working has had one unfortunate aspect: we have not been able to build up a group of younger people whom we could foresee turning the business over to.

Scott: You do not have a junior cadre coming along and moving up to be full professionals?

Pinkham: That's right, we do not have that, and it is a very deep concern to us. I do not know that we will be able to continue operat-

ing. Bob Spracklen is the youngest, and I'm over eighty.

Scott: Have you tried to get junior staff to come in and move up, or is that kind of difficult?

Pinkham: We have not found anybody who would be compatible with this type of organization and willing to stick around. We have had a number of people on the staff whom we thought would fit in as principals, but about the time we were thinking about asking them to join, they would leave, saying, "No, we want to do it on our own." That has been the situation for many years.

Scott: That has happened to other firms. Mike Pregnoff and Jim Stratta both told me about their experience. Jim was working for Mike, and they were really pretty close; but about the time Mike was thinking of asking Jim to become a partner, Jim and Al Simpson went off and set up their own firm. So that has apparently been a frequent pattern. They come up through the firm, learn the ropes, and then after a while they go on, perhaps to set up their own shop.

Pinkham: Yes, quite a number of people have graduated from this firm, and they're off in their own business. If we had a few younger ones around, I'd feel much better, and it would be much easier for all of us.

Upgrading Existing Buildings

Scott: How would you characterize the main bulk of your firm's work?

Pinkham: The bulk of our work is still actually the design of buildings, although these days it is more about upgrading existing build-

ings—adding on, fixing them up, changing their occupancy, or enlarging them.

Scott: The upgrading is not necessarily in connection with seismic retrofit, but simply enlarging or modifying their buildings?

Pinkham: That's right. And some industrial problems are also involved. One example of such a job was relocating a whole series of drop hammers for Douglas. That isn't too much of a design problem because they had been using these drop hammers for some twenty years or more and had had no problems. So we just in a sense copied what they had there from the old drawings and redid it. An especially interesting problem on that job was what to do with an inertia block, a block of concrete roughly thirty feet by thirty feet in plan, and thirty feet deep. What should be done with it, since it was no longer going to be used? Should it be left there, or dug out and disposed of?

Scott: That was a huge chunk—what was done?

Pinkham: Yes, it was a huge chunk. If it was left there, would it be an impediment to the use of that property? With that in place, at some future date they would not be able to easily run trenches to put in piping and what not—you would have to go around that block. But they were not trying to sell the property, they were just moving the drop hammers from one side to another. They were relocating their lines, changing facilities, rearranging the whole thing, because they needed the hammers in a different location. So they just left the block in place.

Recollections of Steve Barnes

Scott: Would you say more about your recollections of Steve Barnes?

Pinkham: From the beginning, as young fellows coming out of school, we took in quite a bit of the philosophy Steve Barnes had developed. Steve had his own approach to things. He liked to find out the specifics of any problem, and he wanted us to do that too. Sometimes when we couldn't figure out something and asked him what he would do, he would toss the question back to us and say, "You figure it out." He was sort of suggesting that our answer would be as good as something he could give.

I don't know of anybody who really did not like the man. He was a very enjoyable person. Even though there have been some personality conflicts, he was a steady person that everybody could get along with.

He was always trying to get into things that would be of help to the overall community, particularly with regard to earthquake problems. When the Schoolhouse Section was first started up under the Field Act after 1933, he was head of that for a very short while. Then he went off and formed his own firm—that was in 1934.

He did quite a bit of camouflage work for the facilities down on Terminal Island during World War II. For this work, he didn't get specifically into seismic design. That work was sort of special. For an earthquake you don't necessarily have to figure out the properties of chicken feathers, but for camouflage, you do. There are always different problems you get into—some that are crazy.

One time on a job, I found out that there are two different types of garbage. I didn't know

that they were categorized. One is “slop” and one is “hay.” I didn’t know that, and I don’t think it’s been put down in any book either. You bump into peculiar things like that every now and then.

Investigatory Work

Pinkham: As to the general trend of the firm’s work, Steve Barnes thoroughly enjoyed investigatory work: looking into situations where there were problems. A good many of Steve’s own clients were insurance companies. He got involved in quite a few situations where people had special problems, and he did a good deal of work as an expert witness in court cases. He liked that kind of work and kept at it until he was not able to get around physically to do the investigations. When it got to the point that Steve could no longer climb underneath houses nor on top of them, he figured that was enough. He quit because of that, not because he lost his eagerness for it. And he would still take problems that could be solved by looking at things in the office.

Earthquake Site Visits and World Conferences

Pinkham: As part of his investigating, Steve went on visits to some of the earlier earthquakes. He was more or less going “earthquake chasing”—as Henry Degenkolb did.

Scott: Yes, Henry Degenkolb often used that term: earthquake chasing.

Pinkham: Oh, Henry loved earthquake chasing, and he had to have about three cameras along with him, all slung around his shoulders. I bumped into him going through Pompeii when we were at the World Earth-

quake Conference in Italy in 1974, and he had many cameras slung around his shoulder.

Anyway, Steve went to earthquakes in Alaska, South America, and so on. Many times Steve would go along with John Blume; or if John wasn’t going, John’s wife, Ruth, would go along with Steve and his wife, because Steve’s wife knew Mrs. Blume very well. And the group would involve Bill Wheeler. They would go off to world conferences and visit some of the earthquake sites. So he had quite a lot of contact with earthquake matters.

Steve went to the 1964 earthquake in Alaska, having been asked to go there for the U.S. Corps of Engineers to take a look at Elmendorf Air Force Base. He went to the 1967 earthquake in Caracas and to one in Chile. Then, of course, we had the San Fernando earthquake here locally in 1971—we all went to that one. Steve chased earthquakes until it became difficult for him to travel. However, in recent years we have not been doing much of that. We are down to two men, and we just don’t have the extra time—except when we do earthquake visits for clients. In the case of the 1989 Loma Prieta earthquake, we had a client in Santa Cruz who wanted to know if their buildings were all right.

Irregular Buildings Committee

Pinkham: For a good many years Steve Barnes was chairman of what we at that time termed the SEAOSC² Irregular Buildings Committee. If there was a disagreement between the City of Los Angeles building

2. The Structural Engineers Association of Southern California was established in 1929.

department and a designer, and the building department didn't know which way to go, they could ask SEAOSC to convene the Irregular Buildings Committee. The committee would sit as sort of a group of peers to review the problem and make a decision, and both parties would have to abide by it. The committee was initially set up to examine a particular problem facing the City of Los Angeles. Later, it was formalized into a continuing committee for any

community that asked SEAOSC for such help, but most of the committee's meetings were with the City of Los Angeles.

Scott: It was a special appeals body?

Pinkham: Yes, a separate little appeals court. For a good many years, Steve was usually the chairman of that committee.

Materials Testing

In earthquake engineering, the material variability problem is complicated by the fact that stronger may not be better.

Development of Materials Testing

Scott: Tell us about your work on diaphragm testing, as well as other kinds of testing.

Pinkham: The very first testing job was run down at Terminal Island, back in 1949. H.H. Robertson had an arrangement with Bethlehem Steel to build the test jigs and the test frames at the shipyard on Terminal Island. The testing was done there. It was a while before other deck manufacturers started competing. For a time, H.H. Robertson was the only company that had diaphragm values that engineers could use in design so that these floor or roof components could be counted on for resisting lateral forces. At that time, there weren't many steel deck fabricators. It actually wasn't until the mid-1950s that Inland Steel came along and ran some tests to develop design diaphragm values. Fenestra, a break-off from H.H. Robertson, also ran some tests at Cornell University.

Steve Barnes went back and witnessed the tests there, and we reviewed the report Cornell came up with based on their testing. We played a part in that research, analyzing the data for use by designers. That activity sparked the industry's interest

in testing for many years. Cornell continued diaphragm testing, but they have not done any since 1979; Cornell has gone on to other areas of cold-formed steel testing. “Cold-formed” and “light-gauge” are synonymous. You can bend relatively thin pieces of steel into the desired shape at room temperature. Thicker sections, like the columns and beams constituting the steel frame of a highrise, are hot-rolled—shaped with machines while the steel is hot and more pliable.

Cornell’s testing started in the time of George Winter. George was a professor at Cornell and initiated the design procedures for cold-formed steel for the American Iron and Steel Institute (AISI); steel decks fell into that general category. George was intimately involved with that work until his death. He was also a member of the AISC Specification Committee and the ACI 318 Committee, so he had sort of a broad review of code writing and testing, which his successors have taken over since he died. Cornell is still continuing with those interests.

One of Dr. Winter’s successors is Professor Emeritus L.D. Luttrell of West Virginia University. Since leaving Cornell, Luttrell has continuously been interested in developing design criteria for steel deck diaphragms. He has provided the testing and development of the diaphragm criteria for the Steel Deck Institute.

Scott: For the record, please give the full names of AISI, AISC, and ACI.

Pinkham: AISI is the American Iron and Steel Institute, the trade institute for the steel mills. They were the group who backed George Winter in his initial testing and writing

of the first edition of *Cold-Formed Steel Specifications* (1946).

AISC, the American Institute of Steel Construction, was established in 1921 and is a separate entity. They are an institute of fabricators of hot-rolled products and are the ones who come up with the design specifications for hot-rolled steels.

ACI is the American Concrete Institute, which handles the design specifications for concrete structural systems (ACI 318).

Description of Tests

Scott: I take it your role has been to set up the programs, but someone else does the actual testing?

Pinkham: That’s right. We assist in setting up the test jig, and if there is no test jig, we design one. We set up the test program, witness the tests, and take the data from an independent testing lab as required by code officials. This is to ensure that the data is independently gathered, rather than by somebody who is financially interested in the outcome. Then we analyze the information from the test and put it in a report format to submit to code authorities to gain their approval of a product and of its performance. You are right, we do not do any testing ourselves—we have no testing facilities.

Scott: Is testing today different from what you were doing then?

Pinkham: Not that different, although testing has been modified a little, so there is some dissimilarity. We keep getting asked to solve some problems that I think should have been done a long time ago. The initial diaphragm tests were actually run using a three-bay test

jig. Tests were set up so one part could be held while the other part was pulled. It was more or less like holding a bow and pulling on the bowstring. The specimen to be tested would be put alongside a very strong steel beam. The ends of the specimen were fastened to the beam, and jacks applied loads in two places, one-third of the way in from each end. The test jig was entirely free to rotate and move about, but instrument readings could be taken at all corners and at all load points, and one would be able to work out what the actual deformations were at the various loadings.

But since the Fenestra tests, which were run in the early 1950s, the test jig and test specimens have been modified for a cantilever-type test. Frames were used in which a very rigid jig (reaction element) supported a single rectangular or square test specimen. A jack loaded the specimen, which was reacted to by the jig. So the specimen was tested in shear, as opposed to the other method of testing—a three-bay system that tested in flexure. The cantilever frame is a much easier method of testing, so testing has generally used this method.

You can get the same information from cantilever frame tests that you would get from the other type of test. Some very large and strong testing has been done at Iowa State University by Professor Max Porter, who also used a cantilever test jig. His load input was at a slow rate with load reversal, using jacks at each edge of the free end of the cantilever. It rocked back and forth (cyclic loading), rather than making a single pass in one direction (monotonic loading). Porter was specifically testing very strong systems: concrete-filled diaphragms. He had an extremely heavy abutment at the back of the

specimen, to which he attached the specimen in order to simulate a continuous element, rather than just tying it to the corners. As far as the actual shear strength and stiffness of the diaphragm is concerned, it doesn't really make that much difference—I think the answers are essentially the same. Rarely has a whole building been tested, except when a large earthquake comes.

Scott: I presume the diaphragm testing you have been involved in is done principally for seismic design purposes?

Pinkham: Yes, seismic loading is principally a horizontal loading, and the testing simulates seismic loading. The designer has to create a method of transferring the seismic responses of the building system's distributed masses to vertical structural systems that carry the loads to and from the ground. Either diaphragms or braced systems are used for that purpose. The testing is done to get an idea of the strength and stiffness of diaphragms.

Basic Considerations in Designing Tests

Scott: You have given a good brief description of testing, but I realize that the subject is pretty complicated. Could you say a little more about some of the basic considerations that underlie decisions as to how to go about testing?

Pinkham: First off, the testing we do represents a compromise made in order to gain a little knowledge and get a general idea about the behavior of materials. Procedures are devised that will give a reasonable approximation of what you are searching for.

Dynamic testing of diaphragms is an example. When we first started testing dynamically, we

were using the very poor equipment that was available at the time. Those efforts failed utterly because the methods and equipment were not sophisticated enough. So we were not able to input adequate simulations of earthquake-type motions.

UCLA and Caltech developed one type of testing machine, which had offset horizontally rotating masses that simulated purely cyclical, sinusoidal-type loading. But that was still not really earthquake motion, which is more mixed and erratic, almost chaotic. While earthquake motion can be simulated reasonably well on modern shake tables, the one at the Earthquake Engineering Research Center in Richmond is not big enough to do more than test models that are only a fraction of the size of a real building. And the big one in Todatsu, Japan, which could do very large-scale testing, is closing down because it has been too expensive to keep going. It had been financed half by industry and half by government; but the economic recession in Japan at the time affected both the government and private sector's ability to continue the financing.

Another consideration has been the time required to assemble a specimen and get it on the table, which usually takes several months. So it is lucky to get three or four done a year, which means there is not time to get much accomplished. So we look for other methods of providing reasonable values for design.

There are also, of course, other approaches to testing. For instance, in testing diaphragms we were able to use some NSF (National Science Foundation) financing and to get help from Rockwell, one of the aerospace companies. Rockwell had some machines that we adapted

for testing diaphragms on a set of tests that were especially related to wood roof systems, which are found in older existing buildings, particularly unreinforced masonry buildings (URMs). We were able to run tests on a real-time basis and get motions that simulated what might be found in an earthquake.

That testing was part of the work of the joint group Agbabian-Barnes-Kariotis (ABK). ABK's work was associated with the City of Los Angeles, which had embarked on a retrofitting program for URMs.³ ABK did quite a lot of dynamic testing of diaphragm materials and systems, primarily centered around trying to understand the behavior of diaphragms in URM buildings. Albin Johnson of our firm headed up our portion of testing for ABK.

Where there are very rigid vertical systems such as unreinforced masonry walls and comparatively flexible diaphragms, the driving force for the motions is really the flexible system—the diaphragm—rather than the rigid system of the wall. While it may be the wall that eventually comes apart, the response to the input motion from the earthquake would be controlled by the flexible diaphragm. The ABK effort attempted to get a better understanding of this concept.

Even those ABK tests were not a total simulation—the only total simulation would involve getting results from an actual building during

3. "Methodology for Mitigation of Seismic Hazards in Existing Unreinforced Masonry Buildings: Diaphragm Testing." Topical Report 03, December 1981. ABK, A Joint Venture, for the National Science Foundation. Contract number NSF-C-PFR78-19200.

different earthquakes. Even with results from actual earthquakes, it is pretty hard to dissect the root causes of damage because most buildings are such complex systems.

