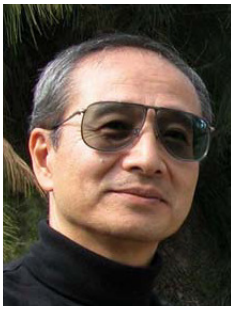
Function of Grids in Adaptable Buildings



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KEYWORDS

Grid, Function, Buiding System, Dimensional Coordination

1. Preface

The grid has various functions in building systems. In the 1960's numerous arguments were developed concerning modular coordination, but nowadays it is seldom discussed. However, the issue of dimensional coordination is still important for the design and construction of buildings. The problem is that the function of the grid in building construction is not clear. In this paper the author describes the process of applying the grid in three architectural works, and analyzes the function of grids in each case.
In the Japanese traditional wooden construction system or the industrialized systemsbuilding developed in the 1960's, a simple grid of parallel lines based on an interval unit from 900mm to 1500mm was used. In such case, the centers of columns are set to the axes of the grid. On the other hand, the dimensional coordination method for materials such as plywood or tatami mats is different, with the edge of the material adjusted to the reference line. The same holds for three-dimensional components such as bathroom units. For components such as partition panels, both the axis system and surface system are used.

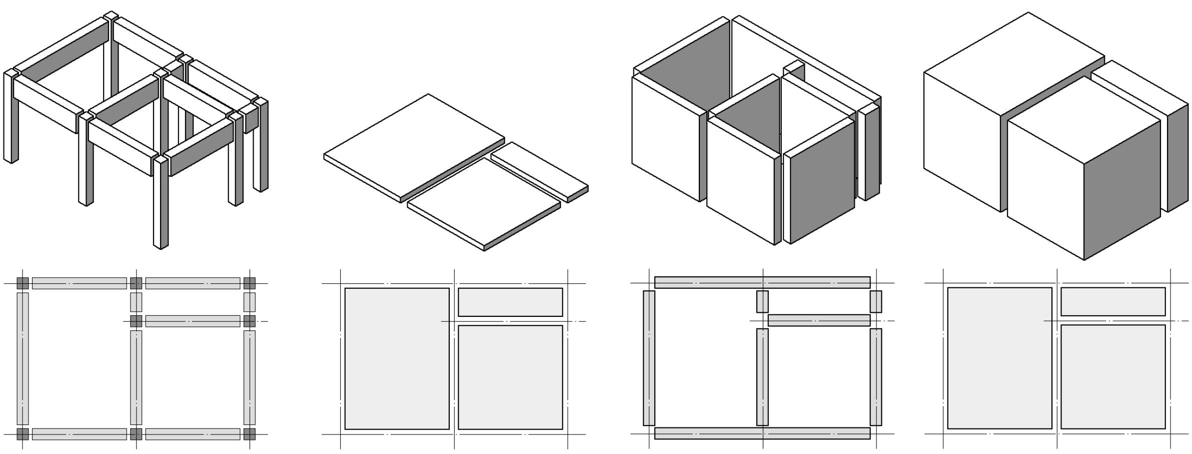

Figure 1. Types of components and reference lines

In the past, many attempts have been to resolve the conflict between the two systems. To comprehend this problem, it must be understood that there are several types of building components that relate to dimensional coordination.

Figure 1 shows the 4 types of components. The relation between component and reference line is different for each type. Therefore, suitable grids for determining the position of each component differ from one another.

It is also important to distinguish between two functions of the grid. The first function is to control the disposition of components belonging to the same group of components, and the second function is to coordinate the interface between different groups of components, i.e., the interface of building subsystems. It is difficult to make a simple single grid serve both these functions, but this can be accomplished by a sophisticated superimposition of a group of grids.

The followings are three architectural works in whose building system different interval grids are superimposed.

