SECOND CONFERENCE ON TALL BUILDINGS IN SEISMIC REGIONS

MAY 16 AND 17, 1991, LOS ANGELES, CALIFORNIA, USA

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INTRODUCTION

This article reviews the Second Conference on Tall Buildings in Seismic Regions held in Los Angeles on May 16 and 17, 1991. This conference was organised jointly by The Los Angeles Tall Buildings Structural Design Council and The Council on Tall Buildings and Urban Habitat.

Approximately 150 delegates from nine countries attended the conference, including the writer.

The stated purpose of the conference was to overview current and future trends in design and construction of tall buildings for seismic and wind effects.

The following papers were prepared for and presented at the conference by New Zealand engineers:

> "Design and Construction of the National Bank Centre, Auckland"
> Kevin C.F. Spring and G.K. Sidwell (Rankine and Hill Limited).
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> "Implications of the 1989 Newcastle Earthquake on the Design and Construction of Tall Buildings in Australia"
> David Brunsdon and James Forbes (Irwin Johnston and Partners, Sydney).

This review comments briefly under various headings on items presented or discussed at the conference that are considered to be of interest, based on the sessions attended by the writer.

BUILDING APPROVAL PROCESSES

The first plenary session of the conference featured Los Angeles-based property developers and consultants reviewing the various steps involved in obtaining authorities approvals for a multistorey project in Los Angeles and the changes to those steps that have occurred over the last five years. The main point of interest in this presentation was the increasingly political nature of the approvals process in Los Angeles, and the implications for other cities.

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Key changes in the approvals process include the following:

- The obligation to satisfy onerous new State and Federal requirements in addition to the established City planning conditions. One such recent requirement is the need for an Environmental Impact Report for virtually every land development project, including those in the centre of the city.
- Elected city officials having greater input in and control over the process, with correspondingly less involvement from employed officers. Many of these elected officials have won office on "no growth" platforms. In addition, some Councils now require a unanimous vote in favour of a project before approval is given, rather than the former majority decision.
- Associated with the involvement of elected officials has been the trend towards the imposition of additional "city amenity fees" on a project-by-project (i.e. ad hoc) basis.

As an indication of the impact of these changes, it was estimated that a project which took nine months to gain authorities approval in 1987 would currently require at least three and possibly five years for the corresponding approval. The consequential increase in overall project costs has represented another negative influence on a recessionary real estate market.

LATERAL LOAD RESISTING SYSTEMS FOR TALL BUILDINGS

Various case studies of recently designed tall buildings were presented, and each featured one of the three following lateral load resisting systems:

- moment resisting steel frames.
- moment resisting ductile concrete frames.
- reinforced concrete shear walls.

A recent variation to the conventional ductile beam and column frame is the development of a modular vierendeel subframe for resisting lateral loads. This system has been developed in response to the many architectural constraints in the lower levels of buildings where a large proportion of perimeter columns cannot pass without interruption through main entry lobbies, atria and car parking floors to foundation levels.

Vierendeel frames are formed over a number of floors by the use of columns at reasonably close spacing and beams on each floor. These frames span vertically back to key continuous columns, and can possess appreciable lateral stiffness. They can be designed as either concrete or steel subframes, and stacked vertically one above another in a modular fashion with the use of a separation detail in the non-continuous columns which limits the amount of vertical load retained in those secondary columns.

The inelastic response of the structure involves the yielding of both the intermediate columns and the majority of beams.

The principal advantage of this system is that the gravity load is concentrated in fewer vertical elements, thus counteracting axial tension forces induced by the lateral loads. However considerable effort is required in reinforcing the beams and intermediate columns appropriately in order to ensure the development of an acceptable inelastic mechanism.

BASE ISOLATION

The seismic design of what is reported to be the world's largest base isolated structure was described by Japanese engineers. To be used as a computer centre, this seven storey building currently under construction in Tokyo has a footprint of approximately 80m x 60m.

Base isolation is achieved by the installation of 68 lead rubber bearings, which range in diameter from 1100mm to 1500mm. All isolating bearings were tested to check their stiffness and damping characteristics prior to installation.

HIGH STRENGTH CONCRETE

The use of concretes with strengths up to 130 MPa in the United States was reported at the conference. Strengths of 100 MPa appear currently to represent an upper bound with respect to the considerations of economics and practicality.

Laboratory testing to ascertain the ductility achievable from high strength concrete columns is still at a relatively early stage in the United States, as it is in New Zealand. One test programme recently completed confirms the current thinking in New Zealand that acceptable inelastic performance of structural elements constructed using high strength concrete can be achieved with the use of high yield strength (eg 700 MPa) transverse confining reinforcement. This test programme did not however evaluate the performance of columns under high axial loads, and details of the spacing and configuration of the reinforcement were not presented.

STRUCTURAL STEEL

In two of the case studies involving structural steel-framed buildings, the designers highlighted uncertainties surrounding the determination of the appropriate effective length multiplier for in-plane buckling of column sections restrained by beams framing in at a skewed angle (eg 5^o - 20^o) to the longitudinal or minor axis. American code provisions in this regard were shown to be ill-defined, typically resulting in unrealistically high effective lengths.

POST-EARTHQUAKE ANALYSIS

A number of papers focussed on the response of various completed buildings in San Francisco in the October 1989 Loma Prieta earthquake. These structures ranged from a 10 storey masonry building to a 49 storey structural steel-framed building. None of the structures described sustained significant non-structural damage, and no signs of inelastic activity was reported.

The main point of interest was the processing of information gained from strong motion equipment that had been installed in some of these buildings. This information was compared against parameters computed from various dynamic analysis programmes. Reasonable agreement was achieved for the models which made allowance for cracking in the member section properties.

The practice in the United States of using gross rather than cracked member section properties in the seismic analysis of reinforced concrete lateral load resisting systems was noted in a number of the papers.

NEW TECHNOLOGY

The development, testing and application of two proprietary prefabricated elements used in earthquake-resistant structures was outlined.

- A high strength welded wire device for the confinement of critical base regions of concrete shear walls. This machine-fabricated mesh minimises the overall depth of tie sets and removes the uncertainty of tie bending tolerances.

- Elements consisting of a series of deformable steel plates that can be installed in structural steel braced frames to increase both the damping and stiffness of a structure. This patented device acts in a similar manner to the link section in an eccentrically braced frame, but can in theory be removed and replaced following a major earthquake.

Both of these elements have been the subject of several university-based test programmes, and the mesh product has been installed in a 17 storey building in San Francisco.

The conference as a whole was somewhat disappointing from both the organisational and technical points of view. The standard of chairmanship of the technical sessions was poor, with no time being allocated for questions. Given that nearly all of the conference delegates were from an engineering background, it was also surprising to find that the plenary sessions were dominated by developer/architect/town planner issues.

It was however reassuring to learn that engineers are continuing to enhance their knowledge of the seismic response of structures from recent major international earthquakes, and that innovative new products and structural system designs are being developed.