Approval of Building Products

Pinkham: Most of the testing we have done on diaphragms has been to assist people in getting design values established and approved by ICBO Evaluation Service, so they can be used in designing buildings. ICBO is the International Conference of Building Officials, which has promulgated the Uniform Building Code.

Scott: For the uninitiated reader, say a little more about where your testing work fits into these activities aimed at product approval.

Pinkham: Our own testing and analytical work is primarily at the interface between a manufacturer trying to sell a structural product and the reviewers considering the product for use by the code agencies. There is a gap between those who are essentially selling something and those who are trying to review something analytically and critically. The language is not quite the same. We try to fill the gap by taking the information and presenting it in such a manner that the reviewers and users can understand the data and write a report that accepts the product for certain applications.

Scott: Is there a conflict between the manufacturer's wish to make his products look good and the need for realistic, demanding tests?

Pinkham: I think a manufacturer's real concerns are with meeting the competition. They would like to have the same playing field as their competitors (or slightly better, if possible). So the real concern I find among vendors is not

just that they beat somebody else, but that they are at least on a par with their competition. For example, say one manufacturer or vendor gets certain approvals, but then a competitive firm that would like to have exactly the same approval is unable to get the same test results.

A lot of things can influence test results. The same individual running tests on the same kind of specimen a year or two later may come up with somewhat different results. There is usually some variability, no matter who does the testing—even when using the same testing agency and similar tests. Sometimes they just need a couple of thousand more specimens to test in order to get the full range of results—the whole bell curve, instead of just a few points on it. To sum up, I think manufacturers and vendors are always looking for ways to have something that is at least slightly better than their competition, and at less cost.

Scott: Another problem in testing is the variability in performance found in many if not most building materials. They vary some. Yet the designer needs to have a pretty good idea how the members he is working with will perform under earthquake loading.

Pinkham: That is right. There is variability in construction materials, whether concrete, steel, masonry, aluminum, or timber. Steel specified to have a minimum yield of 36 ksi has been found to have yields way into the 50+ ksi range. Also, in an earthquake, the stronger material may hurt the design—particularly in the design of connections—rather than help it. The typical assumption is, “If it is stronger, it is better.” But that may not be the case in earth-

quake design. This is the really big problem that the steel industry is facing.

Unexpectedly high strength at some point may place greater demands at some other point, which is not what the designer had in mind. In earthquake engineering, the material variability problem is complicated by the fact that stronger may *not* be better. It will probably take many years to test this out and really to understand it.

Model Code Agencies

Scott: I take it that in due course the results of much of the testing are incorporated into key standards that, in turn, are generally accepted?

Pinkham: Yes. It is part of the code process, but the results of the tests and analysis are not themselves incorporated into the codes. Instead the results come out in the form of source books. The Evaluation Service of the International Conference of Building Officials (ICBO) has published all these evaluation reports, which are one of the sources of information on the performance of building systems—structural products, roofing, and so on.

About twenty years ago, a joint nationwide service, the National Evaluation Service, was started. That is a combined effort of the three code organizations, ICBO, the Southern Building Code Congress International (SBCCI), and the Building Officials and Code Administrators International (BOCA).

Scott: So three model code agencies have joined forces together under the Council of American Building Officials (CABO) and issue this as a joint product?

Pinkham: The National Evaluation Service and the ICBO Evaluation Service publish reports that are accepted by model code groups and which serve as recommendations to code authorities. The City of Los Angeles has now finally accepted it, but even before Los Angeles did, most of the other California communities were using all of these things as backup to their own codes.

Recently, the three model codes combined their efforts and produced the *International Building Code 2000*, which will be used as the basis for implementing a nationwide building code. How well the amalgamation will work will probably be better known after the first code cycle, which is scheduled for 2003. At the present time, either UBC 1997 or IBC 2000 can be used for the development of National Evaluation Service and the ICBO Evaluation Service reports.

Another development by ICBO Evaluation Service has been a compilation of “Acceptance Criteria” that detail the methods and organization of the evaluation reports. Over 150 of these acceptance criteria are currently in effect.

Los Angeles Research Unit and Colonel Rapp

Scott: Los Angeles used to do an independent review of the evidence on performance, but now the department accepts other reviews and evaluations?

Pinkham: Yes. The City of Los Angeles had their own approval system. They still have their own research unit, which reviews the ICBO evaluations for conformance with the city code, but the research unit does not do any testing.

Scott: How does the Los Angeles process work? Also say a word or two more about the research unit.

Pinkham: Applicants now can have an approval based on the ICBO Evaluation Service approval. The City reviews the approval, and if anything contradicts what is given in the Los Angeles Building Code, then the local code prevails.

Scott: Previously, the City of Los Angeles had its own separate review and approval system. Was this because Los Angeles was substantially ahead of most other code-enforcement jurisdictions?

Pinkham: Yes. It started many years ago when Colonel Vivien Rapp was head of the research unit for at least ten or twelve years, probably having come to the Department of Building and Safety after World War II. Like many of the other people in the department at that time, he was never a member of the Structural Engineers Association. I am not sure when he left the department, but he was there at least until the late 1950s, when his successor, Walt Brugger, took over the research program.

While Colonel Rapp was head of the research department, he was the person you had to deal with. He not only carried the title of colonel, but also let you know about it and asserted himself in various other ways. For example, he had several little signs around his office, one of which said something to the effect that he did not give a damn what went on outside of the boundaries of the City of Los Angeles, but he sure as hell did care about what was done within those boundaries. Another little placard on his desk said something like: “YOUR

ARGUMENTS ARE ALL SOUND . . . ALL SOUND.” Presumably that was to warn visitors that they should not necessarily expect him to agree with what they said.

Scott: He sounds a little uncompromising.

Pinkham: Very much so. Colonel Rapp had a very dogmatic approach to things, always stood his ground, and was not one to be pushed around. Thus he carried on a long-term argument with Underwriters Laboratories that lasted for years. Despite his being difficult, however, I think Colonel Rapp was rather effective. But when you dealt with him, you had to be very straight; he was someone you could talk to as long as you kept it completely on a professional level. We always tried to do that in our relationships with the City and with ICBO—to keep it strictly on a professional basis. And I think we always enjoyed good relations with the department, then and now.

The research unit is still there, but is not operating in quite the same manner as when Colonel Rapp was in charge. During his tenure, he did not have any of his actions or approvals written down—that was all in his head. So when Walt Brugger took over afterward, he had no records of the previous approvals and actions. That made it very difficult for Walt when he came in.

Some Unusual and Exceptional Testing Projects

Scott: I realize that most of the testing you are involved in is done to help qualify new systems for ICBO and other code agencies, but I would also like you to give some examples of

the unusual kinds of projects that don't fit the typical pattern.

Pinkham: One example of an exception was a building in Arizona that had been completed before it was discovered that the connections were not right. So they needed to find out how good the actual diaphragm was, which did not conform to anything we had tested. To do that, we ran a special test for that particular configuration. We assembled a test jig and frame that did exactly what they had done in that building. As I recall, the configuration tested out to be adequate.

Another exception involved the Citicorp Building in New York, which had been designed by the firm of W. J. "Bill" LeMessurier. Bill LeMessurier's firm, which has designed all over the world (Saudi Arabia, for example), was also involved in fixing up the Hancock Building in Boston for wind motion. He used mass dampers to resist wind forces, moving masses automatically by computer to create forces opposite to the wind forces. During heavy winds, that cuts down on the building motion quite significantly and holds a building relatively still.

The Citicorp Building in New York was very peculiar. There was an old church—a historical monument—on one corner of the lot the building was to occupy. So for the first eight stories, all four corners of the building were voided. Up to that height, the whole structure was supported on four points. Above that height, the building filled out the corners, and that was supported by bracing that came down to the four main supports.

You normally design for wind forces in one direction, and then for wind at a 90-degree

angle to that. For wind in those directions, the braces were always in compression regardless of what the wind did. But they did not design for wind in a diagonal direction and never checked the diagonal until the building was built. Then they learned that those enormous braces would have to take quite a lot of tension and that the connections would not handle it.

After tenants were being moved into the building, the engineer went to the owner and said, "The building is not safe, and I know what to do, but it will cost money." The owner went along and accepted a less-than-cost settlement with the engineer's insurer for the necessary work. They had to redesign connections for many of the braces so they could take tension as well as compression. The members themselves were all right—it was the connections that had to be redone.

They redistributed the forces in the building on every eighth floor, so in effect, they had a series of eight-story buildings working inside a bigger building. The diaphragm characteristics needed at every eighth floor, where they did the redistribution, specified some quite high forces. The designer needed to verify that the diaphragm already built into the building would qualify. They asked me to go back and help them figure out how to determine the capability of that system.

They were particularly concerned about an area where they had "trench headers," and the design engineer wanted to get better evidence of the actual strength of the diaphragms under those circumstances. Many tall buildings have concrete floors on a steel deck system and feature trench headers—places where the concrete is eliminated from the steel deck. Where a

trench header occurs there is about a 3-foot space with no concrete on the deck. The question was, What effect does the exclusion of concrete have on the entire system's ability to act as a diaphragm?

It so happened that one tenant was going to occupy two adjacent floors and wanted a stair between them. We had them cut the hole for the stair in such a manner that we could do an in-place test of the diaphragm. Instead of knocking out a hole to build the stair, we cut a slot around the section, leaving it partially connected long enough for us to test it in place. Everything came out okay: the diaphragm was adequate for the need. That test was quite unusual—it is the only test of that type that I've ever done.⁴

There was also the case of a California cellular floor system, composed of double decks with one sheet welded to another with shop welds. The system was brought out to the job site already welded down and ready to install when they noticed that some of the welds were about 50 percent not fastened; they were broken or incomplete. They wanted to determine whether this could be repaired by replacing the welds with screws. We had them put the screws in a separate assembly, which was put in a jig for testing screws in lieu of welds. The test showed that the screws would do the job. So they were able to fix up the job that way. Periodically things of that nature come along that differ from the normal testing processes.

4. The 1978 Citicorp experience was discussed in a *New Yorker* article by Joe Morgenstern, "The Fifty-Nine Story Crisis," May 29, 1995.

We have done quite a bit of work on the testing of composite slabs made of steel deck and concrete. That has not been as steady as the steel decking diaphragm-testing work, because usually the firms we deal with develop a shape themselves and only need one test series to find out its capabilities. We work up a set of load tables for them to submit to the code people. After that it might be a long time before that firm comes in with a new composite slab for testing. Also, several other people around the country do that kind of testing and analytical work.

There are numerous ways of analyzing such test results. While there have been efforts to boil things down into one standard, there is still no single standard in use, because there are still about five different ways of doing the analysis. They are all more or less acceptable because they are all based on test data and they all come up with approximately the same answers. You have to test and choose the actual test make-up so you do not have to test all of the sizes and all of the variables. You test certain ones and interpolate the data between those. The differences are basically in the approaches to data interpolation.

We also got into testing with some peculiar testing jig designs, particularly in industrial design. Years ago, we designed a test jig for Douglas Aircraft Company to test full-size sections of the DC-8, when they were originally designing that model. In a sense, we put sort of a birdcage on each end of the section. The cage at one end was fixed, and the other one was moveable with jacks. The unusual part was that the whole system turned out to be a bolted three-dimensional cage. There was one spot

right in the middle that had twenty-six members coming into one bolted joint.

It was difficult to draw up something that could convey to the steel fabricator what we wanted made. We were trying to give a three-dimensional picture of something that was quite unusual. We tried every which way to get it on the drawings, trying three-dimensional perspective views of the thing, breaking it down into sections, and so on. At one point, I used a spool of wire to make a little three-dimensional model of what the actual cage would look like. The fellows here in the office who were doing the drawings used that wire model as a reference. The steel detailers finally came to our office, and when they saw that model they grabbed it and took it with them. Being three-dimensional, the model was better to work from than the drawings—the detailer could see where everything was.

SAC Steel Project

Pinkham: A lot of new experimental testing has been accomplished as a result of the 1994 Northridge earthquake and the SAC Steel Project. SAC is a joint venture partnership of the Structural Engineers Association of California (SEAOC), the Applied Technology Council (ATC), and the California Universities for Research in Earthquake Engineering (CUREE)—now Consortium of Universities for Research in Earthquake Engineering (CUREE).

The SAC Steel Project has focused on the behavior of the structural steel moment frame beam-to-column connection. That project tried to determine the fundamental behavior of materials typically used in these connections. It

is very difficult to simulate in the laboratory what is actually found in the field. It took quite a lot of testing to duplicate some of the failures observed in the earthquake.

Also, in testing it is important not to overlook some of the seemingly unimportant things that may later prove to be part of the overall story on the behavior of materials. For example, in some of the post-Northridge work done apart from the SAC Steel Project, a lot of large-scale testing was done, but some very basic material problems were not tested—not just welding problems, but problems of the basic material itself (the steel).

The “through-thickness” strength of column flanges, for example, was a significant concern. Sometimes the material itself actually pulled apart, so the failure was not just the flange connections breaking. For steel to yield, it has to elongate over a certain length. At the intersection of the beam to the column, the steel cannot yield, but goes into a tensile or brittle-type failure. This was one of the properties of steel that was tested during the SAC program. It was concluded, however, that this potential problem is not critical in the design of moment frame connections.

Scott: So the engineer needs to know when such a problem is critical. Otherwise, he may be trying to design something to resist forces that it may basically be unable to resist.

Pinkham: Yes. They may test a specimen and find that it tests fine. But you need to know how much the material properties can in fact deviate from what the test showed and still come out okay. The “dog bone” is one configuration that is promising. Inelasticity is made to

occur where the beam section is reduced. But the usefulness still depends on knowing the property of the steel in the column.

The dog bone shape allows the material to elongate before causing the connection to the column to break. As part of the SAC Steel Project, there is a report that displays a collection of the types and details of moment frame connections that have been shown through testing to perform to different ductility limits. I hope it will become a living collection so that as more tests are performed they can be incorporated into the listing.

Welding

Scott: What about welding? Welding involves steel building materials modified by the welding process.

Pinkham: I think the testing in the SAC Steel Project, along with other outside studies, has provided a fairly good handle on welding. But then it is a matter of actually getting the work done properly in the field. The engineer needs to understand the welding processes and the problems in order to specify a proper weld. That is all spelled out by the American Welding Society (AWS), but I think most engineers don't read their material very diligently.

Scott: In general, would you say testing is becoming more and more sophisticated all the time?

Pinkham: Well, somewhat more sophisticated. The bulk of physical testing that is done is actually fairly routine: checking on such things as concrete cylinders to see if the concrete is strong enough, or checking steel speci-

mens to find out if they have the right material. The difficult kind of testing tries to understand the philosophy of design. That kind of testing is much more demanding and much more costly.

