# Design of tall apartment buildings for fire resistance

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# Design of Tall Apartment Buildings for Fire Resistance

Conception de bâtiments d'habitation hauts en vue de leur résistance à l'incendie

Entwurf von hohen Wohnhäusern in bezug auf Brandeinwirkungen

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The existing Japanese building codes for fireproof constructions prescribe the fire endurance of the individual structural elements, such as beams, columns, floors and so on, without concerning the fire properties and structural features of buildings. Buildings have been designed against fire according to these codes. However, researches on the fire properties in compartments and the behaviour of steel structures under fire have recently been carried out and made the design of fireproof constructions possible by engineering methods.

This paper discusses the method and the results of the fireproofing design of the Ashiyahama Housing Project currently under construction. The Ashiyahama Housing project consists of many multistoried buildings as shown in Photo 1 and the dwellings totaled 3384.

The fireproofing design system used on this project is illustrated in Fig.1, and the following procedure was applied:

1) Fire compartments were allocated as shown in Fig. 2.
2) Fire loads were estimated from the quantity and the quality of the combustible materials for individual fire compartments.
3) Using a monograph, the equivalent fire duration time of dwelling unit was obtained from the fire load, floor factor, temperature factor and others. The equivalent fire duration time of public floor was determined by taking into account the fire load and burning phenomenon in the open space.
4) If the fire was not to spread to the adjoining fire compartments, then advance to the next step.
5) Using a computer program, allowable temperature of the steel frame was calculated from dead load, live load, thermal expansion and deterioration of steel members at elevated temperature. Shown as example, Fig.3 represents the joint displacement according to only thermal expansion and Fig.4 shows the distribution of bending moment that is due to the ordinary design load and the thermal expansion.

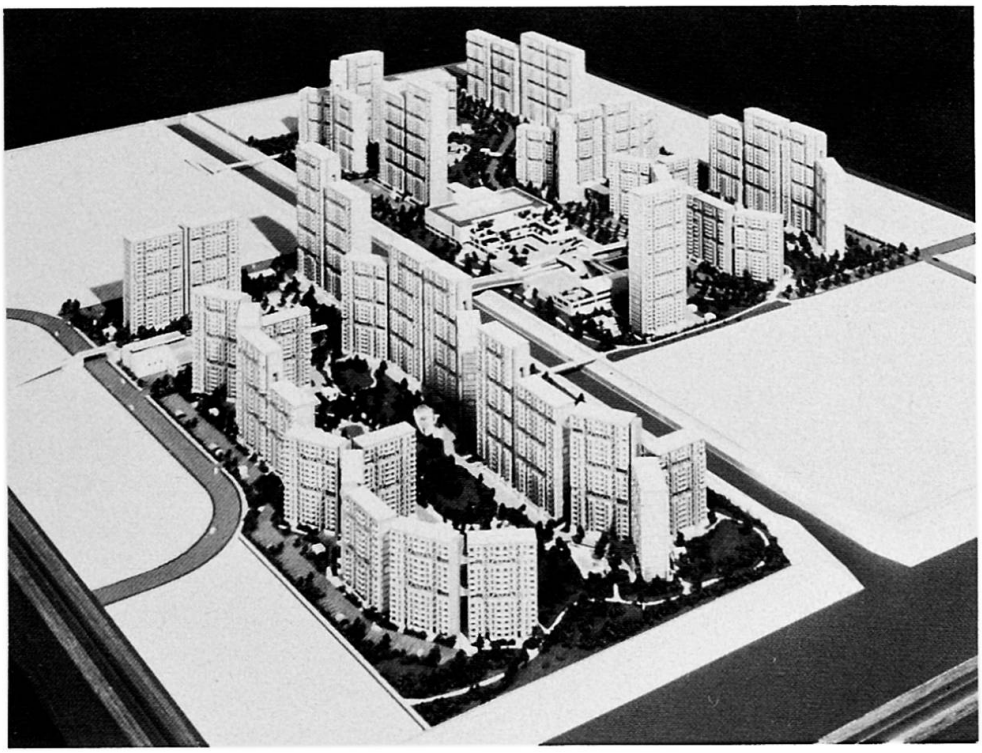

Photo 1: The bird's-eye view of the Ashiyahama Housing Project.(model)

