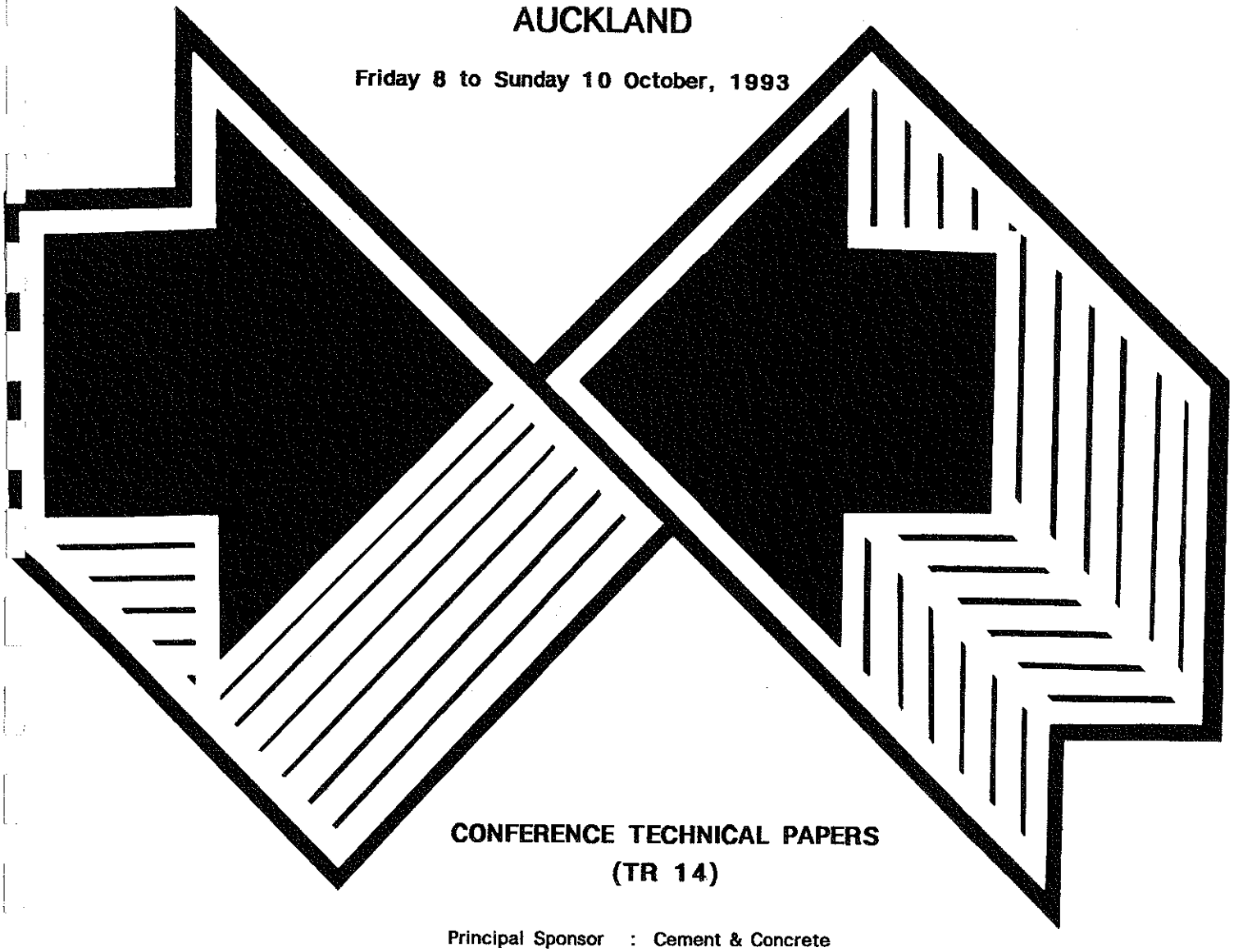
NEW ZEALAND CONCRETE SOCIETY

CONCRETE '93

TECHNICAL CONFERENCE AND AGM
WAIPUNA LODGE, MT WELLINGTON
AUCKLAND

Friday 8 to Sunday 10 October, 1993



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Technical Conference and AGM
Waipuna Lodge, Mt Wellington, Auckland
8-10 October