Scott: When the needs are military or for the space age, government support is available for the testing to be done. We don't get that level of government support, however, for something like earthquake-related testing. And the private sector alone cannot come up with that kind of money and make up the difference.

Pinkham: Yes, and we need that kind of public-private fusion to get some of these jobs done. In aerospace, they use quite sophisticated analysis in designing things, but prior to placing their planes in use, they test them. We do not get the opportunity to test a building after it is finished, until an earthquake comes along. It represents a major difference between aerospace engineering and earthquake engineering.

Scott: We mentioned Henry Degenkolb earlier, and how he used to insist on actual earthquake site visits as an invaluable part of the learning process. The site of an earthquake is a real life laboratory, but the observations take a lot of interpretation, because most buildings are not instrumented.

Pinkham: I agree with Henry Degenkolb on the importance of observations of actual earthquake damage and site visits; that is a real testing laboratory where a lot of the problems can be found. But you are right, sometimes it is awfully hard to dissect the results and fully understand what you see in a site visit.

Seismic Concerns and the SEAOC Blue Book

I think that when the National Science Foundation chose Buffalo for the National Center for Earthquake Engineering Research (NCEER) in 1986, they were trying to break up some of the parochial trends.

Pinkham: At Berkeley in the 1930s and 1940s, we really heard nothing about seismic code work or design as related to building codes. About the closest I came was the course on aircraft design that I took with Howard D. Eberhardt as sort of an extra. That course got into the theoretical background of the strength of systems. Actually, it was a very good course in the sense that it gave a broad understanding of the behavior of materials and systems. Eberhardt was around Berkeley for quite a while. I sat with him at a Berkeley Faculty Club dinner once, and we did a lot of reminiscing. During the war, he lost his leg while doing tests on airport paving.

Statewide SEAOC Seismology Committee

Scott: I presume you became active in seismically related matters soon after joining Steve Barnes?

Pinkham: Yes. Of course, seismic matters were more or less always part of the design work we did in the office. As far as activities outside of the firm's work, I started getting immersed in the committees of the Structural Engineers Association of Southern California (SEAOSC) in the mid-1950s, and in 1961 I got on the statewide SEAOC Seismology Committee. I maintained my connection with that committee for about fifteen years. My direct connection with the statewide Seismology Committee lasted until around 1975, the year I was the state President of SEAOC. Of course, being President meant that I had some involvement with the committee, even though I was no longer a member. Subsequent to that, I've just been operating with the local committees of SEAOSC. For many years, I periodically attended meetings of the statewide Seismology Committee.

SEAOC Blue Book

Pinkham: Let me give you a little history of the SEAOC Seismology Committee and the Blue Book.⁵ Around 1950, about ten years before the first SEAOC Blue Book was com-

pleted, a northern California group had written a report for ASCE called Separate 66.⁶ Meanwhile, the seismic part of the Los Angeles building code was developed. That was during the war, and I wasn't here, but they had a slightly different approach from the one up north.

Then in the mid-1950s, Los Angeles removed the limit of 13 stories and 150 feet, which had been in existence for zoning purposes—not for earthquake concerns—for over thirty years. In the early 1920s, the city council and people who were politically involved apparently did not want Los Angeles, which was beginning to grow rather fast, to be a city that had only a little space between tall buildings. So the limit was put on to keep buildings short and to encourage a spread-out type of development. That is one of the decisions that started the sprawl that characterizes Los Angeles.

When Los Angeles removed the height limit in 1954 or 1955, they had to accommodate their building code to that change. One approach would have been to adopt Separate 66. But instead, the southern and northern groups of SEAOC decided they should get together and see if they could come up with a common approach. That is how the statewide Seismology Committee got started, and the first Blue Book was written in 1959. I got on the committee in 1961 and later was chairman for three years, 1968–1970.

5. *Recommended Lateral Force Requirements and Commentary* (SEAOC Blue Book). Structural Engineers Association of California, Sacramento, California. First edition published in 1959 without Commentary. First complete edition published in 1960.

6. "Lateral Forces of Earthquake and Wind," A.W. Anderson et al., *ASCE Proceedings—Separate 66*, April 1951. Separate 66 is discussed at length in *Connections: Michael V. Pregnoff and John E. Rinne*, EERI, 1996.

Scott: The initial SEAOC Seismology Committee was the one Bill Wheeler chaired?

Pinkham: Yes, Bill Wheeler was chairman, and Steve Barnes was on it, along with a lot of others. Together they wrote the first Blue Book. In the 1999 Blue Book, under “Acknowledgments,” there is a listing of all of the members who have served on the SEAOC Seismology Committee since its inception.

The development of the Blue Book started the activities of the SEAOC Seismology Committee, which are still going on. The first Blue Book was dated July 1959, and the first revised document was printed in 1960—which got a little fatter primarily because a commentary was developed, with explanatory information that went along with the design provisions and gave a little of the thought process behind it. So the 1960 edition more or less completed the initial effort. Changes or revisions have been made periodically since then.

The 1967 edition was the one that actually introduced the concrete provisions, and there were some rather extensive changes in 1968. Next came the 1973 and 1974 editions. The 1974 edition was the one that was used in the Uniform Building Code (UBC) for many years.

Scott: Then in 1975, the thicker loose-leaf commentary went along with the 1974 material.

Pinkham: Yes. Then the next edition came in 1980 and made some minor revisions to the 1975 edition. The 1980 edition was used until the 1988 edition (the fifth edition). In 1990, the fifth edition was published with a commentary. Since then, the Seismology Committee has been working on changes to go directly into the seismic provisions of the UBC. Because of

the timing, it must go to ICBO in order to get into the UBC. So new revised analyses and procedures were developed for inclusion in the 1996 modifications to the UBC for release in the 1997 UBC. This edition will be the last UBC edition until the 2000 IBC.

Meanwhile, a SEAOC group called Vision 2000, separate from the Seismology Committee, has tried to take a leap forward and lay out what they think the seismic codes will look like after the year 2000 and beyond.⁷

I should also mention that ICBO and the other two model code agencies are now anticipating that they will amalgamate in the year 2000, after which there will only be one code. I recently asked John Nosse, who heads the ICBO Evaluation Service, what he knows about similar efforts to amalgamate the evaluation services, and if so, how that relates to the National Evaluation Service. Nosse does not see any indication of moves to amalgamate the evaluation services, which all operate differently. So we shall see how that works out.⁸

Scott: Talk a little about the SEAOC Seismology Committee and how it works. Is it almost continuously engaged on Blue Book revisions?

Pinkham: At the beginning, they had an extremely large committee, which came up with the first Blue Book. They needed a large committee to represent different viewpoints and bring all the parts of the state together.

7. *Vision 2000: Performance-Based Seismic Engineering of Buildings*. Structural Engineers Association of California, Sacramento, California, April 1995.

8. ICC Evaluation Service was established in 2004.

The committee setup since then calls for a little explaining, because the four regional structural engineer associations are four independent groups, and the rules governing each of them are different. For instance, the Structural Engineers Association of Northern California (SEAONC) allows a person with a civil license to be a voting member, but the Structural Engineers Association of Southern California (SEAOSC) does not.

Each of the four associations has a specific number of members on the Seismology Committee—I think it's three members from San Francisco, three from Los Angeles, two from San Diego, and two from Sacramento. Then there is a chairman who rotates. There is also a chairman-elect, so the person who will become the next chairman also meets with them. And I believe the old chairman stays on for one year afterward. I don't know all of the current rules because I haven't really had direct knowledge of their operations since 1975, although I've gone to occasional meetings.

The 1988 Blue Book was a major operation, however, because they wanted to convert over and take as much as they could out of the Applied Technology Council (ATC-3) document.⁹ So the work was split up, and the individual work and the writing of the various segments was done on a much larger basis. Individual segments of the work were split

9. *Tentative Provisions for the Development of Seismic Regulations for Buildings*, ATC 3-06, NSF 78-8. June 1978. Prepared by the Applied Technology Council, Redwood City, California. Pinkham served on the ATC 3-06 committee for approximately four years.

among subcommittees—people not on the Seismology Committee. For example, if SEAOSC (the southern association) did the writing on the steel section, then that would be reviewed by the other groups and argued on the floor. The writing assignments were distributed because of the enormous volume that they had in trying to adapt to ATC-3.

I should also mention that the other structural engineer associations, such as those in Washington State, are very active and send a representative to the California Seismology Committee meetings. Arizona also gets quite involved. And the industry people come in and have their say-so. Sometimes it can be quite a sizeable gathering, depending on what is being discussed.

SEAOC Blue Book, 1968 Revision: Concrete

Scott: You mentioned the concrete revision in 1968. Would you discuss that further?

Pinkham: There was a major revision in 1968 when the concrete industry got around to assembling enough information to make it possible to build tall buildings out of concrete. Prior to that, the Blue Book was more or less pointed toward steel in tall buildings, and no details were given on how to handle concrete.

The material added in 1968 specified rebar encasement provisions for confinement of concrete. The 1968 edition was intended to answer questions raised when the City of Los Angeles eliminated their limit of 13 stories and 150 feet. The City only permitted the design to go over the limit if it had a steel frame.

The concrete people had been partially excluded from the area of tall buildings, so when the limit was removed, they got busy.

Within a couple of years, by the early 1960s, they had a book out that more or less explained what they wanted to do.¹⁰ But then it took several years to get it written into accepted and approved code provisions. About this time (1967), I became Chairman of the SEAOC Seismology Committee, and as I said, I chaired it for three years—1967, 1968, and 1969. So the 1968 concrete revision happened while I was Chair.

SEAOC Blue Book, 1973 Revision: After San Fernando Earthquake

Pinkham: The next major change was actually made in 1973, after the 1971 San Fernando earthquake.

Scott: The main Blue Book changes in 1973 related to observations of what happened in San Fernando?

Pinkham: Only partly. A lot of things had been observed in earthquakes in Mexico City, South America, and the big one up in Alaska. That information had come in even before the San Fernando material came in. So the Blue Book was being modified to respond to all of the information that had become available on its shortcomings. Certain things were found to not have been done quite right. This was the first major revision that incorporated all of the groundwork based on people actually observing earthquakes and analyzing the problems. However, the 1973 revision was really initiated after the San Fernando earthquake.

Los Angeles County Earthquake Commission

Pinkham: One of the things I got involved with after the San Fernando earthquake was the Los Angeles County Earthquake Commission. The earthquake happened while I was President of the Structural Engineers Association of Southern California, so I was called to sit in on the earthquake commission, which made a report.¹¹

Scott: That was a pretty high-powered group—I see that Harold Brown, President of Caltech, was the chairman.

Pinkham: Yes. One chapter has quite a long discussion of the concerns about unreinforced masonry buildings (URMs). As a result of that, the County and the City of Los Angeles made a number of further studies. I mentioned before that my father had started up the city's parapet correction work, which had been done many years before the San Fernando earthquake. But parapets were only one facet of the problem.

The Earthquake Commission report emphasized the need to review the whole concept of how to mitigate the URM hazard. The issue sort of worked its way up from there, picked up first by individual groups, and then in more and more organized forms. Then the City of Los Angeles adopted its mitigation program for URMs in 1981. The City worked up a program for going ahead and fixing the hazard, and developed the initial requirements. Then a

10. John Blume, Nathan Newmark, Leo Corning, *Design of Multistory Reinforced Concrete Buildings for Earthquake Motions*. Portland Cement Association, Skokie, Illinois, 1961.

11. Los Angeles County Board of Supervisors, "Report of the Los Angeles County Earthquake Commission—San Fernando Earthquake, February 9, 1971," November 1971.

major research effort was made—the Agbalian-Barnes-Kariotis (ABK) joint venture study—which had NSF backing and was able to do some rather significant testing. Several reports were made on that work. Although the Los Angeles program was already set, and definite requirements had been adopted before the ABK work came along, the ABK method was also adopted as an alternate. As I mentioned earlier, test results on diaphragms factored heavily into the ABK approach.

Other Kinds of Earthquake Hazards

Pinkham: The 1979 earthquake in El Centro, which damaged a relatively new reinforced concrete county building so badly that it was later demolished, showed that URMs were not our only earthquake hazards. There are some rather serious deficiencies in some of our existing buildings. For instance, for many years the design of a flat slab permitted you to cut off the bottom bars as soon as they got into the drop panel of the flat slab; this would result in a lack of continuity on the bottom, through a column. Yet, when such a design deforms in an earthquake, moments develop at the columns that are reversed from those generated by normal gravity loads. As there were no bottom bars, and the bottom face of the slab could be in tension on the bottom, the section resisting the moment would be an unreinforced section.

I do not know of any way to repair this problem in a flat slab. In some older buildings the details do not provide reinforcement, so they are brittle. The only thing that can be done is to stiffen the building to the point where its deformation can be controlled. The real problem is how to deal with these existing buildings. They have to

be evaluated: are there reasonable ways of mitigating the hazards they present?

Scott: You would be looking for life safety?

Pinkham: Yes. If not, then maybe you could say, “All right, let’s make all of the new buildings as safe and up-to-date as we can, and earthquakes and time will eventually take care of the rest of them.” We could just follow a policy of attrition—but we don’t like to do that when life safety is at risk. We would like to at least determine what hazards are present and see if there are mitigating measures that can be taken, within reason, without necessarily having to bring the building up to the latest standards.

The City of Los Angeles is currently beginning to study how to handle the problems of unreinforced masonry infill buildings. These buildings have unreinforced masonry wall infilling between the steel or concrete columns, so they behave differently than a URM bearing wall building. The problems of the URM infill buildings were not covered in the Los Angeles URM program, although they were covered in the Long Beach ordinance that pre-dated the Los Angeles law. So it is a continually evolving matter. And of course, the level of interest varies depending on how long ago the last earthquake occurred and the kinds of damage that were observed.

Scott: Nonductile concrete is one of the hazards in existing buildings, isn’t it?

Pinkham: Yes. I mentioned the 1979 El Centro earthquake because of the county services building, which theoretically had been designed to have ductility. But there were a few oversights, and also the building was actually

built before many of the ductile details had been defined.

Similarly, some of the problems encountered in the San Fernando earthquake were caused by failures to include things that the code specifically called for at the time of construction. With rational thinking about what happens during an earthquake, however, the nonductile concrete problem could have been solved without having specific code provisions. So, instead of making requirements so rigorous that new buildings virtually cannot be built, we instead need to upgrade engineers' understanding of how to do good seismically resistant design work, while keeping costs down.

Recently, a FEMA-sponsored program conducted by BSSC/ATC/ASCE on nationally applicable *Guidelines for the Seismic Rehabilitation of Buildings*¹² has been completed.

Regional Differences Among Engineers

Scott: Henry Degenkolb talked about regional differences among California engineers. For example, he would say that at many earthquake sites he saw more northern California engineers than southern California engineers, and so he seemed to think that those in northern California were more active “earthquake chasers.”

