INTRODUCTION

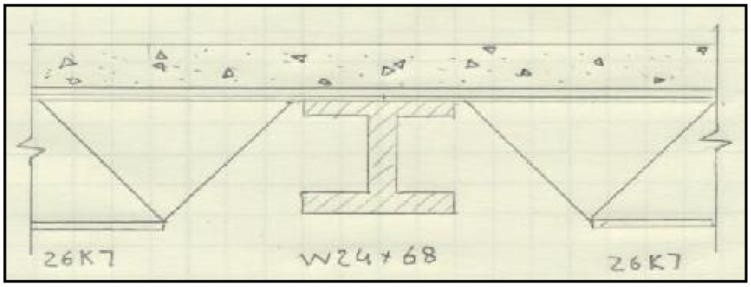
The Northbrook Corporate Center is a 5 story building located on 1150 Northbrook Drive, Philadelphia, PA. The building provides approximately 26,000 square feet of office use area per story, that is a total of 104,000 square feet of usable space, not including the garage. The total height of the building is 74 feet, with each story being 14 feet high. The building provides a parking garage on its lowest level and office space on upper four levels. Because the entrance into the building is located on second floor, the story number count begins at the second level. The levels are marked in the following order: Garage level, first, second, third, fourth levels, roof. The exterior of the building is decorated with red brick finish. The combination of the round concrete roofing slab with the four stories high curved glass curtain wall at the entrance of a building adds to Northbrook Corporate Center's clean and aesthetically pleasing appearance.

LATERAL LOAD RESISTING SYSTEM

The Northbrook Corporate Center's lateral force resisting system consists entirely of moment connections. Because the building is only 74 feet high, the accumulation of wind forces is small enough for moment connections to resist. Most columns are spread 30 feet o.c in each direction and rest on shallow concrete foundations. Typical column size is W12x72. Almost all columns span from the garage floor to the third story, where they are connected to and continued by a smaller column, typically W12x53. This connection is located 4 feet above the floor of the third story. Typical girder size is W24x68. The girders are connected to the columns through a moment connection, capacity of which ranges from 40 ft-k to 15 ft-k. 40 ft-k moment resistive connections are found on the first and second floors, 30 ft-k moment connections are found on the third floor, and 15 ft-k moment connections are found on the fourth floor. The girder size is adequate to carry all gravity loads without the help of moment connections, thus, the moment connections are used to resist the lateral loads only. The steel joists rest on girders, and support 4 inch concrete slab on metal deck. Because the building exterior outline incorporates curves and inconvenient angles, the structural layout is not entirely uniform. The bays located in the center region of the building vary in size and proportion. In some instances 'W' shaped beams are used instead of steel joists.

FLOOR SYSTEM

Northbrook Corporate Center's floor system is composed of 4 inch reinforced concrete slab on metal deck, steel joists, and steel girders. Concrete is poured on 9/16" – 26 GA. UFS form deck, and is reinforced with 6x6 – W2.9xW2.9 WWF. A typical bay is a square bay with dimensions of 30 ft x 30 ft. Steel joists, typically 26K7, are spaced 3 feet o.c., and are supported by steel girders, typically W24x68. The overall depth of the floor system is 30 inches.



Because of the light weight nature of this system, high levels of vibrations are often observed. In technical report 2 this system was checked for strength and feasibility, and proved to be satisfactory; however, the levels of vibrations were not checked. This uncertainty leads to further investigation of Northbrook Corporate Center's floor system.

PROBLEM STATEMENT

The design of Northbrook Corporate Center incorporates steel joists and 4 inch concrete slab on metal deck, as explained above. There are several disadvantages involved with this system. High levels of vibration are often observed when steel joists are used in high traffic areas. Due to the properties of the steel joist section, the overall depth of the system is extremely large. Consequently, the design of mechanical systems could be negatively affected.

It is also acknowledged that the previous study of the building's floor system lacked to answer many questions that directly relate to system's feasibility. It was assumed that the concrete slab and steel joists are not compositely related. The existing disadvantages of the system, and the lack of clear understanding of this topic creates the need for further study and investigation of the building's floor system.

Considering the high reputation and experience of the engineers that were involved in the design of the Northbrook Corporate Center, the chance of finding an error or an area of poor design is infinitely small. However, for educational purposed, this thesis proposal challenges the architectural, structural, and economical supremacy of the floor system incorporated in the design of the Northbrook Corporate Center.

PROPOSED SOLUTION

The typical bay of Northbrook Corporate Center's structural design is 30 ft x 30 ft. The two-way floor system is often more favorable in square bays, and I propose that the two-way waffle concrete slab system will possibly eliminate the unfavorable factors of depth and assumed vibration. The existing floor system and the two-way waffle concrete slab will be deeply studied and then compared in several categories, including depth, weight and its effect on architecture, vibration, and constructability.

SOLUTION METHOD

The structural engineering firm will be contacted to verify the details of the existing floor system. Using the obtained information the system factors such as strength, vibration levels, and deflection will be manually calculated and checked against the IBC 2003. The two-way waffle concrete slab will be designed using the CRSI 2002 Concrete Design Handbook. The results of both designs will be compared under these categories: weight, depth, constructability, and cost.

BREADTH STUDIES

Two breadth studies will be performed in additional to the studies mentioned above. The first study will be a detailed check of the interior column's footing. The footing will be checked in the following categories: size of the footing, puncture shear strength, flexural strength, and steel reinforcement.

As a part of second study, the cost of a similar size concrete building will be compared to the cost of the existing design. RSM Means will be used to roughly estimate the cost of material and installation, and the values will be compared.

TASK AND TOOLS

- PROPOSED SOLUTION
    - Study the existing system
        - Contact the firm for details of the system
        - Check the strength
        - Check the vibration
    - Design the waffle slab system
        - Use CRSI 2002 Concrete Design Handbook
        - Consider other method to design the waffle slab
    - Compare the two systems
        - List advantages and disadvantages of both systems
        - Describe the effect each system has on mechanical design

        - Use the comparison chart
            - Include the weight
            - Include the constructability
            - Include the material and installation cost
            - Include the depth
    - Breadth study 1
        - Manually design the footing
            - Size the footing
            - Design the reinforcement
            - Check the flexural strength
            - Check the puncture shear strength
    - Breadth study 2
        - Use RS Means to estimate the cost of the concrete structure
            - Include material cost
            - Include installation cost
            - Include management cost
        - Use RS Means to estimate the cost of an existing design
        - Contact the Construction Manager to verify the cost
        - Compare the costs of two systems in a chart
    - Summary and conclusion of the report
        - Summarize the report
        - Clearly state conclusion based on the results of the comparison of two systems

TIME TABLE

Task	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Study the existing system								
Design the waffle slab system								
Compare the two systems								
Breadth study 1								
Breadth study 2								
Summary and conclusion of the report								

Task	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
Study the existing system								
Design the waffle slab system								
Compare the two systems								
Breadth study 1								
Breadth study 2								
Summary and conclusion of the report								