# Introduction

The Medical Office Building is part of an office complex spanning 111 acres of East Whiteland Township and 5 acres of Tredyffrin Township in Malvern, Pennsylvania. The complex was started in the 1970's with an office building and a data center. A second office building was added in the 1980's and a third office building and a parking garage were added in 1999. The complex has been designed to separate the data center from the office buildings, but the office buildings have been built in the same area and connected by sky bridges to form a single architectural monument (Figure I-1).

**Figure I-1** Artist rendering of the sky bridge between The Medical Office Building (left) and its neighbor

The combined structure of the office buildings forms a helix around a sloping central park. The Medical Office Building holds the highest ground on the site and tries to bring the park into its bottom floor through a circular landing that is half occupied by the building's atrium (Figure I-2). This atrium, which resides on the curved southwestern façade, is the only disturbance to the otherwise alternating bands of pre-fabbed panels and windows. The aesthetic appeal of the consistency of these bands across all three office buildings also impacts the design of the interior spaces.

**Figure I-2** The Medical Office Building atop of the sloping central park

In addition to matching the exterior components of the Medical Office Building with its neighbor, the designers matched the interior components as well. The most important of these matches was maintaining the same floor elevations so that stairs or ramps would not be need in the sky bridges. To further maintain consistency between the structures, the ceiling heights and visible structural systems were also mimicked. In particular, the large concrete columns (Figure I-3) not only serve as a gravity resistant system, but also as a visual continuation of the previous structures. Where visual continuity is not necessary, the Medical Office Building takes more liberties with its structural systems.

**Figure I-3** Concrete columns that serve as the gravity system for The Medical Office Building and an architectural continuation from the existing office buildings

The structural systems of the Medical Office Building are composed of banded beams on columns to resist gravity loads and concrete moment frames to resist lateral loads. The banded beams chosen for this project are a proprietary system from Filigree that consists of 8’ by 18” beams built integrally with 9” to 10” slabs (Figure I-4). The beams span 28’ in the north-south direction while the slabs span 20’ between the beam edges in the west-east direction. Cast-in-place columns, 26” in diameter and 11’ high, spaced on a 28’ by 28’ grid, with additional points for the curved face, support the Filigree beams. Some of these columns also act as part of the moment frames in the building.

The lateral support system of the Medical Office Building is simple in theory, but complicated in practice. Lateral forces in the west-east direction are taken by two exterior and five interior moment frames spanning in that direction (Figure I-5). Interior beams running between torsional members in the west-east moment frame absorb lateral forces in the north-south direction. This system, which is inefficient compared to a direct frame, was necessary because the Filigree system is not intended to resist lateral loads. Although the Filigree system adversely affected the lateral system, it did provide other benefits because of the reduced slab and beam thickness.