Pinkham: That was true, and it was partly through his urging that more northerners went. But I also think Henry was half kidding

when he talked about that. He was originally from southern California himself. I think there were people in both the north and the south whose behavior he did not like.

Scott: Maybe he was kind of needling people, prodding them to get out and visit earthquake sites to see for themselves—to give them a little of the fire and enthusiasm he had about “earthquake chasing.”

Pinkham: On that subject, he would prod anybody, north or south.

Scott: I have often heard other engineers refer to north-south differences among California engineers. Do you think there has been a certain amount of north-south tension, or differences of opinion, on aspects of earthquake design?

Pinkham: I'm not so sure that it is really north versus south. Of course, regional differences can become something of a geographic split when you have two distinct areas with their two separate groups of people actively getting together, discussing problems, and sometimes coming to somewhat different conclusions.

To a limited extent, there was a north-south split in SEAOC; because the southern group formed first, their bylaws were slightly different from those adopted a little later in the San Francisco area. Those in the north were influenced by the people in Sacramento, who had civil licenses but not structural licenses, and yet were doing structural work—like the bridges. A couple of rather vociferous people in the Bay area helped make sure that in the north, civil engineers could be voting members, whereas they could not be in the south. That is, in addition to the civil engineering license, a SEAOSC

12. FEMA 273 and 274, *Guidelines for Seismic Rehabilitation of Buildings*. Federal Emergency Management Agency, Washington D.C., October 1997.

member had to also have the structural engineer's registration.

When I was president of the southern California association (SEAOSC), Keith Bull of SEA-ONC and I helped get ATC off the ground, and we tried to pull the groups somewhat together. Then, when I was president of the state association (SEAOC), I tried to get them to adopt common membership criteria. Now, after all this time, that has actually been done.

I also think there is a little problem because the people in the north see how many members we have down here. They see themselves outnumbered, and the disproportion is increasing. I have always tried to work with all of them. In fact, I was appointed to the chairmanship of the Seismology Committee by the south, the north, and the central groups, one after the other in different years.

Scott: You mentioned that some of the other western structural associations send one or more persons to the SEAOC Seismology Committee meetings. Would you say a little more about that?

Pinkham: Structural engineering associations have developed, particularly in Oregon, Washington, Hawaii, Arizona, and Illinois. Engineers in Washington State have become very active in discussing seismic problems, getting together with their peers, and developing their own approaches. Arizona is also getting into the picture more. Arizona does not have the high level of earthquake problems that we have here, but they have become active in pursuing some of these matters.

Scott: Are the other states going in somewhat different directions from California?

Pinkham: Yes, to a certain extent. It really is a matter of parochial concepts, in the sense that each group develops its own way of thinking and tries to promote that particular direction. Bringing the engineers together in the seismology committees of their state structural engineering organization provides a rather good place to air out differences of opinion and try to resolve problems. But a lot of times it gets to the point where really there's no way you can fully resolve them. They discuss these things in each state association independently and come to different points of view.

I see the same type of parochial engineering concepts not only here in California and the West, but also all over the country. I think that when the National Science Foundation chose Buffalo for the National Center for Earthquake Engineering Research (NCEER) in 1986, they were trying to break up some of the parochial trends. I have been chiding all the California engineers, north and south, for parochial thinking—because they are not paying attention to what is going on elsewhere, including back East. There are a lot of very able engineers in the East, and we should be taking them into account.

As it stands now, there are three national centers of earthquake study. MCEER, the Multidisciplinary Center for Earthquake Engineering Research at the University of Buffalo, New York, is the successor to NCEER. MAE is the Mid-America Earthquake Center at the University of Illinois. The Pacific Earthquake Engineering Research Center (PEER) is headquartered at the University of California, Berkeley, California. All of these centers are partially funded by the NSF.

Scott: I guess California structural engineers have reasoned that they know seismic matters best because they are closest to earthquake problems.

Pinkham: At one time, it might have been true that the California engineers had most of the seismic know-how in the United States. But now in the eastern and midwestern United States, a lot of the academic people have gotten heavily into earthquake research and testing through the efforts and funding of FEMA, NSF, and others.

Run-of-the-Mill Engineers Resist Change

Pinkham: Also, there are problems all over—in California and elsewhere—when it comes to run-of-the-mill practicing engineers. I'd say that ninety percent of those in California do not know what they are talking about when it comes to seismic design. A tremendous number of them are what you might call “minimum” engineers, and they just follow the code on the seismic matters.

Their resistance to limit state design is a good example. California engineers were accustomed to using the allowable stress or working stress approach, and there has been a lot of reluctance on their part—particularly those in the San Francisco area—to even think of limit-state design. Yet concrete has been a limit-state material since the 1950s. The engineers' resistance is a resistance to change, an unwillingness to learn something new, to spend time thinking about something they don't get money for doing. They prefer to follow their established routine.

Recently Founded Structural Engineering Organizations

Pinkham: In recent years, there have been efforts to place the profession of structural engineering in a stronger position nationally to assist in improving the standing of the profession. The first group formed was the Western States Seismic Policy Council (WSSPC), which has been active for over twenty years.

Another is the National Council of Structural Engineers Associations (NCSEA), which gives the member Structural Engineers Associations a chance to develop consensus positions on national issues.

Another is the Structural Engineering Institute (SEI), for which ASCE changed its structural division into a semi-autonomous institute.

The last is the Council of American Structural Engineers (CASE), which is a part of the American Consulting Engineers Council.

These last three organizations—NCSEA, SEI, and CASE—jointly publish *Structure*, a news magazine.

Tall Building Council

Scott: You are a member of a Los Angeles council on tall buildings, which meets annually. What is its formal name and what does it do?

Pinkham: It is called the Los Angeles Tall Building Council, and it has about eighteen members who are particularly interested in tall buildings. It is concerned mostly with structural analyses and the special design problems of tall buildings. Its purpose is to hold an annual conference.

I should also mention that ASCE has had a tall building council for many years, a joint venture between ASCE and IABSE (the International Association for Bridge and Structural Engineering). That council holds meetings about tall buildings all over the world—Indonesia, Russia, Italy, Turkey, everywhere there is an interest in tall buildings.

While the tall building council here in Los Angeles is a local group of engineers, it has an affiliation with the ASCE national group. So when there is a reason to do so, a joint meeting can be held. Most of the time, however, the Los Angeles Tall Building Council acts independently.

Design Methods: Allowable Stress and Limit State

Under limit state design, the failure mechanisms will occur on a more rational basis than is achieved under allowable stress design—and will be more consistent with what actually happens in earthquakes.

How Design Systems Differ

Scott: Would you discuss the difference between allowable stress design and limit state design in simple terms?

Pinkham: When using the allowable stress design method (ASD)—also called working stress design—the designer first chooses the member to design, assigns how the member will be supported, and determines the nominal loads and where the loads are placed on the member. Then the engineer analyzes the effects of the loads on the member, usually as an elastic element. These effects are determined as stress on the member. The designer then determines the allowable stress permitted on the

member based on the shape and type of material. These allowable stresses are given in the design code and are based on tested strengths of the material divided by a factor of safety. If the allowable stress is greater than the stress from the load effect, the member is satisfactory.

On the other hand, when using limit state design—also called load and resistance factor design (LRFD)—the designer determines the nominal loads, as in ASD, but multiplies each nominal load type by a load factor depending on the type of load combination being analyzed. The load effects are determined as loads (i.e., axial load, bending moment, or shear load) rather than stresses, as in ASD. The designer then determines the nominal strength of the member, usually the mean tested strength. A strength reduction factor (1.0 or less) is multiplied times the nominal strength to determine the design strength. If the load effects are less than the design strength, the member is satisfactory.

Safety factors as used in ASD have the variability both of the loadings and of the actual resistance of materials combined together. In many cases, however, the assignment of safety factors has been hit-or-miss and not related to the actual probability of failure. When this began to be investigated in the 1950s, the margins of safety were found to vary widely, the differences being due in part to variation in the probability of actually experiencing the loads determined under the working stress method. In addition, the resistance of building materials also varies independently of the loads.

Limit state design uses the same nominal loading, but consideration is given to the variations found by the survey that determined the nominal loads. Usually this results in amplifying the

nominal loads by a load factor to determine the reasonable limit that might be reached for that particular type of loading. This “limit load” is compared to the tested strength of the member, which is reduced by a strength reduction factor that is based on the consideration of variations found in the testing. Thus, the acronym LRFD refers to load and resistance factor design.

In discussing limit state design, it is important to understand that the actual forces a building experiences in an earthquake are determined solely by the building’s response to the earthquake ground motions. Once a building has been constructed, the amount of force is limited by the strength and stiffness of the building system. The forces to which the building is subjected can get no higher than the strength limit, regardless of the earthquake motion.

Scott: Is that basically where the term “limit state” comes from?

Pinkham: Yes. The limit state design approach tries to anticipate the maximum loading conditions and recognize the limit state that a maximum load should encounter when it is introduced into a building. Under limit state design, the failure mechanisms will occur on a more rational basis than is achieved under allowable stress design—and will be more consistent with what actually happens in earthquakes.

Variability, Tolerance, and Probable Strength

Pinkham: The limit state design provides more realistic limits, tied to actual testing of materials, members, and systems. A global factor of safety is not used at all. Instead, the variability in the load combinations on the system

being designed is considered independent of the variability of the members. In other words, when a steel beam is rolled, how well the dimensions are reproduced from one member to the next affects the member's strength. How variable the live load or earthquake load is must be considered separately.

Scott: When the range of variability is determined, a tolerance range is established. Does that provide for a margin of safety?

Pinkham: Yes. The margin of safety is handled by knowing the limit state characteristics. By knowing the variability in the actual strength of a member or a material, the designer can figure the desired relationship between the resistance characteristics and the loading characteristics. As I see it, limit state design tries to make it easier for designers to visualize the actual behavior of materials and to correlate testing results into the design process on a rational basis, rather than arbitrarily.

In essence, limit state design endeavors to use actual probable strengths. The design approach tries to anticipate probable peak loading conditions and to determine the limit state of the building elements to resist the load. Also, earthquakes are quite variable in size and what they can do to buildings. The limit state approach permits a more rational approach to selecting a "design earthquake" to be used in anticipating the behavior of the types of materials the designer wishes to use. Limit state design at least provides a way of setting up the information that enables the SEAOC Seismology Committee to take a rational look at what the actual systems do and apply variability

where it is appropriate. The 1999 Blue Book and the 2000 IBC are going in that direction.

Development of Limit State Design

Scott: Would you say a little about the process of developing limit state design?

Pinkham: Yes, it is quite a story.

The American concrete industry actually got into limit state design in 1956 with ACI 318-56—*Building Code Requirements for Reinforced Concrete: Ultimate Strength Design* was included in the appendix. Prior to that, allowable stress design (ASD) was used.

The use of what is now called "strength design" slowly gained favor with designers. I joined the committee in 1967 as a consultant, served as a member of the committee from 1971 to 1995, and was chairman of the seismic subcommittee for twelve years. Then in 1999, ACI published *Building Code Requirements for Structural Concrete* (318-99), and the *Commentary* (318R-99) was published by ACI International in 1999.

Nevertheless, there was and has been a strong resistance to strength design, especially in Chicago, where I think a good many engineers still use ASD. In the rest of the country, I believe limit state design is now pretty well accepted in concrete construction. ASD is still in the code as an alternative design method, but it is only ten pages and in an appendix. In short, they still have ASD in concrete design, but the principal design procedure used is strength design.¹³

13. ACI ceased promulgation of ASD-based standards in 2002, subsequent to this Scott-Pinkham interview session.

Limit State Design for Earthquake Motions

Pinkham: I should note that the use of limit state design for earthquake motions developed separately from the material interests. Back in the 1960s, the concrete people developed a lot of information so that they could get concrete codified. SEAOC first took that information so it could be used for seismic design. It was decided then that earthquake design really should be done in limit state design. Most detailed seismic design ever since has essentially started off using limit state design.

In 1978, ATC-3 and its successor documents, starting with the 1988 NEHRP,¹⁴ were based on limit state design. I have been on the Steel Subcommittee since the start. The 2000 edition is in the final stages prior to its issuance.¹⁵

Initially, the 1988 ASCE-7 was developed on limit state design, but at the last minute ASD was included as an alternate.¹⁶ The seismic provisions of A-58.1 followed the provisions of the SEAOC Blue Book. I have served on these committees since the development of the 1982 edition. The latest edition was published by the Structural Engineering Institute (SEI) of ASCE.

The 1988 SEAOC Blue Book, however, took the alternate route by staying with ASD, that is,

the design forces were given at the ASD level. The latest version of the Blue Book, dated 1999, is given in the form of recommended changes to the 1997 UBC to converge the Blue Book design recommendations with those contained in concurrent NEHRP and IBC provisions, with both ASD and LRFD permissible.

The 1997 UBC was laid out as a limit state format, but permits ASD using two alternate methods of load combinations.¹⁷ This is the model code used by most communities in the western part of the United States. The current 1997 edition will be the last with the UBC name.

Scott: Yes, the big U.S. code agencies finally appear to have succeeded in their effort to achieve at least a reasonable degree of consolidation. Say a word or two more about those code agencies.

Pinkham: There are three code agencies in the United States producing model building codes. These are the International Conference of Building Officials (ICBO), Building Officials and Code Administrators International (BOCA), and the Southern Building Code Congress International (SBCCI). In 1997, after completing their 1997 editions, the three agencies formally began joint efforts to develop a single set of code documents for their common usage.¹⁸ The current 1998 ASCE-7 and the 2000 IBC¹⁹ in general follow the 2000 NEHRP, which is given in limit state design

14. *NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings*.

First edition, 1988. Part I—Provisions, FEMA 95; Part II—Commentary, FEMA 96.

15. The 2003 issue is currently available.

16. *Minimum Design Loads for Buildings and Other Structures*. Approved in 1988 by the American Society of Civil Engineers as Standard ASCE 7-88 as a revision of ANSI A-58.1-1982.

17. *Uniform Building Code*. International Conference of Building Officials (ICBO), Whittier, California. Published in three parts, 1977.

18. *International Building Code 2000* (2000 IBC) is one of eleven codes published by the International Code Council.

procedures, but both provide for an alternate design using ASD. All of the structural design requirements for buildings are contained in 2000 IBC. LRFD, strength design, and ASD are permitted—except when earthquake forces are analyzed, ASD is not permitted in concrete construction.

The current provisions for earthquake design of new buildings and other structures have become more and more complex as new material and concepts have been developed, and some likely directions of future change are already evident in documents now currently available. Two such documents that will have an impact are the set, FEMA 273 and FEMA 274, *Guidelines for the Seismic Rehabilitation of Buildings*. These were developed for FEMA by the Building Seismic Safety Council (BSSC), the Applied Technology Council (ATC), and the American Society of Civil Engineers (ASCE).