CONFERENCE PROGRAMME AND TABLE OF CONTENTS

FRIDAY 8 OCTOBER

SEMINAR:

"Creating Structures in Masonry and Concrete"

SATURDAY 9 OCTOBER

SUNDAY 10 OCTOBER

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KEYNOTE SPEAKER

James E Amrhein, S.E.
Executive Director for Masonry Institute of America

Jim Amrhein, consulting engineer and executive director for the Masonry Institute of America has been active in seismic design and research, including the investigation of structural performance of buildings subjected to earthquakes throughout the world. His BCE was earned at Manhattan College, followed by an MSCE from Columbia University.

He is a registered civil and structural engineer in California and a licensed professional engineer in New York, and is a fellow in the American Society of Civil Engineers and the American Concrete Institute, a member of the International Conference of Building Officials, American Society for Testing and Materials, Structural Engineering Association of Southern California, Earthquake Engineering Research Institute and other professional organisations.

Jim Amrhein is a founding member of the Masonry Society and was president for two terms 1988-1990 and was on the board of directors of the council for Masonry Research, 1988-1990.

He is a Navy veteran who served overseas with the Seabees during World War II and in the Korean Incident. From 1961 to 1988 he was on the evening Civil Engineering Faculty of California State University as a full professor.

In 1983 he received the Outstanding Engineer Merit Award from the Institute for the Advancement of Engineering for his work in masonry research, publications and education, and the Stephen B Barnes Award from the Structural Engineering Association of Southern California for slender wall research. In 1989 he received the Distinguished Service Award from the Western States Clay Product Association. In 1992 Amrhein received the President's Award from The Masonry Society for his contributions to the goals of The Masonry Society.

He is the author of the Reinforced Masonry Engineering Handbook which is in its 5th edition; Marble and Stone Slab Veneer, 2nd edition; Reinforcing Steel in Masonry and Masonry Design Manual. He has written over 50 technical papers and books on masonry, earthquakes, concrete design and construction.

In his primary address to the Conference "Masonry Yesterday, Today and Tomorrow" he highlighted the situation with regard to residential structures. In the next session the highlights will be on industrial commerical applications for masonry together with structural engineering review implications of Hurricane Iniki and Loma Prieta Earthquake. (slide presentation)

THE HURRICANE INIKI

James E Amrhein, S.E.

The Hurricane Iniki struck Kauai one of the Hawaiian Islands at approximately 10:00 am on Friday, September 11, 1992, when maximum sustained winds were estimated at 145 miles an hour with guest estimated at 175 miles per hour.

The Hurricane hit directly over Kauai causing major damage to the structures there. This is a series of slides by the Structural Engineers Association of Hawaii who surveyed the damage immediately after the hurricane and prepared reports on the damage.

The Hotel at Kapaa suffered from roof damage blowing off a good part of the shingles and the covering at the end gable.

One hotel of light framed timber construction in the Nawiliwili area was built on tofu blocks on precast concrete footings. One wing of the hotel slid off the foundation due to inadequate connections from the structure to the foundation.

The wing suffered severe damage to other framing elements after it fell off its foundation. This hotel suffered extensive roofing as well as rafter damage because of inadequate up-lift resistance.

This timber structure in Kukui Grove slid off its tofu blocks that were on precast concrete foundations. There were no tie-downs of the building to the foundation and in effect the wind just blew the building away.

The wind pushed the building and the suction pulled out the leeward wall.

Timber structures in Kapaa slid off its tofu blocks. The structure was not tied down.

There were gable end roof failures similar to those observed on many other residence buildings. Loss of metal roofs were common. The gable end failure was due to lack of blocking and bracing at the end of the structure.

Metal buildings also were severely damaged. Pre-engineered metal buildings collapsed in Nawiliwili. Several pre-engineered steel buildings failed in Nawiliwili as well as in other parts of the Islands.

