Long-Span Girder Using Pre-cast Concrete Beams

Poutres à grande portée constituées d'éléments préfabriqués en béton

Entwurf weitgespannter Träger aus Betonfertigteilbalken

Kohsaku SERA
Director
Nihon Sekkei, Inc.
Tokyo, Japan

Yasuyoshi HITOMI
Structural Engineer
Nihon Sekkei, Inc.
Tokyo, Japan

1. INTRODUCTION

This report presents the design of the roof of Matsuyama Community Center. It also includes the results of the research performed for the deflection due to time of the long span girder used in this roof during and after construction. The roof is placed in an area of 32 x 32 m and, is composed of pre-casted concrete members that are connected and then post-tensioned.

2. OUTLINE OF THE STRUCTURE

Fig. 1 shows the two types of pre-casted girder members used. This roof is composed of 48 pieces of pre-casted elements which consist basically of two crossed beams connected to each other. Post-tension is applied in both, X and Y directions. Concrete strength is 450 kg/cm^2.

3. TEST MEASUREMENTS

3.1 Strain-Time story

Fig. 2 shows the variation of strain when post-tensioning, after taking off the roof supports (jack down) and, 1.5 month after jack down. Here, it is possible to observe that the concrete compressive strain due to tension in the cable, the flexural strain after jack down and, the flexural strain due to creeping increase with the time. The compressive strain when post-tensioning is 179 μ (average of M-1, M-2 curves) and is 205 μ (average of M-3, M-4 curves) from test results. And the compressive stress is 54 - 62 kg/cm^2. The compressive stress is 57.4 kg/cm^2 from analytical calculations. Bending occurs at jack down and the strain produced at the lowest part of the center of the roof is 130 μ. The compressive stress condition remains after jack down. And tension does not occur even if load is applied, thus having excellent post-tensioning conditions.

3.2 Deflection-Time Story

Fig. 3 & 4 show the deflection when applying post-tension, at jack down, and after creeping. The vertical deflection of the central part is zero before applying tension and is 2 mm when applying it. The deflection of the central part is 12 mm after jack down, and the deflection due to creeping is 32 mm three months after jack down, which is approximately 2.5 times the deflection at jack down. The span-deflection ratio is 1/750. And the final maximum deflection due to creeping is 40 mm, remaining almost constant from then on.

3.3 Horizontal Displacement and Rotation

Horizontal displacements are produced as shrinkage occurs after post-tensioning. These are 4.14 mm for X direction and 4.37 for Y direction. The horizontal displacement calculated analytically is 5.2 mm. Considering a 10 % of losses due to friction. The external girders rotated about 1/400 after jack down.

4. CONCLUSIONS

The test results permitted us to have a clear understanding of the processes of post-tensioning, jack down and creeping.

(1) The concrete compressive stress calculated analytically is close to the value obtained from the tests.

(2) There is an excellent post-tensioning condition as tension is not produced at the lowest part of the center of the roof girder.

(3) There is no problem due to deflections,including creeping effects, as the span-deflection ratio is 1/750.