FEMA in turn is currently at work standardizing the concepts of the *Guidelines*, which were intended to provide a step toward performance design methodology in seismic design. With all these new concepts surfacing in earthquake design, it obviously will be years before designers become sufficiently familiar with them to offer them in office practice.

Structural Steel

Pinkham: The development of limit state design requirements for structural steel got a late start in the United States, although the limit state method is pretty much the worldwide design approach, and Canada is 100 per-

cent switched over. In steel design in this country, both methods are still available in separate specifications. The latest ASD version of the AISC manual is the ninth edition, dated 1989, and is not projected to be updated. It is still widely used.^{20, 21}

Several studies were made some years ago, one of the first being a major four-year Massachusetts Institute of Technology (MIT) study, headed up by Bob Whitman, of the overall problem of loadings in general, including earthquakes. The people there had come to realize that Boston was in one of the East Coast's more earthquake-prone areas. Old records back to the 1700s talked of earthquakes causing chimneys to fall and other building damage. While there had not been much activity in recent years, they realized that the potential was there, so they wanted to take a good look at it.

The MIT study considered the general idea of limit state design, reviewed ways of predicting the variability of systems, and attempted to develop a design method that would more closely approach what actually happens. They set up three levels of the limit state concept. The first level, called load and resistance factor design (LRFD), which I mentioned earlier, was deemed to be the most practical and realistic of the three approaches, as well as less complicated and difficult to achieve. The LRFD approach

19. ASCE-7 2005 and IBC 2006 are currently available.

20. *Manual of Steel Construction—Allowable Stress Design*, ninth edition. American Institute of Steel Construction, 1989.

21. Both ASD and LRFD are in one document in the Thirteenth Edition of the AISC manual, dated 2005.

tends to relate test data and its variability more closely to what could actually be used.

Scott: The MIT study looked at the concept of limit state design, rather than its use for a specific material such as steel?

Pinkham: Yes. The LRFD effort in steel was started around 1969 with the research of Ted Galambos, the chief researcher who was then at Washington University in St. Louis and is now at the University of Minnesota. The MIT work was independent of the Galambos LRFD work on steel, which was oriented to more practical ends. The MIT study was more philosophical, opening up the subject a little wider than was necessarily practical.

An advisory committee was set up for Galambos. I was a member, along with a number of other people, both in the steel industry and in private engineering practice. The chairman of the committee was Ivan Viest, who was originally at Bethlehem Steel Corporation and is now a consultant in Bethlehem, Pennsylvania. The research was a long process and involved a lot of testing. It took about fifteen years to develop the first book on using limit state design in steel; the first full manual was published in 1984.

The December 27, 1999 edition of the specification is completed. Similar to the 1994 edition of the manual, it is in two volumes, one on member design and the other on connections.²² The manuals for these latest specifications have not been completed, thus the 1993

22. *Load and Resistance Factor Design Specification for Structural Steel Buildings*. American Institute of Steel Construction, December 1999.

second edition is the latest one available. The work done by the Specification Committee since the first edition has been considerable. Use of the LRFD manual by designers should begin to increase when the up-to-date information becomes readily available. There is also a companion connection manual on the old-style allowable stress design (ASD). Neither the ASD nor the LRFD specifications dealt with earthquake design requirements.

A separate subcommittee of the AISC Specifications Committee was formed under the chairmanship of Egor Popov in order to cover the special design and detailing that would be required in the area of significant earthquake hazard. The first edition of *Seismic Provisions for Structural Steel Buildings* is dated November 1990. Since the advent of the 1994 Northridge earthquake, the SAC Steel Project has developed and provided many changes to the provisions.²³ This document is currently referenced in the latest NEHRP and in 2000 IBC.²⁴

During its meetings in the year 2000, AISC initiated a program to develop a single specification and manual containing both ASD and LRFD design methods.²⁵

Cold-Formed Steel

Pinkham: The first design specification for cold-formed steel members was developed

23. *Seismic Provisions for Structural Steel Buildings*. American Institute of Steel Construction. April 15, 1997. Supplement No. 1, February 15, 1999.

24. The 2002 edition of the AISC Seismic Provisions are referenced in the 2003 IBC.

25. Completed in 2005. AISC 341-05 with supplement AISC-34151-05.

through the work of George Winter of Cornell University, published in 1946 by AISI. The design methodology was based on ASD. This specification continued until the 1985 edition, with a 1989 addendum. The first limit state design edition was assembled by Wei-Wen Yu at the University of Missouri (Rolla), Ted Galambos at the University of Minnesota, and M.K. Ravindra. This edition was dated 1991.

The subsequent edition, dated 1996, combined ASD and LRFD, and the nominal strength was prescribed for both methodologies.²⁶ In order to determine the design strength for LRFD, the nominal strength was multiplied by a resistance factor ϕ , whereas for ASD the nominal strength was divided by a safety factor Ω . The load factors for both ASD and LRFD essentially followed those in ASCE 7. Supplement 1 of the specification is dated 1999. Specific

details and requirements used in strong earthquake motion have not been developed.

AISI has also taken another step—they have made all the factors non-dimensional. That way it does not matter whether you are working in metric or English. Instead, everything comes out in ratios, and as long as the designer is consistent in the units used, it does not matter what measuring system is employed.

Currently, an extension of the Cold-Formed Steel Specification is being developed that would put in a single document the North American Cold-Formed Steel Specification, which would be a joint specification covering Canada, United States, and Mexico.²⁷ However, AISI is more concerned with wind than seismic design.

26. *Cold-Formed Steel Design Manual*, published by the American Iron and Steel Institute, dated June 1997. Supplement No. 1 to the Specification, July 30, 1999.

27. *Cold-Formed Steel Design Manual*. American Iron and Steel Institute, 2000; includes the 2001 edition of the AISI *North American Specification for the Design of Cold-Formed Steel Structural Members*. Supplement dated 2004.

Code and Specification Writing

They just didn't know what they were doing. They responded, "Okay, why don't you become a liaison member on our committee so we can get it straightened out?"

Code Writing and Consensus Group Status

Scott: In discussing code and specifications writing, perhaps it would be good to start with the concept of consensus group status and the consensus writing process. That seems to have become central in the development of codes and standards.

ANSI and ASTM

Pinkham: Consensus writing has been and still is a hot subject. Some years ago, the federal government pushed the development of rules that an organization must follow in order to qualify as a "consensus standard writing" organization. Two basic groups, the American National Standards Institute (ANSI) and the American Society for Testing and Materials (ASTM), have purview over the concept of what a consensus standard is and what it is not. They each have set up some more or less well-defined principles or rules—requirements

that organizations have to follow in order to be capable of developing consensus standards.

ASTM covers materials specifications and the methods of tests to determine properties of materials. They have tried to expand into the area of design loads, but so far have not been very successful in forming committees that actually do that work. ASTM and ANSI are competing consensus standard organizations—that is, ASTM does not get its consensus standards from ANSI but has its own set of consensus requirements that are widely recognized.

So it is quite a complicated story. There is a continuing political battle going on between ANSI and ASTM. ASTM has worked up its own consensus procedure and does not necessarily recognize any others. In other words, they will write whatever standards they feel are appropriate, and these might duplicate what someone else has done.

Most of the groups outside of ASTM usually get their approval by having somebody else review their consensus procedures and say that they can appropriately be a consensus standard group. Thus, ANSI reviews the proposed rules that a group works up and rules on whether the group would be appropriate to be a consensus standard group.

So this is something of a political battle, and it has been made even more complicated by the whole business of the three model code-writing agencies that worked together to develop 2000 IBC.

Major Industry Groups

Pinkham: I am probably the only person left now who has been active on at least four of the

major national industry specification-writing or code-writing groups. These include: 1) the American Concrete Institute (ACI), 2) the American Institute of Steel Construction (AISC), 3) the American Iron and Steel Institute (AISI), and 4) the Structural Engineering Institute (SEI) of the American Society of Civil Engineers (ASCE) codes and standards division.

I was active in the American Concrete Institute (ACI) Committee 318—the building code requirements for reinforced concrete—and was chairman of the ACI seismic provisions committee until 1995. ACI got its own consensus-writing status many years ago.

I was on the American Institute of Steel Construction (AISC) Specifications Committee and also worked with Egor Popov on some aspects of that. Popov was the initial chairman of the seismic subcommittee for the AISC, which is concerned with hot-rolled materials. I worked with Egor Popov on the 1990 and 1992 structural steel seismic specification provisions. Since then, the chairman has been James Malley of Degenkolb Engineers in San Francisco.

The Structural Engineering Institute of the American Society of ASCE is developing design specifications, particularly the standard ASCE 7, through its Codes and Standards Activities Division.

ASCE, ACI, AISC, AISI, and the American Welding Society (AWS) are currently recognized as consensus standards groups.

Scott: Membership on standards committees must take quite a lot of pro bono time and effort.

Pinkham: It does—and it requires a lot of traveling.

Scott: I presume these consensus standard groups are interested in materials performance of all kinds, not just seismic performance?

Pinkham: Yes. Most of ASCE's concerns are rather widespread—they span all over the civil engineering field. The first standard ASCE ever came up with was a standard railroad rail—back in about 1875. So they've been in it for a long time. ASCE is now involved in certain aspects of writing standards for seismic performance.

ASCE's Consensus Approach

Scott: Say more about ASCE and how it went about acquiring consensus-writing status.

Pinkham: When ASCE became a consensus standard organization, they could have obtained that status under ASTM rules or ANSI rules. They opted for the ANSI rules. In short, ASCE is now a fully recognized consensus organization under the ANSI rules.

Since ASCE is a broadly based organization representing civil engineers—including every type imaginable that is not in the military—engineers can form a committee within ASCE that can still qualify. I believe that the actual recognized consensus organization is the SEI Codes and Standards Activities Division. It is acceptable, as long as the committee writing the standard represents interests that are concerned in that particular subject. Sometimes the subject areas of interest are very narrow, and sometimes they may be quite wide, in which case they also need to represent the public interest.

Scott: How does ASCE go beyond their own civil engineering membership when they need to?

Pinkham: There are two ways to accomplish this. One is to broaden out by advertising in a number of publications, for example, the ASCE newsletter. If the particular subject involved some other organization, then they would advertise in the other organization's newsletter. They would announce that the consensus standard proposal is being done, allowing other people to get copies of what is proposed and send in comments. The second method is to use nonmembers of ASCE as members of the standards committees.

The committee that is trying to promulgate the consensus standard would have to respond to the comments received. That way people outside ASCE and its committee structure at least have a chance to comment and receive an answer. Now as to whether changes are made in response to these comments, that is up to the committee and ASCE. In any event, at the stage when the draft standard comes out, ASCE advertises that a standard is available for balloting and comment from anybody that is interested.

I think ASCE has made some progress in their main effort, which was taking over what used to be known as the ANSI A-58.1 standard. Up to 1981, ANSI had been the consensus group that put out the design loads for buildings. Two of the code-writing groups—BOCA and SBCCI—recognized ANSI A-58.1 as the code authority, but ICBO never bothered. ICBO had its own design loads for buildings. With the development of 2000 IBC, the picture has changed. The primary way of changing the design codes will be through the code change process of the International Code Council (ICC).

American Concrete Institute (ACI)

Scott: What about the American Concrete Institute (ACI) and its consensus-writing status?

Pinkham: ACI was initially established primarily as an educational group, to pursue education and the dissemination of information about how to use concrete. Thus ACI's function is not to represent the people trying to sell the cement that goes into concrete. On the other hand, the Portland Cement Association (PCA) is an industry group representing the concrete industry's interest.

In short, ACI's membership is different from and much more open than that of the PCA, and for many years the ACI's code committees have been set up with a degree of isolation from the control of actual materials people themselves. Because ACI's primary emphasis is on education about concrete, and because anybody with an interest in concrete construction can join ACI, the organization maintains that within their own membership they have all the interests represented. For some time, ACI has diligently pursued the consensus process of standard writing, and for some time their work has been approved by ANSI (American National Standards Institute).

Scott: I see that ASCE's membership is more limited than ACI's, in the sense that one must be an engineer to join. But I also take it that if an organization goes through an acceptable process that obtains and considers "outside" opinions, they can qualify as a consensus standard group?

Pinkham: Yes. In addition, however, interested nonmembers are now included in the committee structure. If the committees meet

all the requirements in the rules that each organization sets up, then their action can become a standard. ANSI is the group that approved ACI as constituting a consensus standard organization. ACI has an open ballot that goes to anybody who wants to vote on something, so that way they get feedback. That's essentially what it means.

Why SEAOC is Different

Pinkham: SEAOC and the Seismology Committee, as presently constituted, obviously could not by their very nature qualify as a consensus standards-writing group. The California structural engineers are trying to work out what they consider appropriate recommendations to the code authorities—specifically from a structural engineer's standpoint.

Scott: When they work on the Blue Book, the Seismology Committee is basically doing it for California engineers, although the Blue Book is actually used much more widely. And California is considered a leader in seismic design, isn't it?

Pinkham: Yes. SEAOC expresses its viewpoint, and ICBO has recognized the impact of SEAOC. California structural engineers have been leading in the development of earthquake design.

Scott: However, since the purpose of SEAOC and the Seismology Committee is to reflect the professional opinion of California structural engineers, as you point out, SEAOC is basically precluded from becoming a consensus group in their own right.

Pinkham: Yes, becoming a consensus group would defeat their purpose of expressing the

professional opinion of structural engineering. The Blue Book is the viewpoint of the structural engineers, and as such it cannot become a consensus standard. I think that is the way it should be, and it gives the structural engineers a clear way to express their professional opinion in an undiluted strong voice.

ACI Seismology Committee

Pinkham: It was during my three-year chairmanship of the SEAOC Seismology Committee that the concrete people, the American Concrete Institute (ACI), began putting a seismic appendix in ACI 318. They had a write-up done, which was so horrible that I wrote a letter in response that said, “Something has to be done about this.” It had been put together by what you might call learners. They just didn’t know what they were doing. They responded, “Okay, why don’t you become a liaison member on our committee so we can get it straightened out?”

So for a couple of years I worked as liaison on the concrete group. Then when ACI 318 changed chairmen and reconstituted the committee setup, I became a member of 318. I believe I have been on the ACI 318 committee since about 1970, and for the past two six-year cycles I was chairman of the ACI 318 Seismology Subcommittee. They have a six-year cycle, with a three-year addendum cycle. One main cycle produced the 1995 document. With the completion of that cycle, I declined any reappointment, so I was on ACI 318 until March 1995.

Major Committee Topics

Scott: What does a committee do?

Pinkham: One of the easiest ways of seeing that is to view the work performed by the AISI Specification Committee on the problem of cold-formed steel (a process that is similar to what goes on with hot-rolled steel and the specifications of AISC). I am on the AISI Specification Committee because of my interest in steel deck diaphragms. For instance, there is a rather limited amount of money in the steel industry for research. They don’t have a lot of money for all of the research they would like to get into. So about once a year, they make a list of their “druthers”—the things they would like to see done.