2. Science & Information Center of Musashi University

Figure 2. Science & Information Center of Musashi University

Figure 3. Structure of the Science & Information Center

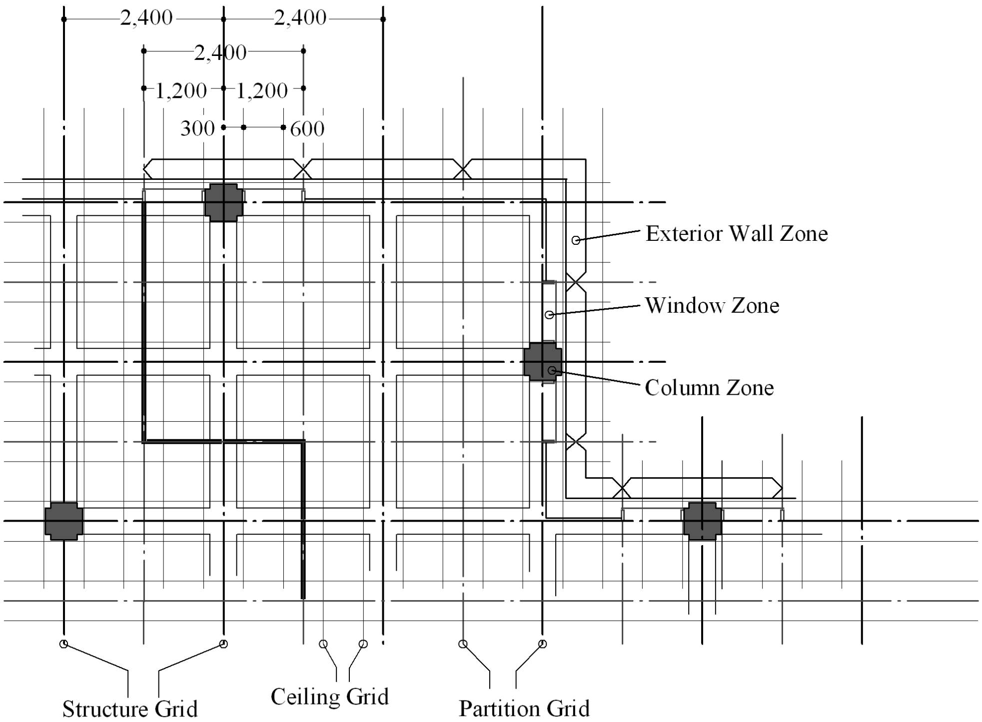

Figure 4. Grid for the Science & Information Center

For the Science & Information Center of Musashi University built in 1988, the design team, including the author, used a 2,400mm single grid to control structural members such as columns and beams. A 600mm grid was used for ceiling panels, superimposed over the structural grid. In this case, the 600mm grid was dislocated, matching its midpoints to the structural grid. The grid for partitions was also 600mm, and superimposed on the structural grid in the normal way. Thus, the positional relationship between ceiling and partitions was unusual but effective for control their interface.

Figure 5. Ceiling panels and partitions

Figure 6. Ceiling and mechanical equipment

3. The Experimental Housing NEXT 21

In the Experimental Housing NEXT21 built in 1993, the design team, including the author, introduced a more sophisticated series of grids. The grid for structural components was 3,600mm. The centerline of reinforced concrete columns was fitted with the grid line, and the size of columns was 750mm.

Figure 7. Experimental Housing NEXT 21

Figure 8. NEXT 21 Structure

Figure 9. NEXT21 External Wall

Figure 10. Floor ceramic tiles

In NEXT21, 13 architects designed 18 houses based on the predesigned structural skeleton, determining the position of their own external walls. The grid for external walls was a tartan grid with a 150mm band whose center corresponded to the structural grid. Figure 11 shows the relation of the superimposed grids. Using these superimposed grids, the surface of external wall is uninterrupted by the structural columns.

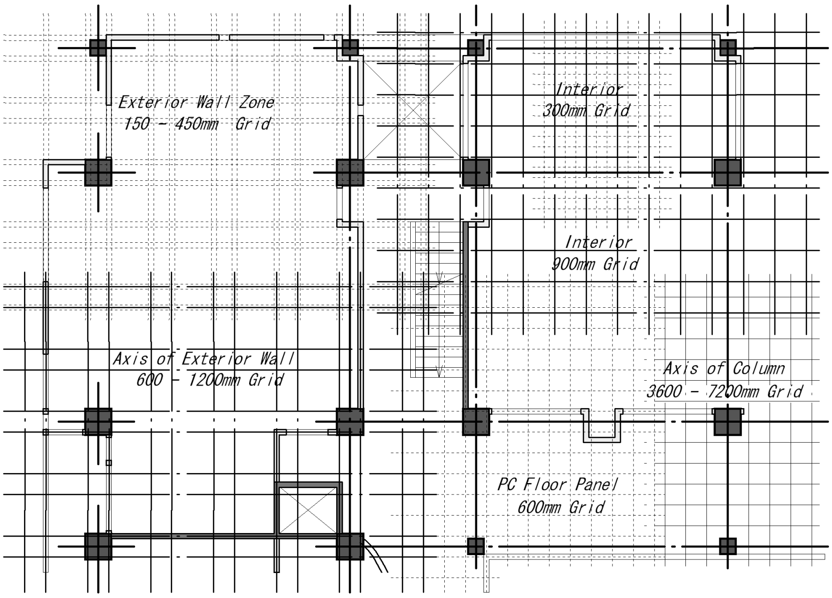

Figure 11. Grid pattern for NEXT 21

4. Shigebashira House

In Japanese traditional wooden houses, we use a 909mm Grid. Traditionally we used the *shaku/sun* system of measurement. One *sun* is 30.3mm and ten *sun* make one *shaku*, therefore, one *shaku* is 303mm, close to a foot in length. The grid interval in the traditional wooden house system is 3 *shaku*.
The author designed "Shigebashira House" in 1996 using the conventional construction system, but in this work, in addition to the 909mm grid, a 5-*sun* (151.5mm) grid was adopted, providing two levels of dimensional coordination.

