Food and Drug Administration
Center for Drug Evaluation and Research
Office Building 2

THESIS PROPOSAL

COMPOSED BY:
MICHAEL O'MARA SPEAR

ADVISOR:
M. KEVIN PARFITT

DECEMBER 12, 2008

Table of Contents

Executive Summary

In this Thesis Proposal, the purpose of the upcoming research involving the Food and Drug Administration, Center for Drug Evaluation and Research, Office Building 2 (CDER2) was established. CDER 2 is a new six story office building for the FDA. This office, located in White Oak, Maryland- north of Washington DC, is responsible for the investigation into drugs.

One challenge facing the designers of CDER2, was the potential for terrorist attacks and other threats on the building's structure and its occupants. For the purpose of this thesis, the problem of progressive of collapse shall be reevaluated for an alternate steel framing system. Plus, blast and explosion loading will also be considered for the new steel structure. Through research and computer modeling of various load cases, the structure will be designed to protect the occupants from these potential disasters.

In addition to the structure, the façade will be evaluated for its blast resistance capabilities. In particular, the atrium's glass curtain wall and the various punch windows will be analyzed and, if necessary, redesigned to accommodate the blast requirements. However by changing the glass properties, other aspects of the building may change, such as day lighting and thermal loads. These and other related concerns will be addressed.

Changing the structure to steel will present new fire protection issues. Both active and passive fire protection systems will be researched and implemented. Also, effective placement of the systems will also be considered; again, the blast loading concerns will be addressed.

ARCHITECTURE

The Center for Drug Evaluation and Research Office Building 2 (CDER 2) is a new six story office building for the FDA. This office, located in White Oak, Maryland- north of Washington DC, is responsible for, as the name implies, the investigation into drugs for humans.

CDER 2 is composed of two separate office wings (Figure 1) connected by an atrium that reaches through the center of the building. The first floor of the atrium is the main entrance which rises up the full six stories, creating a dramatic entrance to CDER 2. Opposite the entrance is the main elevator lobby; bridging the entrance and elevators are the security desks and offices, as well as a few more welcoming spaces such as the large reception area and coffee bar (Figure 2). As the elevators rise, they empty into lobbies which are accessible to both office wings.

The floor plans for both office wings A and B are fairly consistent throughout all levels, with story heights being about twelve feet. Due to the geometry of the office wings, being long and narrow, most offices have a view of either the exterior or the grand interior lobby. The offices themselves are also quite consistent in size.

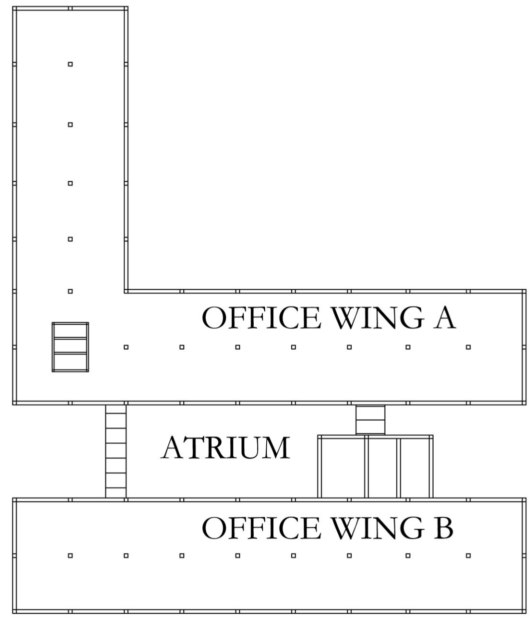


Figure 1: Typical Plan

Figure 2: Interior Atrium

EXISTING FLOOR

CDER2 utilizes a two-way flat slab floor system with drop panels located at the interior columns. Structurally, bay sizes are very typical and almost square being about 30'x31' (Figure 3). The floor slab itself is made up 9.4 inch (240mm), f'c = 4000 psi (28 MPa); at the drop panels, the slab gains an addition seven inches (180 mm). Void of interior beams, the reinforcement of the two way slab consists of primarily of #4-#7 ASTM GRADE 400 steel bars. An even distribution of reinforcement is regular throughout most of the slab, multiple layers of reinforcement are common near columns as well as the deep exterior beams. While there are little variations in the floor system, these differences primarily occur around the areas of egress and in mechanical spaces.