The list may contain as many as 200 items, which are considered by the committee of about thirty-five to forty people, and prioritized. They start dealing with the items at the top of the list, but don’t get to the others until maybe years later. There are many things that they want to do, but which they just can’t do because they do not have the time or the resources.

But sometimes things come along that obviously need to be done, so then they try to find money somewhere. They go to NSF or some other such organization if it’s a really important item. They try to meet the most pressing needs.

Discussions and Interchange in Code Writing

Scott: Are there group dynamics in a room full of people discussing code provisions?

Pinkham: It involves quite a number of people with individual views, and each group will have a different philosophy about how to inter-

act with each other. Some of the participants can be almost clannish, or they “follow the leader.” If one of their key people says something, the others will accept it. If the person taking the lead is really knowledgeable and thoughtful, that can be good. But sometimes this results in an issue not getting the discussion it should.

I think it really helps when the smaller details can be developed in a subcommittee, with later review by an overall committee that is interested enough to consider all phases of what they are presented. But that can sometimes be hard to achieve. An example is the committee of ASCE on loads on buildings, which has ten different task committees to deal with different facets of loads on buildings. All too frequently, however, the members of one subcommittee may not be interested in what is going on in the other subcommittees. So there may not be a really good interaction and overview on all the different types of loading.

Scott: How have they dealt with those problems of getting a good representation and interaction at committee and subcommittee meetings?

Pinkham: You just have to try to get as much attendance and discussion as you can. The amount of cross-pollination achieved varies from group to group. American National Standards Institute (ANSI) committee members were all paid to attend meetings. The SEI Codes and Standards committee chairman has a “control group.” These are a few members he can invite to a meeting to discuss the philosophy of the committee, and SEI pays their travel expenses. Initially, they only had the five con-

trol group members, but now they also have arranged to have control group members in each of the ten task committees. Even with that change, perhaps three-quarters of the people on the subcommittees were not having their travel expenses paid to go to meetings—as a result many or most of them would not go.

Scott: So a good deal of the participation comes through mailed ballots. That is obviously valuable and important, but it is not the same as an actual meeting, is it?

Pinkham: No, it is definitely not the same as sitting down around a table and having face-to-face discussions. And if you are not participating in this way, it is difficult to understand what all the concerns are. When a good discussion gets going, that is when you start learning things. The meetings in connection with the SAC Steel Project are a good example of how you can learn from such sessions. All these people came in who were experts in certain areas and had specific engineering interests. I am sure everybody learned quite a lot from those discussions.

Scott: What kinds of people do you get in these interactive, cross-pollination meetings?

Pinkham: Just about all kinds, at one time or another. For example, one area in which the Applied Technology Council (ATC) has quite an interest is insurance. ATC has been quite involved in all kinds of insurance, not only earthquake insurance. A liaison member from the insurance industry comes to all board meetings of the ATC. When I attended the ATC board meetings as a liaison for EERI, Greg Chiu represented the Insurance Institute for Property Loss Reduction (IIPLR), an insur-

ance industry group that was headquartered in Boston and was interested in all kinds of hazards—wind and coastal hazards as well as earthquakes. Now it's called the Institute for Business and Home Safety and is located in Florida. Greg Chiu shows up regularly at ATC board meetings, and ATC has also added two new board members who represent coastal hazards and wind hazards—as ATC has a view to get into projects involving those hazards.

Of course, the insurance industry's concern tends not to be with individual buildings as such, but with the bigger regional issue of how an earthquake can impact many buildings in a large area. They are less interested in the kinds of things that concern structural engineers. Previously, there was some interconnection through what was called the Pacific Fire Rating Bureau, which Karl Steinbrugge headed for a long time. Some of the insurance people were very interested in having that information. Vince Bush was also involved in that for a time in their southern California office.

Scott: Yes, and in the 1930s and 1940s Harold Engle, Karl's predecessor in that agency—which much earlier was called the Board of Fire Underwriters of the Pacific—also played an important role in the relationship between earthquake engineering and insurance. Engle co-authored a monograph on seismic design sponsored by the insurance industry, and also did risk rating of individual buildings and types of buildings for the insurance industry.²⁸ Now it's called the Insurance Services Office.

Implementing and Using Standards

Scott: How are the standards adopted by consensus groups actually implemented and used?

Pinkham: Here are some examples of sources of consensus standards of building materials:

1. *Building Code Requirements for Structural Concrete and Commentary*, ACI.²⁹
2. AISC specifications for structural steel buildings.³⁰
3. AISI cold-formed design specifications.³¹
4. Building code requirements and specification for masonry structures by the Masonry Standards Joint Committee.³²
5. Structural welding codes for metals in buildings, by the American Welding Society.³³
6. Manuals for engineered wood construction by the American Forest and Paper Association.³⁴

Here are some examples of sources of consensus standards of loads and load combinations on buildings: 1.) *Minimum Design Loads for*

28. Harold Engle and Jack Shield wrote *Recommendations of the Board of Fire Underwriters of the Pacific for Earthquake Resistant Design of Buildings, Structures and Tank Towers*, published in 1934 by the Board of Fire Underwriters of the Pacific, and reissued in later editions.
29. ACI 318-05, "Building Code Requirements for Structural Concrete and Commentary." American Concrete Institute, November 2004.
30. a) AISC 360-05, "Seismic Provisions for Structural Steel Buildings." American Institute of Steel Construction. 2005; b) AISC 341-05, *Seismic Provisions for Structural Steel Buildings, Parts I and II*. American Institute of Steel Construction, 2005.

Buildings and Other Structures, by the Structural Engineers Institute;³⁵ and 2.) *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures*, Building Seismic Safety Council for FEMA.³⁶

To become legally effective, these source books or standards must be adopted in a code, such as BOCA's National Building Code, SBCCI's Standard Building Code, or ICBO's Uniform Building Code (UBC). These groups will simply reference a document in their model building code.

Scott: Does BOCA, for example, simply adopt the standard by reference?

Pinkham: Currently, yes. It just becomes part of the BOCA code. ICBO's Uniform Building Code currently does not do that. ICBO had actually maintained that they could not depend on somebody else's publication, but

that the referenced material had to be available to building authorities through the ICBO itself. So they would reprint it in their code document rather than include it by reference.

Scott: ICBO has reprinted it so the user has it right there in the ICBO document?

Pinkham: Yes, but the ICBO arrangement is now in the process of moving toward doing it more or less the way BOCA has been doing it—that is, just adopting by reference. And in fact, ICBO has already taken a lot of the reprinted material out of the code and just gives a list of references. Thus they may refer to a document without necessarily making it part of the code. That is done to provide the user and the building department information they can evaluate on their own.

The ICBO shift is also related to their effort to get the code-writing agencies together on IBC 2000. ICBO's last UBC code edition was the 1997 UBC. The IBC 2000 theoretically will be a common code for all three model code agencies. It remains to be seen how all that will work out.³⁷

31. a) NASPEC "North American Specification for the Design of Cold-Formed Steel Design Members." American Iron and Steel Institute, 2001. Supplement No. 1 dated 2004; b) AISI/COFS/GP, "Standard for Cold-Formed Steel Framing—General Provisions." American Iron and Steel Institute, 2000.
32. a) ACI 530-05/ASCE 5-05/TMS 402-05, *Building Code Requirements for Masonry Structures*. Masonry Standards Joint Committee, 2005; b) ACI 530.1-05/ASCE 6-05/TMS 602-05, "Specification for Masonry Structures." Masonry Standards Joint Committee, 2005.
33. a) AWS D1.1, *Structural Welding Code: Steel*, 2004; b) AWS D1.2, *Structural Welding Code: Aluminum*, 2003; c) AWS D1.3, *Structural Welding Code: Sheet Steel*, 1998; d) ASW D1.4, *Structural Welding Code: Reinforcing Steel*, 1998; e) AWS D1.6, *Structural Welding Code: Stainless Steel*, 1999.

34. a) AF&PA, *Allowable Stress Design (ASD): Manual for Engineered Wood Construction*. 14-book set, 2001; b) AF&PA/ASCE 16-95, *LRFD Manual for Engineered Wood Construction*. 10-book set, 1996; c) AF&PA *National Design Specification for Wood Construction with Commentary*, 1997.
35. ASCE 7-05, *Minimum Design Loads for Buildings and Other Structures*, 2005.
36. FEMA 450, *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and other Structures*. Building Seismic Safety Council (BSSC) of the National Institute of Buildings Sciences (NIBS) for the Federal Emergency Management Agency (FEMA), 2003.

Scott: It must be a real job to keep up with all these code and standard changes.

Pinkham: It is, for both the code agencies and the practitioners. In fact, they are now trying to slow down the rate of issuing new editions. With new standards and code books being issued all the time, it becomes awfully hard, because every time a new edition comes out, you have to go through and familiarize yourself with it. A complete set of ASTM documents come out once each year and costs \$6,100 for the whole set.

Moreover, it is not just the individual organizations that put out standards, but all the other regulatory systems and processes, plus the changes made, such as through the State of California, the Schoolhouse Section (Division of the State Architect), OSHPD (Office of Statewide Health Planning and Development), the City of Los Angeles, and so forth. In short, the amount of material you would have to have in order to be fully referenced is just enormous. In order to keep up with the changes, you really almost need a librarian on your staff to keep the material updated and organized. Of course, most people do not do that.

Scott: So practicing engineers have to be pretty knowledgeable in keeping up with what is important among the changes, or they have to take shortcuts?

Pinkham: That's right. If they do not have something in their own shop, they call around to other engineers. Keeping up with changes in codes, standards, and engineering practice is a real problem—a horrendous problem. Unfor-

tunately, too many engineers are not even aware of the problem.

Scott: Some engineers do not even recognize that there is a difficult problem in keeping up-to-date. You would wonder about the design work of an engineer who is out-of-touch that way.

Pinkham: This is really why I became involved in so many of these things—to understand what is there.

AISI, which has the cold-formed design manual and specifications, has a page on the World Wide Web and is dispersing ballots and backup material that way. That might be the wave of the future: get what you need off of the World Wide Web. That would work if people knew what they needed, where to look for it, and how to find it.

Materials Interests Role—Decline in Research Funding

Scott: I have heard some structural engineers suggest that the materials interests have too much influence on the writing of codes and standards.

Pinkham: They sometimes do, and I think this is pretty much true in all areas. But I also think that the budget cuts they have had to make have reduced the producers' influence in recent years. AISI used to fund quite a bit of research but has not done much in the past few years. It now has very limited research funds. The concrete industry's ability to do research has also been cut way back.

The basic problem is money; to some extent this has been a problem of the industry as a whole, which takes the short view economi-

37. The 2006 IBC is the current edition.

cally. It is hard to plan for the long term if you are afraid of going out of business. There is a tendency to focus on the fiscal balance sheet for the profits of the current year. But without the long-term view, eventually you may lose business anyway, because your domestic or international competition comes in and takes it away.

Scott: I have heard a similar complaint from a number of older structural engineers. They deplore the lack of investment in research, especially in the construction industry. That is related to what you are talking about.

Pinkham: Yes, that is right. The interrelationship between builders, designers, and building authorities is quite different in different countries. In Japan, of course, to quite an extent the builders or contractors become involved in research. They put up the money themselves in many cases, or in some countries, contractors may be directly subsidized by the government to do certain research work, probably much more so than we do here.

A Degree of Independence

Pinkham: For many years, the code committees of the American Concrete Institute (ACI) have been set up with a degree of isolation from the control of actual materials people themselves. For some time, ACI has diligently pursued the consensus process of writing standards, and for some time their work has been approved by ANSI (American National Standards Institute).

Some of the other materials groups—such as AISC, the fabricators of hot-rolled steel—have kept control within their materials group. Nevertheless, the people writing, their specifica-

tions have tried diligently for many years to maintain a balance in terms of influences on specification writing, and are in the final process of getting the accreditation from ANSI. So you see academic groups, the people in the trade, the design people, and governmental people all represented and having input into writing the AISC specifications.

There is a parallel in cold-formed steel, which is under the American Iron and Steel Institute (AISI). At one time, AISI had many other kinds of specifications, such as for stainless steel and others steels, but has now pretty well dropped all except the specs for cold-formed steel. Several of those steel standard activities have been taken over by ASCE, whose committees are producing stainless steel specifications, as well as some of the other specifications that AISI used to develop. Standards for composite slabs, for example, were also originally issued in an AISI committee document, but later that was turned over to ASCE.

Scott: Did they make those changes because the materials people were considered too close to the standard-writing process?

Pinkham: No, it was done partly because of the high cost. Also, AISI lost interest in stainless steel specifications because the producers of stainless steel were no longer in the United States—the principal producers are now in South Africa. Since we import all the stainless steel we use, AISI no longer has a great interest.

But, of course, stainless steel is used in the United States, so somebody here should take an interest. That is why ASCE assumed the writing of those specifications. ASCE wants to ensure that there is a core of people present at the

meetings, so they pay travel costs for members of a small control group to meet. The other members are not paid at all. They may come on their own, or participate by mail or by ballot.

ATC and BSSC

Scott: Would you discuss the roles of the Applied Technology Council (ATC) and the Building Seismic Safety Council (BSSC), particularly concerning consensus standards.

Differences Between ATC and BSSC

Pinkham: ATC is basically an engineering group, whose first main project was developing ATC-3, *Tentative Provisions for the Development of Seismic Regulations for Buildings*, published in 1978. It was intended as a resource document for people writing on code matters. ATC's purpose was to develop up-to-date information and commentary for use by engineers and code-writing authorities. The idea was to provide technical guidance for the drafting of seismic safety regulations that would be appropriate for state, regional, and local conditions. In other words, ATC was offering suggestions from the engineering community as to what should be done.

ATC was established in 1971 by SEAOC to facilitate SEAOC's code development work. ATC's board of directors has representatives from SEAOC, the Western States Council of Structural Engineers Associations, and ASCE, plus four at-large representatives from outside California who are concerned with structural engineering practice. The number of at-large members was raised from two to four in order to add representatives of interests in wind design and in the special problems of coastal

areas. That was done in anticipation of getting into multi-hazard solutions.

BSSC is different from ATC, in that BSSC tries to represent all of the people interested in the earthquake standard-writing process. So BSSC also gets outside of engineering, as such, and into other fields concerned with buildings, construction, and real estate. In short, BSSC includes not only engineers but also others with an interest in buildings, in order to provide for their input into seismic design policy. Four major materials groups—concrete, steel, masonry, and wood—are represented, along with AFL-CIO (the building trades), SEAOC, EERI, and ASCE. To a certain extent, I think the way the people are appointed by groups tends to be a little bit overdone. For instance, ASCE has a member, as well as PCA, and AISC, and so on. Through the grouping of the different interests, it becomes a bit weighted down so that most members are not technically oriented.