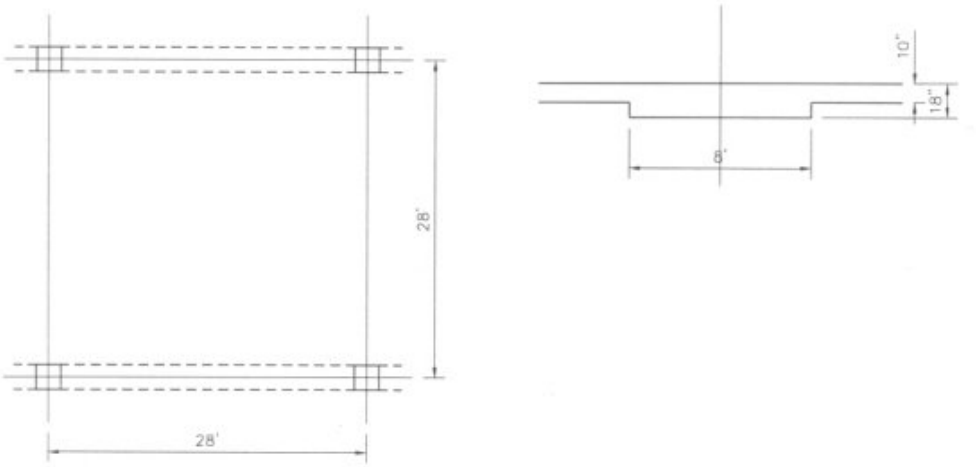


**Figure I-4** Filigree beam system schematic

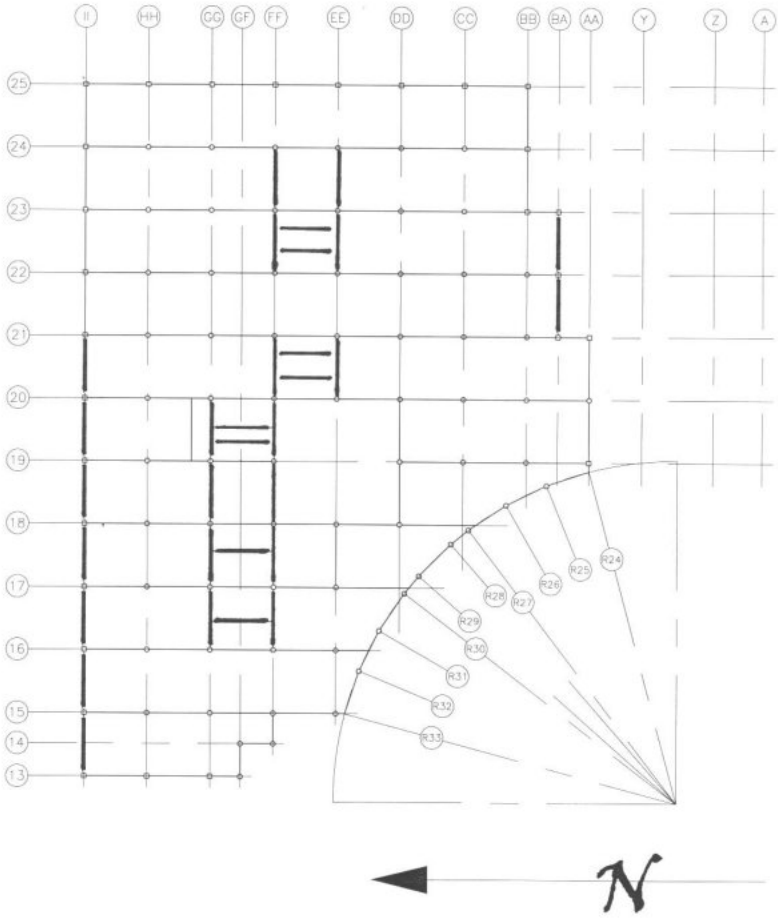


**Figure I-5** Lateral Resistant System Layout

Even though the floor elevations match between each office building, the Medical Office Building's finished slab elevation is 6" lower than its neighbor's. The difference in the height of the slabs is compensated for by a raised floor system. This system creates a plenum for all the electrical and telecommunications wiring in the building. This has several positive benefits, particularly in laying out the areas of open office space, since cubicles do not need to be clustered around the columns to reach the electrical outlets. Also, the suspended ceilings only have to support the lighting and heating ventilating and air-conditioning (HVAC) system, thus eliminating sag issues that plague the two older buildings.

The main reason why ceiling sag is such an issue is because of the massive amounts of wiring utilized by the offices in the complex. The Medical Office Building alone has over $2.8 million in wiring. The daunting size of the wiring of the building is matched only by the massive redundancy of the electrical system (Figure I-6). Due to the importance of the information stored in the data center two 1500kVA power lines feed the complex. In addition, all the major circuits are protected by three hour uninterruptible power systems and by four diesel generators capable of providing power for two and a half days. Another benefit of the data center is that it acts as a free heat source.

**Figure I-6** Switching board for the Medical Office Building

As an office, the Medical Office Building requires cooling year round from its HVAC system. This cooling is provide by four 50 ton, three 70 ton, and one 90 ton central heat pumps, which extract heat using a variable air volume (VAV) ventilation system. This system is networked to a central handling station, but can be overridden by local controls in each zone. In addition to the VAV system, the Medical Office Building takes advantage of the heat from the data center to control the building envelope heat transfer. This is accomplished through a heat recovery system, which uses heat from the data center to raise water to 100ºF before running through 311 perimeter heat pumps (Figure I-7). These heat pumps absorb most of the envelope heating load during the year.

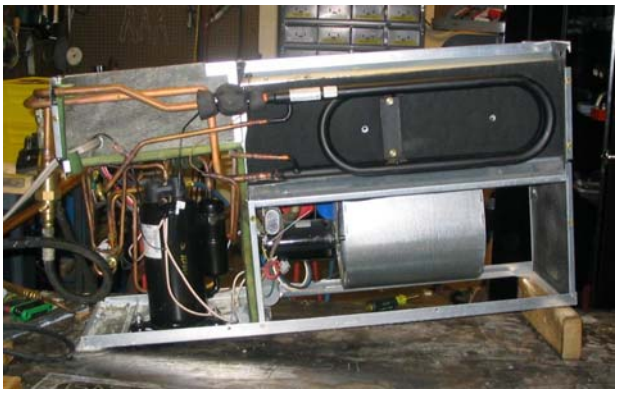

**Figure I-7** A disassembled perimeter heat pump, heat pumps such as these control the interior envelope temperature and absorb most of the envelope heating load.

The mechanical systems of the Medical Office Building also include two fire protection systems. The first fire protection system is a wet sprinkler system. Sprinklers are placed in every zone of the building on a 12’ by 12’ grid to protect the general office spaces. The atrium is protected by a water curtain system that is triggered by laser smoke sensors. Both of these systems are connected to a Simplex 4100 Annunciation panel that monitors and controls each sprinkler head. Fire doors are also interspersed in the office spaces to divide the building in case of disaster.

The technology used by the systems in the Medical Office Building largely address the technological, safety, and serviceability concerns of the owner. However, these systems are not without their drawbacks. One such example is that the electrical outlets on the raised floor often crack from foot traffic. Although this does not have a severe impact on the building, it shows that minor modifications to the building could improve its overall quality. With this philosophy in mind, the following report will explore alternative designs to the structural, mechanical, and lighting systems in the Medical Office Building.