RC조 아파트에서 시공중 동바리의 하중분포에 대한 연구

김영찬
부경대학교 건축학부

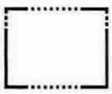
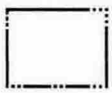
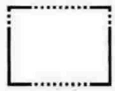
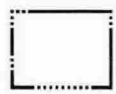
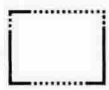
1. Introduction

Grundy and Kabailia[1] did a pioneering work on the study of shore-slab interaction in multistory reinforced concrete structures. They proposed a simplified method for the estimation of load flow in slabs and shores with assuming that shores are rigid and the stiffness of slab is time-independent, which was proved to be unrealistic by many investigators. Design consideration for formwork and development of realistic approach for the determination of construction load distribution are comprehensively covered by Chen and Mosallam[2]. Recently, floor load distribution in shear wall with flat plate structure is studied by Fang et al[3]. For the selected portion of slabs surrounded with shearwall in 5 floor plans, distribution of axial force in support during construction is examined using finite element analysis.

2. Description of Structural Unit

In the modeling of shore-slab system, as living room area is the largest slab surrounded by shearwalls, only this area is modeled to investigate load distribution in slab and shores. The structural detail of five units are summarized in Table 1. The shoring distance and concrete design strength of slab units are 120cm and 240 kgf/cm^2, respectively except model 5 whose values are 90cm and 210 kgf/cm^2. In the boundary condition and slab shape it is assumed to fixed at the shearwall line and continuous at the slab extended to and rectangular shape to simplify which is not influence the result.

Table 1. Summary of Slab Unit

	Model 1	Model 2	Model 3	Model 4	Model 5
Boundary condition					
Size(m)	5.3×5.1	7.1×7.4	5.6×5.7	5.6×6.2	7.4×6.3
Slab thickness(cm)	13.5	20	15	15	18

Note) a-boundary condition, ━ fixed, ···· continuous, b-abscissa × ordinate

One-story shoring and three-story clearing is normally employed in construction site and the rate of construction is 10 day per story. Steel pipe is used for shoring. A typical concrete casting cycle is

(1) stage 1: install a story of shores and forms and cast the floor slab above
(2) stage 2: partially remove shores from the lowest shored story
(3) stage 3: remove shores from the lowest cleared story

The plate element and truss element of MIDAS[4] were utilized to model slab and support, respectively.

3. Axial Force in Shore

The axial force in shores for model 5 is shown in Fig. 2. Including impact, dead and live loads for concrete placement, the load on the shore supporting newly cast slab is 838 kg/m^2. Then, the initial load on the 0.9m×0.9m-spaced shoring is 680kgf and this is obvious from the Figure 3. As concrete hardens, the load on shore is reduced. At the next day of concrete pouring 70% of shores is removed and the force in shoring varies very little until the concrete casting of the upper story slab, causing 1920kg of axial force in the reshores. The Euler buckling load for the steel pipe is 1800kg. This is less than the maximum value, meaning buckling of reshores. However, failure didn't occur in the reshores. Presence of friction at the both ends of reshores and live load less than the specified might avoid the buckling.

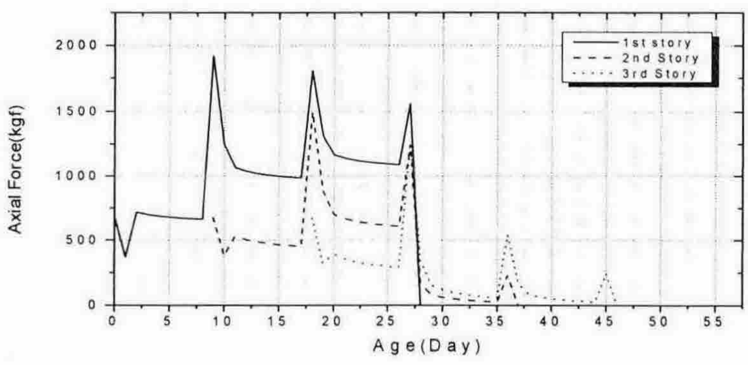


Fig. 2 Axial force distribution in Model 5

In Table 2, the ratios of the maximum value in each story to the initial load for each shore are listed. The shores in the 1st story shores which is assumed to be supported by unyielding foundation takes 29%-182% and compared to the 2nd story 25% more load is transmitted to the 1st story. It is common to use the same size of steel pipe for the entire story. However, if these ratios in Table 2 are considered, it may be possible to use different size of steel pipe for each story, saving construction cost.

Table 2. Ratio of forces in shores

Story	Model 1	Model 2	Model 3	Model 4	Model 5
1	1.43	1.84	1.51	1.29	2.82
2	1.17	1.42	1.20	1.02	2.20
3	1.01	1.19	1.01	0.86	1.84

4. Estimation of Axial Force in Shores

To estimate the range of forces transmitted to shores various size of rectangular slabs with two-side fixed and two-side continuous boundary condition are analyzed. Using these results and considering the slab size, the ratio in table 1 is compared in Table 3 to examine the possibility of estimation of axial force in shore. It is clear for

Model 2 and 5 the error is too large to be accepted. In other models, it is possible to estimate the ratios within 10% of error.

Table 5. Estimated force ratio in shores

Unit	Estimated ratio			Error(%)		
	1	2	3	1	2	3
Model 1	1.59	1.27	1.08	9.9	8.1	6.4
Model 2	2.18	1.73	1.45	15.8	17.8	17.9
Model 3	1.61	1.28	1.08	6.1	6.5	6.4
Model 4	1.75	1.42	1.21	26.0	28.0	28.7
Model 5	2.95	2.36	2.06	4.2	6.8	10.8

Note: Error(%)=(Estimated - FEM)/ Estimated *100

5. Conclusions

Considering the aging effect of concrete, load variation in the floor slab and shoring system of shearwall-type RC structure is investigated. To evaluate the load ratio transmitted to shores various size of slabs are analyzed. Based on the analysis result, it is possible to estimate force in shores during construction within 10% error. Construction efficiency may be enhanced by arranging different size of shores according to estimated force ratios.

References

1. K. Grundy and A. Kabailia, "Construction Loads on Slabs with Shored Formwork in Multistory Buildings." ACI Journal, Vol. 60, No. 12, pp.1729-1738, 1963.
2. W.F. Chen and K.H. Mosallam, *Concrete Buildings.* Boca Raton: CRC Press, 1991.
3. D. Fang, C. Geng, H. Zhu, and X. Liu, "Floor load distribution in reinforced concrete buildings during construction." ACI Structural Journal. Vol. 98, No.2, pp.149-156, 2001.
4. Posdata, *MIDAS GEN user's manual,* 2000.