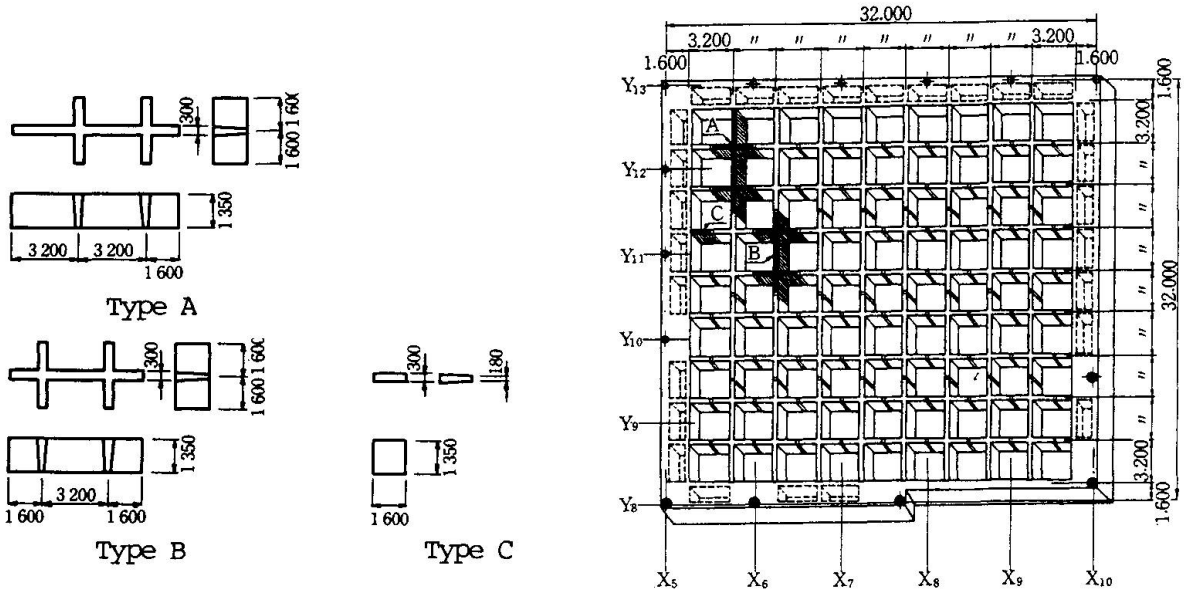

Fig. 1 Types of Pre-casted members and plan of the roof

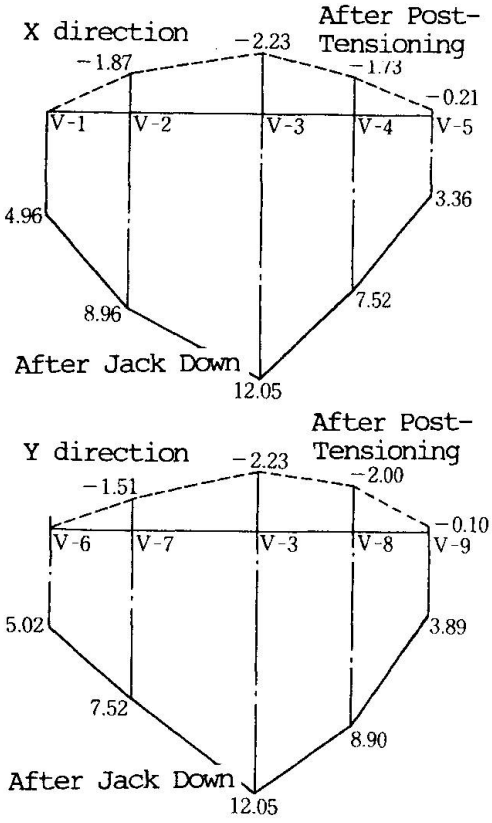

Fig. 3 Deformation of the long span girder

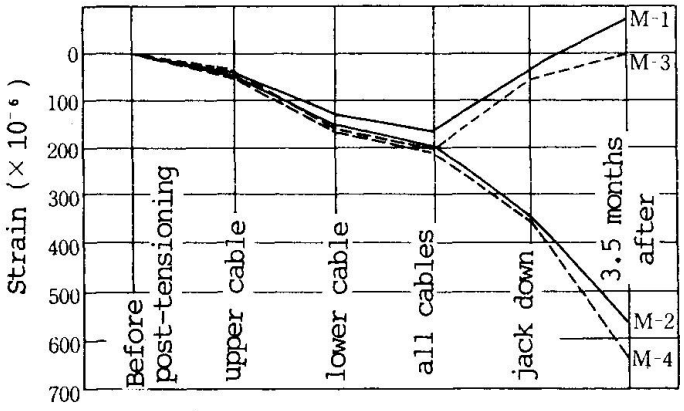

Fig. 2 Strain Time-Story

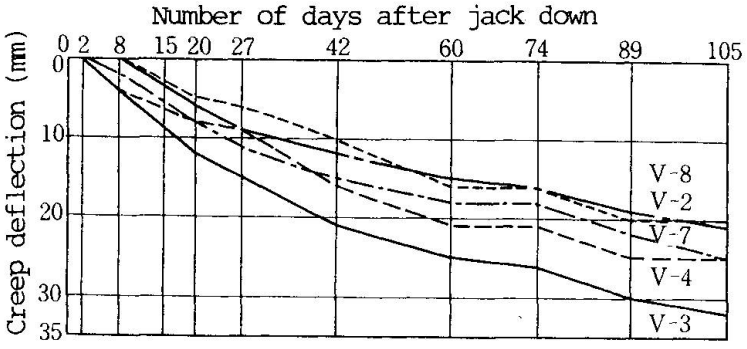

Fig. 4 Creep deflection after jack down