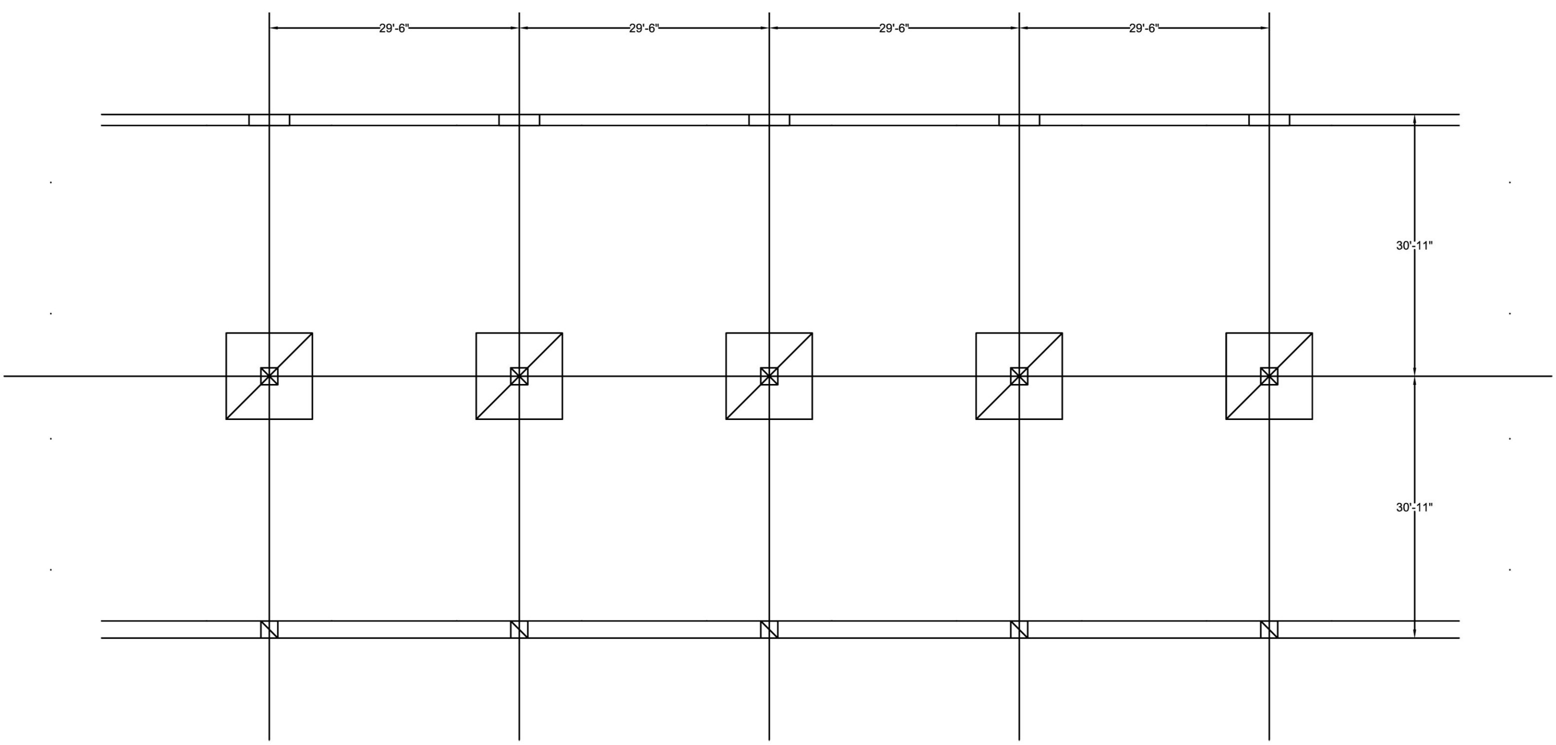


Figure 3: Typical Bays

STRUCTURAL SYSTEM

With a concrete moment frame, the lateral and gravity system of CDER2 are the same. A uniform grid of columns with deep exterior beams and a two-way flat slab, establishes the structural system.

There are two main column geometries: the interior square columns and the long and lean exterior columns. The interior columns are about 24"x24" (600mm x 600mm) using 4000 psi (28MPa) concrete. In addition to being found at the interiors of the office wings, these 24"x24" columns are also located where the wings are bordered by the atrium. The exterior columns are about 16"x58" (400mm x 1460mm) and are also composed of 4000 psi concrete. Reinforcement within the columns is fairly consistent with #9 bars, but varies in arrangement and number depending on the loading and level.