The pre-engineered steel building in Nawiliwili suffered total collapse possibly from wind blown debris. It was also stated that a Maston cargo container was picked up by the wind and blew into the middle of the columns and caused a failure of the columns.

Pre-engineered rigid frame steel framed building in the Lihue industrial park, completely collapsed and other roof members are all twisted.

Industrial park building in Lihue lost its metal siding and the steel girts. The winds just peeled off the siding of this building. Steel frame warehouse building in Lihue industrial park - frames collapsed and siding blown off.

Steel rigid frames collapsed.

Pre-engineered rigid steel frame building, lost siding, roofing and girts.

Steel building with reinforced masonry walls on two sides collapsed due to the failures of the roll-up doors and lack of roof connections to the masonry walls. Note however, the rear masonry wall is still standing. Reinforcing masonry walls remained standing while the steel covered framing and metal walls blew away.

Engineered reinforced masonry buildings suffered little or no damage. However, there were instances of non-engineered masonry walls collapsing because of inadequate lap splicing of reinforcing bars. In other instances, horizontal reinforcing bars were inadequately anchored at wall intersections and corners.

The school cafeteria in Kapaa with reinforced concrete columns, glue laminated timber roof girders and heavy timber roof deck suffered extensive envelope damage. The building had a majority of its large perimeter windows broken. The loss of perimeter glazing increased internal pressures that when combined with external suction forces, some of the heavy timber roof blew off.

This high school gymnasium in Lihue suffered extensive roof damage at the end gables.

In the foreground portable class room buildings that are completely collapsed. These portable classrooms were light framed timber rooms supported on blocks in an exposed area. Portable classrooms that were shielded by the main building suffered some damage. Many of the portable classroom walls collapsed and the structures slid off the foundation blocks.

The portable classroom buildings became wind born and were propelled into adjacent buildings. This is the adjacent building and the roof of this building is torn up by the sheeting from the portable classrooms.

One story residential building had the roof completely blown off. The metal hurricane fasteners kept the timber trusses and ceiling joists tied to the structure but the roof sheeting was lost.

The wind completely blew off the dry walls off the studs on the interior of this single family residence after the roof was blown off.

One story family residence slipped off its blocks. The structures lifted upward and shifted horizontally due to lack of connections from the structure to the foundation. The structures were displaced from 3 to 5 feet and in some instances as much as 15 feet.

Single story residence in Hanpepe lost their metal roofing. This was very common in the area. These houses suffered extensive water damage.

Single story residence Lihue, suffered gable roof and end wall failure.

Interior view of a single family residence in Lihue, roof missing.

The reinforced masonry home performed well but suffered roof covering damage. There were no observed failures of walls of the masonry homes. Masonry houses with hurricane clips had no roof failures but had roof covering damage. Homes without hurricane clips had some roof failure. Hurricane clips when used were tied from rafter to wood plate that was bolted into the grout in the masonry cells. The masonry homes performed well and there is now an increase in the construction of masonry homes in Kauai.

A recently completed home in Lihue suffered damage with the roof completely blown off. There were inadequate hurricane clips that tied the roof to the walls.

Pre-engineered package steel framed industrial building in Nawiliwili in which the steel siding completely blew off but at least the frames are still standing.

End wall on the concrete masonry building collapsed due to lack of ties to either the side walls or to the roof diaphragm.

Masonry walls performed in these buildings in Lihue but the roofs blew off.

The only concrete tilt-up structure on Kauai performed well. Several of the metal doors were blown in. There was no or minimum structural damage.

Steel stud frame structure with exterior gyp board. It was under construction and the siding blew off or was never even installed. The roof siding was blown away.

Metal siding of this pre-engineered package steel structure in Lihue was blown off when debris flying around caused damage of the structure itself.

Kauai Western Hotel and area. Hotel had $25 million in damage due primarily to water damage, landscape damage and architectural damage. 10% of the windows were damaged. The engineered structures performed well structurally.

Ocean view of cove at Kauai Western Hotel.