BSSC is an amalgam of everything, and comparatively few technical people get to have input into what is done, unlike the Seismology Committees of SEAOC, all of whose members represent structural engineers and their viewpoints. Although their number is small, there are some very good technical people in BSSC, and its effectiveness is really based on the contributions of those members who are technically qualified—this includes some who represent the industry people, plus some of the engineer members. I should note that BSSC does not have academia fitted into the picture, except indirectly. For example, Egor Popov of U.C. Berkeley has worked on BSSC matters through the structural engineers. But in general, academic people are not one of the interested groups.

BSSC's Goal

Pinkham: BSSC was established in 1979 within the National Institute of Building Sciences to continue the ATC-3 effort for seismic codes, and eventually it came up with what are called the NEHRP provisions. ATC's first major project was the report referred to as ATC-3. Then BSSC took over and reviewed the document, enlarging the number of people represented on the committees.³⁸

After reviewing ATC-3, BSSC revised it somewhat and came up with a revised version.³⁹ Since then, BSSC's main code-related activity has been preparing revisions to NEHRP. BSSC has updated the NEHRP provisions approximately every three years, the last one dated 2000.

BSSC is also in charge of what was called ATC-33, which is composed of work done by BSSC, ATC, and ASCE. The program was sponsored by FEMA to develop nationally applicable *Guidelines for the Seismic Rehabilitation of Buildings*. ATC was responsible for developing the guidelines, under the supervision of BSSC. ASCE was assisting on specific supplementary tasks, and I was on the ASCE Project Steering Committee.

38. ATC 3-06, *Tentative Provisions for the Development of Seismic Regulations of Buildings*. Applied Technology Council for the National Science Foundation (NSF 78-8) and the National Bureau of Standards (now NIST), June 1978.

39. *NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings and Other Structures*, with separate Commentary. Building Seismic Safety Council for the Federal Emergency Management Agency, 1985.

This project was completed in 1997 with the publication of NEHRP guidelines for the seismic rehabilitation of buildings, which has the reference name FEMA 273.⁴⁰

After the completion of these documents, a follow-up program was undertaken to test the guidelines to see if they were usable and produced rational and reasonable results. In September 1999, *Case Studies: An Assessment of the NEHRP Guidelines for the Seismic Rehabilitation of Buildings* (FEMA 343) was published. I served on the Case Studies Project Committee, whose chairman was Dan Shapiro of San Francisco. One purpose of the Case Studies Project was to provide information to the committee so they could convert the guidelines into a standard.

Scott: There is some concern now about pushing toward a single national code, especially regarding seismic design. In that connection, I believe there has been some movement away from the basic idea that the ATC material and NEHRP are only a resource, not a draft of a code.

Pinkham: Yes. Back during the development of ATC-3, I was on Henry Degenkolb's subcommittee. One of the things that everybody in that group tried to emphasize was that the whole purpose of the work was to gather a body of information that could then be used by others charged with reviewing the seismic requirements for the different areas of the country.

40. *NEHRP Guidelines for the Seismic Rehabilitation of Buildings*. Applied Technology Council, Building Seismic Safety Council, and American Society of Civil Engineers for FEMA (FEMA 273). Companion Commentary (FEMA 274).

The people in each area would thus have a background book from which they could draw when developing their own code provisions for seismic design. Now, however, there is an effort funded by FEMA to make the document called NEHRP into a standard so that it will actually have the force of law.

Scott: Like an adopted code?

Pinkham: Yes. But this a touchy question, because it gets away from the other idea of NEHRP being a resource document. The battle is still going on to decide which direction it will go. I hear about what goes on in BSSC, but I do not attend the meetings. BOCA recently adopted NEHRP as a reference document, and another standard closely paralleling NEHRP has been generated by ASCE: ASCE-7, *Minimum Design Loads for Buildings and Other Structures*, 1998.⁴¹ I do not know of a parallel effort in the Structural Engineering Institute (SEI) Codes and Standards Activity to develop seismic provisions for rehabilitation of buildings.

Scott: In the mid- to late 1980s, Henry Degenkolb was expressing concerns about BSSC and the way it was going. Basically, his concern was its influence on the seismic criteria that have been developed here in California. He feared that by trying to take it national, the whole thing could get watered down and weakened.

Pinkham: Henry and I always agreed on that. With SEAOC and the Blue Book, you do

not get people outside of the structural engineers into it—at least the outside people are not voting on the criteria.

Scott: If you agree with Henry, are you then concerned that BSSC and the new procedures SEAOC is talking about may affect seismic standards adversely?

Pinkham: Not necessarily. But the standards process has been going in the direction of so-called “consensus” procedures. The federal government called for developing procedures to arrive at consensus requirements. Under these procedures, to be capable of developing consensus standards an organization cannot have its membership limited to structural engineers only.

Scott: How does SEAOC deal with this in its work on the Blue Book?

Pinkham: SEAOC’s local and statewide Seismology Committees always took ATC-3 to be a source document that they might or might not accept. SEAOC currently has proposed significant changes to the 1997 UBC in the provisions for seismic design that will be in a future International Building Code. This was done in the 1999 Blue Book.⁴²

Code Writing Abroad

Pinkham: The way the codes and specifications are written here is distinctly American. In the United States, the process has remained

41. See also *NEHRP Recommended Provisions for Seismic Regulations for New Buildings and Other Structures*, with separate Commentary. Building Seismic Safety Council for the Federal Emergency Management Agency, 2000.

42. *Recommended Lateral Force Requirements and Commentary* (Blue Book). Seismology Committee of the Structural Engineers Association of California, Sacramento, California. Seventh edition, September 1999.

relatively independent of the government, and their writing has been lodged with each of the materials groups—except for the areas undertaken by ASCE in fairly recent times. ASCE is trying to tackle some of the areas that none of the materials people have handled, such as provision for loads on buildings or structures. In each of these areas, ASCE—through the SEI Codes and Standards Activity—has set up committees to come up with standards covering areas that in the past have not been generally covered, except by the model code groups.

To keep their material up-to-date, the model code groups seek outside help because they do not necessarily have the full expertise and information required for code writing or revision. The people in the model code groups are usually the code enforcers—primarily the building officials. So the model code people need help from the academics, the designers, and those who produce the various materials.

Canada's process, for example, is entirely different from ours. They develop what are termed national codes, although not all the provinces use them. In Canada, they have a centralized government committee, which is broken into subcommittees that develop the national codes. In recent years, the Canadians have begun to modernize their overall code, using national committees to do the job. I presume their federal government contributed funds to handle the costs—probably to pay the participants' travel costs and possibly compensation for time spent doing the work.

In any event, the Canadians have come up with a whole series of specifications for design, which are quite thorough and quite up-to-date. To a certain extent, they are well ahead of what we

have in this country, which is more diverse in its codes and specifications. For example, in the United States you design to different loads in steel than in concrete. We hope that will eventually be straightened out, but it will take time.

In Canada, however, all the loads are already in one code. So their code is a more effective design document that can be used more quickly in actual design practice. I should note that many of our trade groups—like the concrete industry and the steel industry—that develop standard specifications, have members from Canada. So there is sort of an interfacing of people who are familiar with the Canadian approach and with what they are producing for use in the United States.

The North American Specification for Cold-Formed Steel Design is the one effort to consolidate design specifications internationally that involved the United States.

Eurocode and the International Standards Organization

Pinkham: We obviously need to be considering what is being done internationally in terms of design standards. I want to mention two international groups. One is the European Convention for Construction Steelwork (ECCS), which is active developing a common Eurocode so all of the member countries will have a common building code. In working toward that end, they have been in contact with many of the people who work with the code writing bodies in Canada and the United States.

The second organization is the International Standards Organization (ISO). To some extent, ISO has recently pulled back on its code work,

waiting to see what happens on the Eurocode. Many of the people active in ISO are also active in the Eurocode. The federal agency that used to be called the National Bureau of Standards (NBS) and is now the National Institute of Standards and Technology (NIST) serves as the United States' secretariat on the ISO group.

There is an overall tendency toward going more global, although to some extent I also see parochial effects. The code people in California have comparatively little contact with what is going on globally—they are more or less oblivious to that. On the other hand, BSSC operates as a branch of the National Institute of Building Sciences (NIBS), which gets into the international impact on building sciences. NIBS maintains close contacts with European and international groups. One of the reasons I have been involved in design specifications is to keep myself apprised of what is going on.

Scott: But do you consider many of the California people kind of oblivious to this?

Pinkham: Most of the California structural engineers have no idea what is actually happening—they do not have the contacts. Some do, of course, such as Loring Wyllie of San Francisco, who is on 318 for ACI and is a past president of EERI. And some of the other California people involved in the national groups are aware of what's going on. But very few Californians are involved in this.

NIST as Interface

Scott: Does the diversity in U.S. codes and specifications influence our international trade, or might it in the future?

Pinkham: Yes, very much so. There is, however, also something of an interface through the National Institute of Standards and Technology. NIST assigns people to interact with the Europeans—with the Eurocode people and the ISO—so I do think most of the specifications-writing people are aware of what is going on. Nevertheless, it probably will be a long time before U.S. and European design practices are really brought close together.

Scott: Can you talk about how the diversity affects our trade or the ability of foreign users to use our products?

Pinkham: No, I really don't know any details as to how it affects our export trade. But I should point out that there is a reverse trend of growing imports from abroad and the development of international sources for materials and products available for use here in the United States. There is enough of an American market to persuade foreign suppliers to meet American standards, regardless of their own home standards. Thus, structural steel shapes that comply with American standards are available from many sources, such as Canada, England, Japan, and Korea. So there is no real immediate push to have a common set of standards, although I think it will occur gradually with communication and the influence of economic forces.

Scott: If European and U.S. practice were in time brought closer together, what would this entail? Would it mean adopting their usages, including metric, or what?

Pinkham: No, I do not think that coming together on practices means one country adopting the design provisions of another. There should be dialogue between the coun-

tries so that eventually there could be an exchange between them, with both adopting the best parts of each other's practices.

For example, the United States and Japan have biennial meetings of designers to exchange ideas. This effort is currently organized by ATC, and the seventh such meeting took place in Kobe (January 18–20, 1996). Similar exchanges are taking place with Canada through the participation of Canadian designers and academics in U.S. code groups. There are also exchanges with Europe through U.S. academics (mostly East Coast) and through ISO.

Metric Usage

Pinkham: With respect to our adoption of metric usage, I believe that it is already well on the way here. Numerous deadlines have been set for when all U.S. federal government construction documents must be in metric only. Also, according to AISI, their material is designed to be compatible with metric. They do this by converting standards to ratios, so the same equations can be used for either metric or English measure.

Incidentally, I should point out that the system we have been using here is not really "English." For one thing, the English are now on metric. Also, the measurements that we have used here differed from "English" measurements in some ways, particularly in weights. So the system we have used should be called inch-pound.

In any event, all the developments seem to be making a U.S. transition to metric easier. The actual center around which most of these things are coming together is the American Society

for Testing and Materials and its metric standard book, which is published periodically.⁴³

Earthquake Concerns

Scott: Are there significant implications for seismic design in these international connections that you have been discussing?

Pinkham: The main problem is that seismic design is foreign to people who don't live in areas considered seismic.

Scott: Talk a little more about these earthquake design concerns.

Pinkham: Most European design procedures are different from the ones we use here. In the western United States, and to some extent in other parts of the country, we have earthquake concerns. Only a few places in Europe, however, are concerned about earthquakes, but even in those areas that do have earthquakes, seismic design has not been considered in depth, such as we have done here in California.

Japan, of course, pays a great deal of attention to seismic concerns, although its approach differs significantly from ours; Japan's earthquake design specification is very broad in scope. They do not have an explicit design code or design specifications, such as the structural engineers have in UBC. The Japanese generally outline the level of investigation that should be made with regard to different sizes of

43. *Standard for Use of the International System of Units (SI)—The Modern Metric System*. Sponsored by the Institute of Electrical and Electronics Engineers and the American Society for Testing and Materials, 1997. IEEE/ASTM SI 10-1997 replaces ASTM E-380.

buildings. They indicate how far the designs should go, to what agencies the designers must report, and how thorough the review conducted by the governmental review agency should be. Thus, the Japanese influence design in a different way from either the Americans or the Europeans.

Scott: I take it the Japanese put the responsibility more on the design professionals and their judgment, backed up by peer review or governmental regulatory review?

Pinkham: Yes, although for certain things, the governmental agencies say: “This is the way

we would like to see you do it.” The designers tend to follow a set pattern that has slowly evolved—they follow very closely what others are doing in their engineering community.

The United States is keeping in close contact with what is being done in Japan. There are meetings every year or so between a group of engineers from the United States and a group of engineers from Japan, and ATC has been active in that activity. Anyway, there is contact with the Japanese, enabling us to pretty well understand what they are doing, and vice versa.

Leaders of the Profession

I am a little reluctant to get into a discussion of “leaders” because there are, in fact, many leaders whom I may not happen to mention.

Scott: You discussed Steve Barnes and his activities and philosophy. Would you reminisce about some of the other key leaders of the profession of Steve’s generation?

Pinkham: I am a little reluctant to get into a discussion of “leaders” because there are, in fact, many leaders whom I may not happen to mention. But there are about a dozen leaders that I feel I know fairly well, and I will mention them.

First, of course, is Stephenson B. Barnes, about whom I have already talked at some length. Steve had a very good grasp of all matters related to engineering design and the construction of buildings, and did not hesitate to apply himself to professional matters outside the firm. In discussions with staff, clients, and fellow professionals, he was always level-headed and kind. I believe he was the only person to have served as president of both SEAOC and SEAOSC concurrently. He received an honorary doctorate from Purdue University, his alma mater.

I served along with George Housner of Caltech as a member of the Los Angeles County Earthquake Commission, which was set up in 1971 to report on the San Fernando earthquake. I have always found discussions with him on technical and professional matters very informative.

I have served with Professor George Winter of Cornell University in several capacities, including the specification committees of ACI, AISC, and AISI. Winter was the author and proponent of the specification for AISI on cold-formed steel (dated 1946), and the current specification follows the basic format that he set up back then.

More recently, Professor Teoman Pekoz of Cornell, along with Professor Wei-Wen Yu and Roger LeBoube at the University of Missouri, Rolla, have continued the work on cold-formed steel and are the primary researchers in this field.

Many people could be mentioned as leaders in structural steel design, including William A. Milek, who for many years was chief engineer for AISC. Since his retirement, he has continued as a leading consultant to the AISC Specification Committee.

I served with John Rinne on the SEAOC Seismology Committee. Rinne's discussions of the problems we faced set a very active pace for the entire committee.

For a number of years, I served with Henry Degenkolb on the committee that developed the ATC-3-06 document. His leadership of the committee enabled us to pull together a composite document that reflected the different views of individual committee members.

I have been in contact with Professor Egor Popov of U.C. Berkeley for many years. In the 1960s and 1970s, I served on advisory committees for a number of his research projects, and more recently have worked with him to develop seismic design provisions for AISC. His enthusiastic approach to solving problems has been a big help to everyone he has worked with.