Consistency is a regular theme throughout CDER2; this is no different for the exterior beams. A 16"x50" (400mm x 1260mm) beam of 4000 psi (28 MPa) concrete exterior beam is quite regular. As mentioned previously, these beams serve the purpose of gravity as well as lateral loads. The only noticeable change in beam design is at the office wing/atrium interface; here a wider, but shallower beam of 24"x21" (600mm x 530mm) can be found. Reinforcement sizes for the beams ranges anywhere from #4-#9 ASTM GRADE 400 steel bars, throughout the top, bottom, and side faces of the members.

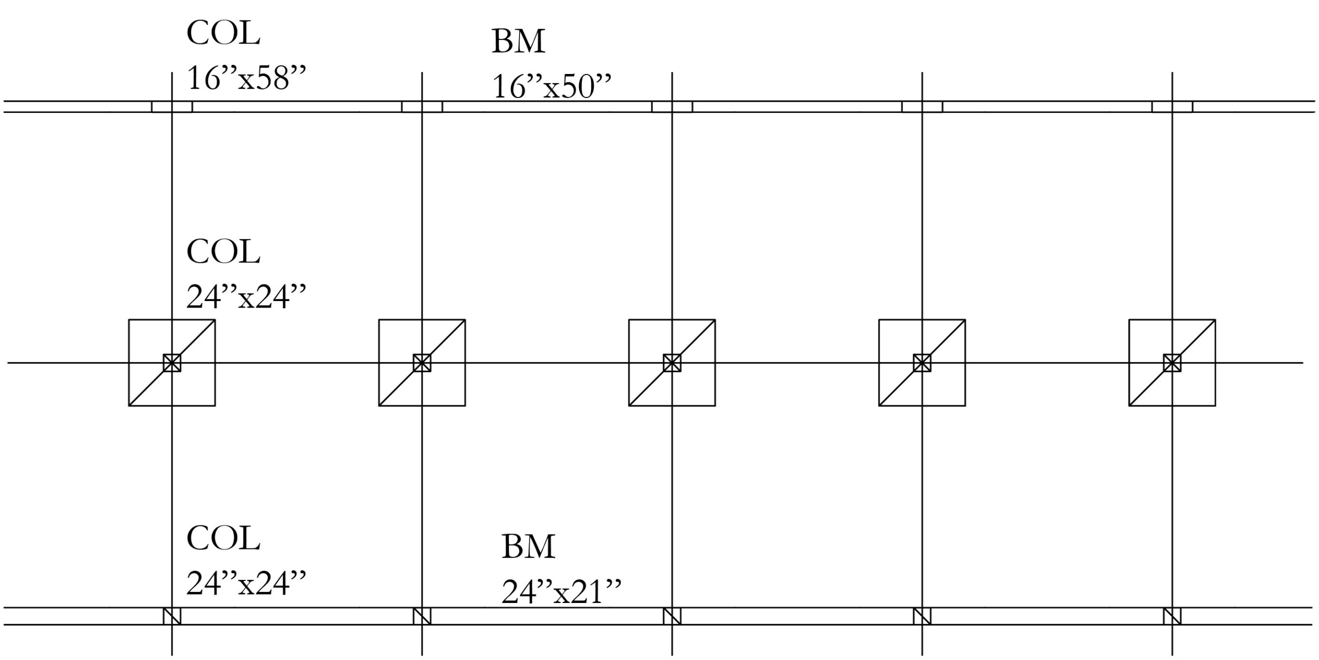


Figure 4: Typical Bays with Column and Beam Indentification

Problem Statement

One challenge facing the designers of CDER2, was the potential for terrorist attacks and other threats on the building's structure and its occupants. As a result of disasters, such as the Oklahoma City Federal Building bombing as well as the 9/11 World Trade Center collapse, the methodology for designing federal buildings has changed. In the case of CDER2, the designers had to employ the "GSA Progressive Collapse Analysis and Guidelines" when designing the ground level structural elements.

For the purpose of this thesis, the problem of progressive of collapse shall be reevaluated for an alternate steel framing system. In addition to progressive collapse considerations for the ground level, potential blast and explosion concerns will also be addressed. Due to the relative ease of accessibility, as compared to the other levels of the building, only ground level structural threats are going to be addressed; all blasts will be assumed to have originated on the ground level or site level and any "blasted-out" columns will be constrained to the first floor only. This parallels the challenges faced by the original designers. In order to minimize threats to the building, the site design will need to be evaluated and a preventative design will need to be employed. Additionally by considering an alternate steel framing system, a new gravity and lateral resisting structural systems will also need to be implemented.

