The reform of story-increasing and anti-seismic strengthening of certain historical buildings

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Abstract

This article introduces as an actual example the effective reform of a certain historical building which has already been used for more than 40 years. It was a 3-storeyed dormitory and is now increased to a 7-storeyed one. In this way not only the usable area is much more enlarged, but also it has completed an anti-seismic strengthening work. Now the building has taken a new look! Also highly increases its usable time, thus obtaining remarkable social and economic benefits. We have accumulated the successful experience for protection, reform and renewing of a historical building.

1 Introduction

The 2# quarters for singles of a certain factory were originally built in 1954 with reinforced brick construction, was a 3-storeyed L-type office building. There was a basement partly attached to it, having a rigid strip foundation constructed with C10 class reinforced concrete, and right at the east side, there is a 3# dormitory. Its size is symmetrical and its type and style are also agreeable.

Because of the rapid development of the factory district, and the sharp increase of staff and workers. To solve the housing problem, it is finally decided to adopt the story-increase and consolidation reform process, so as to let the historical building satisfy the requirements of enlarging usability and the building itself takes a new look, and it can be used continuously later on.
2 Structural story-increase, reform and repair

2.1 The original condition of the old building construction

As the buildings were used as quarters for singles as early as in the 70’s the wash-room and the wooden floor at various stories were terribly deteriorated, the basement leaked seriously, while the toilet walls were also badly damaged.

2.2 The design of the structural system of story-increase reform

To satisfy the requirements for reforming the above-mentioned building into a guest house and a high class dormitory for singles, it is necessary to enlarge the span of the original building, therefore outer frame type story-increase structural system is adopted, and in order to reduce the story height of each frame, the vierendeel truss of web member system is adopted. It is later filled with wall material making a good separating wall between rooms.

The truss frame is longitudinally connected with 6 connecting beams to form a space truss system, among them a part of the outer frame columns are made with T-type cross-section, the inside part of the house turning corner adopts L-type cross-section, while the other outer frame columns adopt rectangular cross-section so as to meet with the space requirements of the surrounding road enlargement.

On considering the story-increase structural system to meet with the anti-seismic requirements, respective calculations are made on the loading stress, so as to fully satisfy the requirements of the design construction and its bearing load.

As the building is very close to a 6-storey residence, it is necessary to let day light get through, so unequal height of story-increase structure system with both story-decrease and story-increase is adopted; i.e. it will be a multi-story structural building consisting of 4, 5, 6, and 7-storey outer frame structure system after story-increase.
2.3 Foundation engineering design

Two ways of design for digging holes of the pile foundation under the outer frame columns of the building i.e. by manual digging holes for piling and drilling holes for cast-in-place pile. Among other factors, we have considered the site condition, the anti-seismic requirements, the loading capacity and economic index and by making full comparison on all sides, we come to the conclusion to choose manual digging of large diameter holes for piling and adopted three kinds of pile type namely, JC, JD, and JF. The pile diameters are 1800mm, 1300mm and 1600mm respectively. The diameters of the enlarging ends are 3000mm, 2100mm and 2400mm respectively.

For the outer longitudinal walls, outer and inside horizontal walls of the increased story after reform, the C10 class reinforced concrete rigid strip foundation is adopted, so as to be agreeable with the original building.

2.4 The construction measures for structure repair

As there have been story-decrease and story-increase for the building, the outer frame structural system rigidity is quite varied at different places. Therefore it is very important to strengthen the joint construction between the truss girder with web members and the outer frame columns. This engineering has consolidated the joint distribution ribs at this place, so as to form strong space structural frame between the truss beams of the span direction with the 6 longitudinal tie beams and strengthens measures assuring the structural skeleton to have firm and durable and rigid construction, so as to make the structure system as a whole more firm and have greater ability to adjust the difference in settlement.

Since the soil property of the building foundation is such that the west side is better, the south side varies greatly, and the north side is worse, therefore, the diameter and length of the piles under the outer frame columns are also properly varied in accordance so as to satisfy the requirements accordingly. According to the subsoil deformation, strictly control the theory and estimate settlement value and effectively control the difference settlement to the minimum.

To ensure the agreeable settlement of the story-increase structure and that of the original building as a whole a settlement joint is set at the floor board connection between the back side of the outer frame columns and the original building. After the whole load of the outer frame structural system has been placed and a definite amount of settlement is produced, then connect the settlement joint and the later filled band to eliminate the difference in settlement which is harmful to the structure, thus ensuring the effective implement of the reform for the building story-increase.
3 The monitor of foundation settlement

3.1 The arrangement of observation points

In order to ensure that during the process of loading, the outer frame columns of unequal height can adapt the uneven soil property and will be able to settle down evenly, therefore the monitoring of foundation deformation has to be strengthened.

On the walls of the original building and the outer frame columns and walls of the story-increase structure, 16 settlement observation points are placed (as shown in Fig.1) in order to monitor in all-round way and to make comparison analysis.

3.2 Observation results and analysis

Foundation settlement is observed until the 4~7\textsuperscript{th} story increase and white-wash have been completed. There is no settlement difference at the S\textsubscript{1}~S\textsubscript{16} observation points placed at the original building; the settlement difference of the S' \textsubscript{1}~S' \textsubscript{16} observation points placed at the increased stories of the outer frame columns is also very small being somewhere between 2~3 mm; only at the point S' \textsubscript{10}, the value is 4 mm, while the absolute even settlement value is 2.6 mm, thus ensuring that the structure construction of story-increase has been favorably and satisfactorily carried out.

4 Conclusion

(1) By means of dealing with the reform and repair of story-increase, historical buildings can adapt the progress of the society and improve their functional uses, thus obtaining social and economic benefits. This building has its area increased from the original 2445 m\textsuperscript{2} to 4565 m\textsuperscript{2} producing effective results.

(2) By means of maintenance and repair, and consolidation of historical buildings, especially the anti-seismic consolidation under present condition, strengthening connection construction of structural system to consolidate the stability durability of the whole body, In this way, not only its life of use can be prolonged, but also the area of the building can be enlarged, thus changing their functional uses to satisfy human desire in various ways.

(3) To ensure safe and favorable reform, maintenance and repair of the historical buildings, it is extremely important to strengthen the settlement observation both at the new and old part of the foundation of the building. This is the reliable means of the principle for carrying out information construction.
Reference

Figure 1: Plan of the settlement observation points the 2# quarters for singles of a certain factory.