Figure 12. Shigebashira House

Figure 13 Shigebashira House interior

The basic construction system of the Shigebashira House is traditional Japanese post-and-beam, but the density of columns is extraordinarily high. The column interval is 5 *sun*.
The curved wall was produced by positioning the columns on a sine-curved line. A 151.5mm interval corresponds to 7.5 degrees, and 12 columns form a 90-degree curve.
Figure 16 shows the detailed plan. In post-and-beam construction, the centerlines of columns correspond to the grid. In this case, the function of the grid is to specify the position of the components. But we can also represent this as in Fig. 17, in which the function of gridlines is to specify the area of the components. What is the difference between Fig. 16 and Fig 17 ? For the dimensional coordination of the columns, the functions of two methods are the same. But concerning the coordination of the interface between groups of building components, the gridlines of figure 16 and figure 17 have different meanings. The philosophy how to assign tolerance for components also differs.

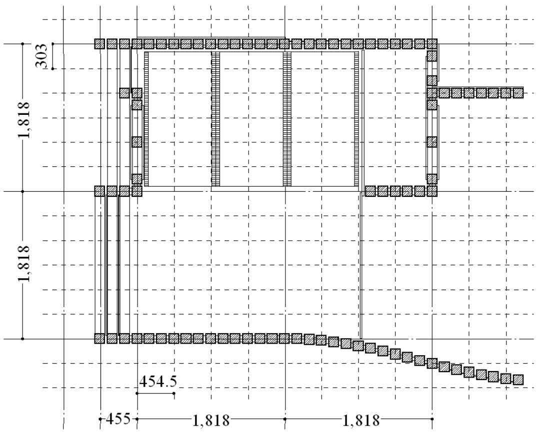

Figure 14. Plan of the Shigebashira House

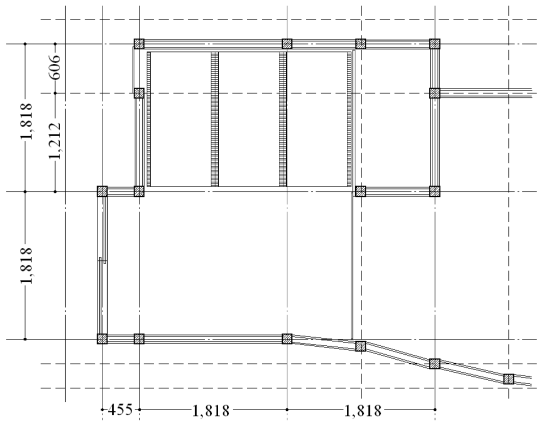

Figure 15. Conventional Construction

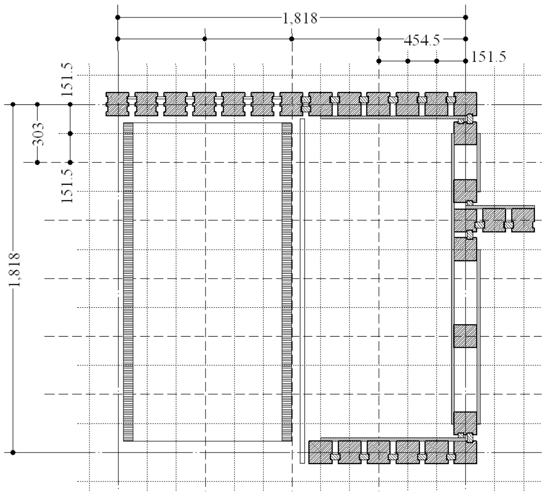

Figure 16. Detailed plan, axis system

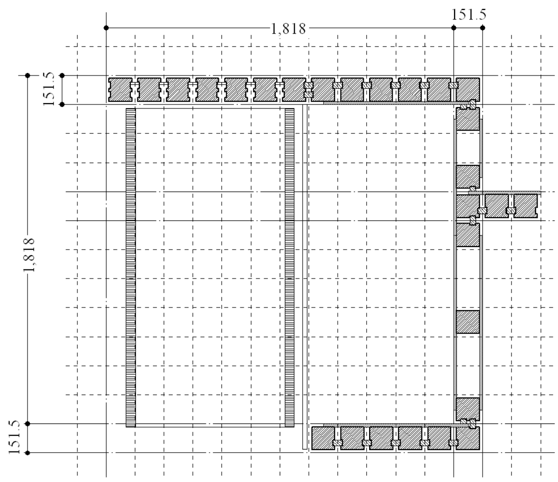

Figure 17. Detailed plan, surface system

In the Shigebashira House, plywood was used to resist horizontal load. The plywood was nailed to the columns according to the grid lines. In Japan the standard width of plywood is 3 *shaku*, and at the corners of walls the full size of plywood was used without cutting. (Fig.16)

5. Conclusion

For good architectural design, it is effective to achieve dimensional coordination using multiple grids of various levels superimposed on one other. The suitable grid system differs depending on the nature of the building components. An adaptable building system can be obtained through the use of a sophisticated grid system. A halfway-dislocated grid system is useful for such dimensional coordination.

6. References

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