The utilization of a steel structural system, instead of the current concrete moment frame system, poses new design problems as well. In learning from the World Trade Center collapse, the building's fire protection systems will now have to consider the effects of blast loading. CDER2's active and passive fire protections systems will need to be redesigned for the change in structure material as well as new design loads.

When considering the effects of a potential blast or explosion, other building components besides just the structural system need to be considered. In particular, the central glass curtain wall system, enclosing the atrium, is the visible gateway into CDER2 and could be a potential target for a terrorist attack. In the Oklahoma City Federal Building bombing, broken glass accounted for a majority of the sustained injuries. Therefore, the glass curtain wall and punch windows of CDER2 will be designed to resist a blast load and to minimize glass related injuries. Changing the glazing system could result in other design modifications. As a result, the any curtain wall modifications will result in further analysis of day lighting, thermal loading, moisture control, and architectural aesthetics of the atrium.

Solution Methods

Before beginning the progressive collapse and blast loading analysis, a steel framing system, which will resist the gravity and lateral loads of CDER2, will need to be designed. While the current structural grid will serve as a guide, the steel framing system design will not be blind to the progressive collapse concerns and deviations from the current framing layout may be necessary; floor to floor heights will remain unchanged. Several braced frame and moment frame schemes will be investigated in order to determine the most viable solution.

The procedure for addressing the progressive collapse concerns involves the analysis of the building in the event of a loss of a primary structural element, as the result of a blast or other destructive means. Critical perimeter and interior gravity members will be considered "lost" due to an event, such as blast, and the structural analysis will proceed without the "lost" members. This analysis procedure utilizes specific loading criteria and is compared to the ultimate strength of the structure.

The design of the gravity and lateral load resisting system, as well as the drift and displacement requirements, will be governed by ASCE 7-05. The progressive collapse analysis will be prescribed by "GSA Progressive Collapse Analysis and Guidelines". Additionally, AISC Design Guides for progressive collapse will be utilized in the development of the steel structural system. For the design of the resistance to gravity and lateral loads, as well as progressive collapse analysis, RAM Structural System and/or ETABS will be used to generate computer models.

Task 1) Research Possible Progressive Collapse Solutions for Steel Framing Systems
a) AISC design guides
b) case studies
c) discuss options with AE Faculty

Task 2) Research Blast Loads and Effects
a) research explosion properties
b) research possible site planning and structure solutions
c) research blast effect on façade and other non-structure elements
d) research blast effect on fire resisting elements, esp. as it relates to steel

Task 3) Design of Gravity Framing System
a) determine dead and live loads
b) determine possible framing systems
c) determine typical member sizes

Task 4) Design of Lateral Framing System
a) determine lateral loads
b) determine possible framing systems
c) determine typical member sizes

Task 5) Create Preliminary Computer Model
a) employ ETABS/RAM Structural System to implement designs
b) check strength requirements
c) check serviceability requirements

Task 6) Determine Blast/Progressive Collapse
a) determine reasonable blast load cases
b) determine progressive collapse load cases

Task 7) Research Chemical and Biological Threats
a) research plausible terrorism dangers
b) case studies
c) discuss options with AE Faculty
d) research possible solutions

Task 8) Research Façade Blast Resistance
a) determine required blast resistance
b) research curtain wall blast resistance concerns/solutions
c) research other façade systems' blast resistance as necessary
d) determine possible solutions

Task 9) Design Blast Resistance Structure and Necessary Components

a) design façade
b) determine fire resistance locations
c) implement necessary changes to structural layout caused by (a) and (b)
d) employ blast/progressive collapse load cases
e) check strength requirements
f) perform size upgrades as needed

Task 10) Conclusions of Blast/Progressive Collapse Analysis

a) chosen façade blast properties
b) fire resistance locations
c) final sizes and computer model analysis findings

Task 11) Design Solutions to Chemical and Biological Threats Developed in Task 7

a) design solution pertinent to CDER2
b) discuss other, more aggressive solutions
c) conclusions

Task 12) Determine Façade Change Effects

a) day lighting changes/concerns
b) thermal load changes/concerns
c) moisture control changes/concerns
d) architecture changes/concerns

Task 13) Design Solutions to Concerns Developed in Task 12 (as necessary)

a) day lighting design
b) thermal load design
c) moisture control design
d) architecture design
e) conclusions