William J. LeMessurier of Cambridge, Massachusetts, is a leading structural engineer with whom I served on the AISC Specification Committee. I mentioned him earlier in connection with the Citicorp Building. His office practices worldwide and has designed many tall buildings in New York and Boston. LeMessurier has a particular interest in problems with the stability of structures, on which he has written or contributed many articles.

For many years, I was on an advisory committee for research studies that Professor Robert Whitman of the Massachusetts Institute of Technology (MIT) was conducting on the basic concepts of structural design. I thoroughly enjoyed the discussions generated at those committee sessions.

Certain people became extremely interested and active in committee work, a good example being Edward Teal. He was long associated with the steel industry, is now semi-retired, and has been putting a lot of thought into design.

Scott: How was he associated with the steel industry?

Pinkham: I don't know. He wrote some papers for the steel industry, but I do not know whether he was paid to do so or did that as a voluntary, perhaps unsolicited, contribution. He certainly had his own personal interest in

the subject. As sort of a hobby, he has taken much of the results and reports on tests conducted at some of the universities, particularly some of the work Egor Popov has done, and has written quite lengthy critiques of those reports. He goes into things deeply and has the

time to reflect on them. Though he has often disagreed with the conclusions of these reports, I believe his thorough critique and explanation of his reasoning has actually helped the people involved.

Learning from Earthquakes

The interest jumps way up when there is a damaging earthquake, and then gradually sinks down until another earthquake comes along.

Role of EERI

Scott: Would you say a few more words about the Earthquake Engineering Research Institute?

Pinkham: EERI's main purpose is to pull together people from all kinds of disciplines who are interested in earthquakes and to expose them to what others are doing and thinking about earthquake engineering and hazard mitigation. I believe that EERI has helped bring them a little closer together in their basic thinking. EERI is now, of course, different from what it was originally when membership was by invitation. In earlier times, it had a total membership of only about fifty to seventy, but it has since been opened up and now has a much larger group of about 3,000.

EERI is very successful, but I think it still does not accomplish its main purpose to the fullest extent. In the structurally oriented sessions, you see the structural people more than the geotechnical people and vice versa. But EERI does have a

broad, active representation in its membership and attendance, and there is some mixing at its meetings, where all the attendees get the opportunity to learn what the other disciplines are thinking about.

EERI has set up a committee to study the composition of the membership, to seek out new members from disciplines that need more representation, and to consider what the organization could do to provide better services to the members. Although, I think EERI already does a lot, such as all the publications that have been coming out.

In addition, EERI has a well-established endowment committee and an endowment fund that is already sponsoring special projects. That effort seems to be going very well, probably even beyond what was originally expected. For example, the two recent “White Papers”—*Public Policy and Building Safety* and *Construction Quality, Education, and Seismic Safety*—both published in 1996, were sponsored by the endowment fund and were very well done. The endowment fund also sponsored a study to determine how the EERI staff would be best served by computerizing their office. That was intended more for internal policymaking and staff use, however, and was not given a general distribution.

Scott: How long have you been on the EERI Board?

Pinkham: The last year of my three-year term was 1996. I was designated by EERI to serve as a liaison between EERI and ATC, so I also went to all ATC board meetings. ATC also appointed me to serve as their liaison with EERI, so at that time I performed both roles.

Scott: How well do you think we are doing in applying what we now know about good seismic design?

Pinkham: You have to ask, “How good is it now in comparison to maybe twenty years ago?” or “How well are we doing in comparison to somebody else?” I think in general we have been doing very well. I am not saying there will not be some failures. I am sure there will be. But when you look at the number of people killed in West Coast earthquakes compared with almost any other place else in the world, it is minor. So we have been doing something right. People are killed, but not in the magnitude found elsewhere—not even when a freeway bridge collapses.

A Lot of Things Need to Be Looked At

Scott: Would you comment on the key areas where good knowledge and seismic design judgment can give good results, or where its absence can adversely affect the final structure’s earthquake resistance?

Pinkham: We are continuing to learn a lot with each new earthquake, and it is hard to know how to approach the subject. Some of the problems are known, but the solutions are not available. It is like the problem of retrofitting bridges in California. People ask, “How can we fix up those bridges?” It certainly cannot be done overnight, but will take time. Priorities have to be set, and then we hope the next earthquake holds off until the priorities for fixing things up have been met.

Several aspects of construction need to be looked into. Thus we have known for twenty

years or more that a lot of information is needed to design box columns for earthquakes, and yet a recent series of tests on box columns demonstrated that we still need more information in order to design them properly. Good results depend on getting enough time and money allocated to develop solutions that can be applied to high-priority projects.

The problem of steel studs with holes in them has been around for forty years or so. Finally, however, the problem got the attention of one of the code groups, which was hit in the face with the fact that we really didn't know how to design such studs. That led to a series of tests, completed recently, that resolved the problem.

Guarding Against Damage: Base Isolation and Damping

Scott: What about protecting against building damage?

Pinkham: I think the levels of damage can be greatly reduced, almost eliminated, if we spend the necessary money on base isolation of buildings—or, like they have been doing in some museums, base isolating individual statues or suspending them so they are protected. If it is worth it to the owners and they are willing to spend the money, damage can be pretty well minimized.

Scott: Two points need emphasis: first, that damage can be minimized with proper advance precautions and due care; second, that we are still quite a long way from accomplishing that, despite all our progress with earthquake engineering and seismic safety policy. You mentioned base isolation. It is a relatively new technology, at least in its current forms, and yet it is widely

used. Do you have any further comments on base isolation and other devices like dampers?

Pinkham: Base isolation definitely has a place. Again, because it costs money, it is a matter of an owner deciding how valuable it is to mitigate the damage that way. Some people who favor base isolation feel that all hospitals should have it, and that hospitals should even be retrofitted using base isolation; but like the bridges, it might take 100 years to get it done. It would be quite a proposition to do that on all existing hospitals. Regardless, base isolation is available for those who feel that the cost is worth it.

Other damping devices are also on the scene, and they will influence the types, sizes, and shapes of buildings. Mass dampers employ a computer that reacts to the motion of the building and transfers an enormous concrete mass composed of extremely heavy aggregate. The computer controls movement of the concrete mass so that its motion counteracts the building's motion in response to earthquake or wind forces. Dampers have to be able to do that not only for translation, but also for rotations, which requires two dampers operating at right angles to each other, either together or in opposition. So far as I know, they have only been used on some extremely tall buildings in New York and Boston to reduce wind response. Mass dampers cost an awful lot of money, but the system does work.

Scott: In lay terms, describe how the dampers function.

Pinkham: When the building begins to move, sensors attached to the computer feel the movement and activate the dampers to

move the masses in an opposing direction, using electrically powered hydraulic action. So these great big things move all over the place, while the building itself just sits there.

Scott: I suppose with the new knowledge and technologies coming along, there will be a lot of change in seismic design in the next twenty-five to fifty years. There are damping devices and energy absorbing mechanisms that can be set to help the building react during an earthquake and then reset afterward for the next earthquake.

Pinkham: Presumably, depending on a building's size, those devices work just as well as the mass dampers used in Boston and New York to deal with the wind problem. Extremely tall buildings of that type would probably respond similarly to earthquake and wind forces, and the dampers would probably work about as well for earthquake forces as for wind. The fundamental period of very tall buildings is quite long, so it takes time for tall buildings to respond. Consequently the effects of high frequency earthquake motions are not necessarily severe in tall buildings, whereas high frequencies can be very severe in short buildings.

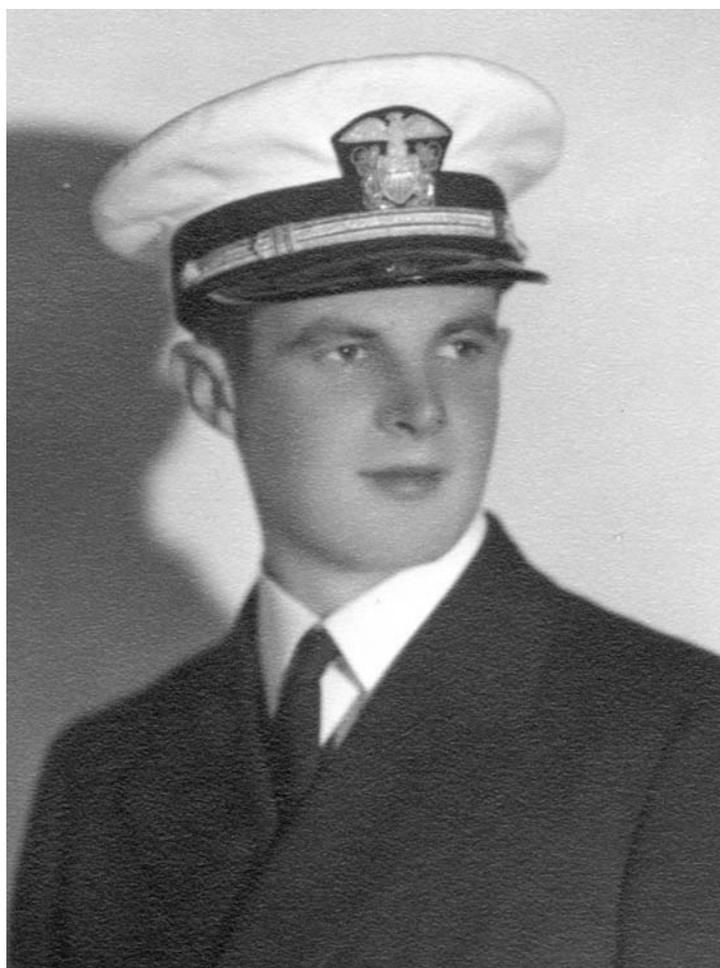
That is why mass damping is not effective on one-story or two-story buildings.

Earthquakes: A Real-Life Test

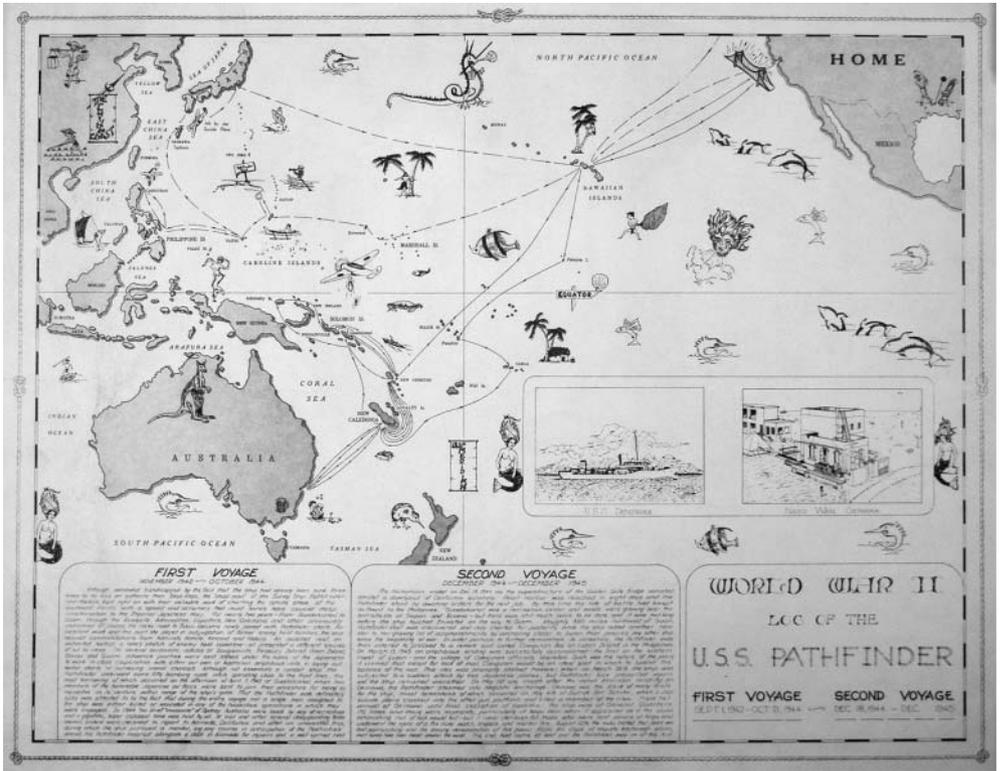
Scott: The actual earthquake experience is the ultimate, real-life test of seismic safety, and it suddenly highlights those things that may have been overlooked before. The earthquake experience also tends to rivet people's attention.

Pinkham: Absolutely. You could draw a curve of the level of interest. The interest jumps way up when there is a damaging earthquake, and then gradually sinks down until another earthquake comes along. It is very important for us to learn from earthquakes when they do occur. Many of the findings are lessons re-learned. That is, we see types of damage that we have seen before and already knew about. So you need to search out details that may not have been noticed before (such as the moment frame connections during the Northridge earthquake) as well as techniques that performed well despite the shaking. Unfortunately, those designs that performed well are not frequently reported on. You hear about the problems, but you do not hear about the successes.

Photographs

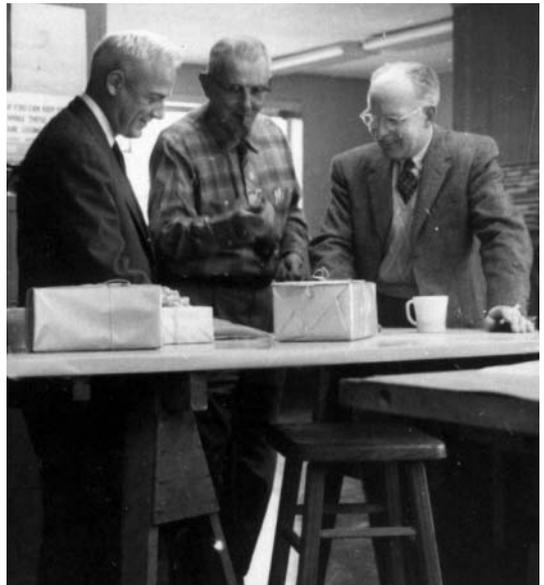


Clarkson Pinkham in the Navy in World War II.



Log of the USS Pathfinder during World War II. First voyage: September 1, 1942 to October 21, 1944. Second voyage: December 18, 1944 to December 1945.

The original partners of S.B. Barnes Associates. Left to right are Steve Barnes, Robert Kadow, and Mark Deering.





Lunchtime in the Barnes office. Left to right are Albin W. Johnson, Clarkson W. Pinkham, Bruce Saltman, and John "Flash" Gordon.



Office staff, 1955.

Clarkson Pinkham, front of table on left, is seated across from his wife, EmmaLu, at a SEAOC convention in 1971.



Pinkham becomes a Life Member of ASCE in 1992.





Hangar at Edwards Air Force Base under construction, 1954.



Erection of the structural steel for the 1901 Avenue of the Stars, Los Angeles, highrise building, 1969.



Clarkson Pinkham, 2000.

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