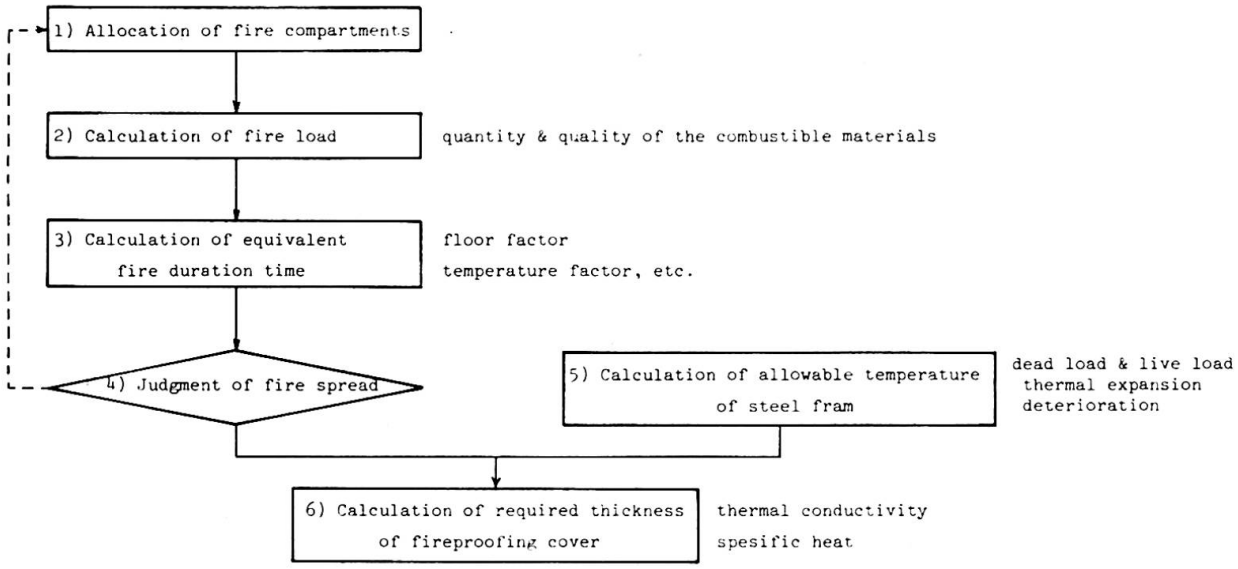


Fig. 1: The fire proofing design system

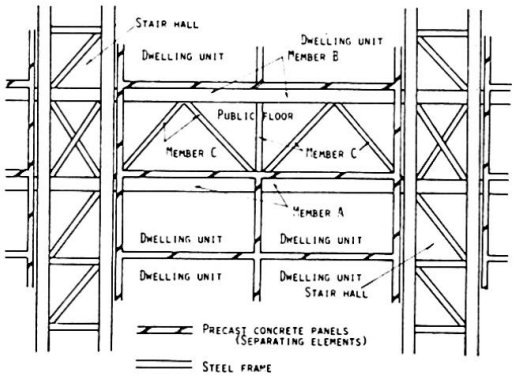


Fig. 2: The fire compartment and steel frame

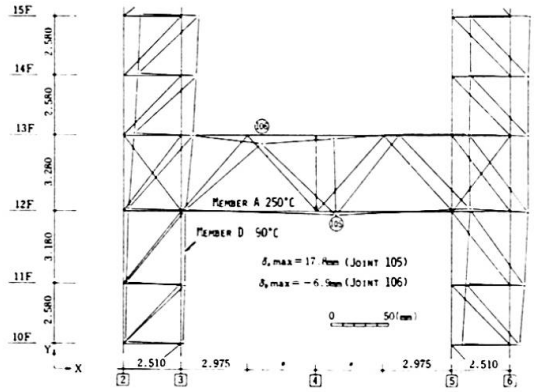


Fig. 3: Joint displacement according to only thermal expansion

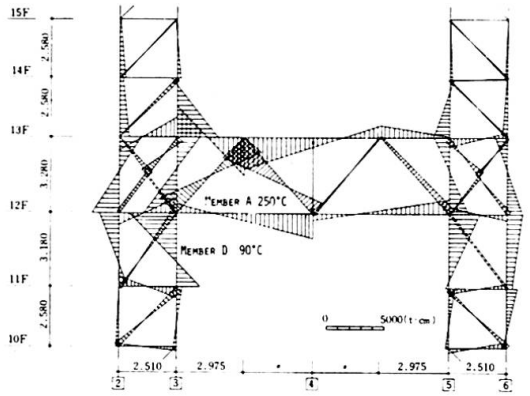


Fig. 4: Distribution of bending moment according to the ordinary design load and the thermal expansion

| Fire compartments | Fire load (Kg/m²) | Equivalent fire duration time (min.) | steel members in compartment | allowable temperature of steel members (°C) | Required thickness of fireproofing cover* (mm) |
|---|---|---|---|---|---|
| Dwelling unit | 60 | 90 | A | 250 | 45 |
| Public floor | 15 | 30 | B | 200 | 15 |
| | | | C | 100 | 15** |
| Stair hall | 0 | | others | | 0 |

* Sprayed asbeston.

** This value was determined by taking into account the heating condition and burning phenomenon in the open space.

Table 1: Results of the fireproofing design

6) The need for some fireproofing cover was realized by which the temperature rise of steel member could be kept below the allowable temperature after heating for equivalent fire duration time along the standard time-temperature curve. The required thicknesses of the fireproofing cover for members named A, B and C were calculated. It was found that other members did not require fireproofing cover.

These results are tabulated in Table 1.

Adopting the fireproofing design in this project despite the current building codes, structural safety against fire was secured and economical design was established.

The fireproofing design system adopted in this project can be applied, without modification, to such design of other buildings.

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SUMMARY

This paper discusses the method and results of the fireproofing design for the Ashiyahama Housing Project currently under construction. By adopting the fireproofing design in this project, without restriction of the existing Japanese building codes for fireproofing construction, the structural safety against fire was secured and economical design was satisfied.

RESUME

Cette étude discute la méthode et les résultats du calcul et de la conception du quartier d'habitation d'Ashiyahama en vue de la résistance à l'incendie. L'adoption de cette méthode qui n'est pas en contradiction avec la réglementation actuelle japonaise en la matière a permis d'assurer la sécurité structurale contre l'incendie et de réaliser un projet économique.

ZUSAMMENFASSUNG

Dieser Artikel erörtert die Methoden und Ergebnisse des Entwurfs in bezug auf Brandeinwirkungen für das derzeitig im Bau stehende Ashiyahama Wohnbauprojekt. Die für dieses Projekt herangezogene Methode gewährleistet einen ausreichenden Brandschutz, ist zudem wirtschaftlich und entspricht in allen Punkten den bestehenden japanischen Vorschriften für brandsichere Bauten.