Task 14) Progressive Writing

a) report work performed/findings developed at end of each week
b) determine any missing links for paper

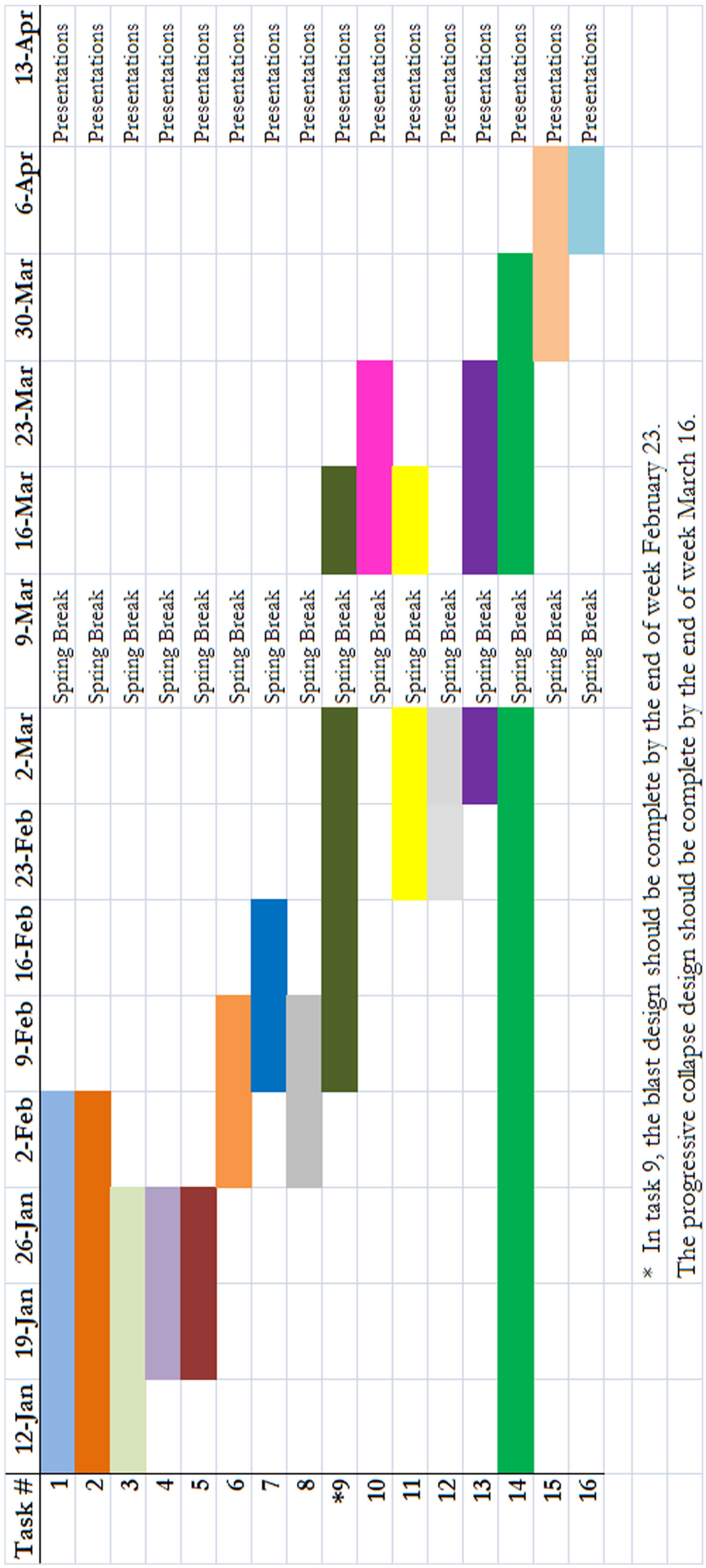
Task 15) Write Final Paper

a) report all work performed and conclusions made from semester work

Task 16) Develop Presentation

a) condense final written paper to 10-minute presentation for faculty

TIMELINE


Task #
1
2
3
4
5
6
7
8
*9
10
11
12
13
14
15
16
12-Jan
19-Jan
26-Jan
2-Feb
9-Feb
16-Feb
23-Feb
2-Mar
9-Mar
16-Mar
23-Mar
30-Mar
6-Apr
13-Apr
Spring Break
Presentations
* In task 9, the blast design should be complete by the end of week February 23.
The progressive collapse design should be complete by the end of week March 16.