<u>Exeter Facility Study</u>

Structural Evaluation

Town Offices

The town office building was constructed in two phases. The exact dates of construction are not known. In 1994 an elevator was added. At some point, probably at about the same time, a concrete ramp was added at the entrance to permit handicapped accessibility.

Both the original construction and the addition have floor framing primarily concealed by ceilings. What areas could be observed are framed with dimensioned lumber. In the original building, there are arched ceilings constructed of clay tile beneath and above areas that were previously used as vaults. It is not evident if the clay tile was intended to serve some structural purpose in supporting the floors above. We believe that the tile was used to fireproof the room and that it was built as an arch because that permitted it to be built as a freestanding element, without relying on the timber floor framing for support. That belief is supported by the fact that the same construction was used over the second floor vaults, which allows the upper surface of the ceilings to be exposed in the attic. There it can be seen that the arched ceilings are not serving any structural purpose other than to support themselves. No cracks or other indications of distress were observed in the ceilings and we did not observe any indication of movement in the floors in the rooms above. Where the elevator was added, concrete masonry shaft walls were constructed in such a manner as to interrupt one of the arched ceilings and the floor framing above. The drawings for the shaft construction detail angles, attached to the new masonry, that were used to support the ceilings. However there are no indications as to how the floor framing was attached to the wall. Presumably, this is a detail that was resolved during construction. Access to the second floor is provided by a series of open stairs and balconies. The heavy timber framing used for the balconies is exposed from beneath. All of the framing and connections are in good condition.

At the addition, the area that was designed to support a new vault is constructed of cast-in-place concrete. The remainder of the floor framing is timber. At one area of the basement a portion of the ceiling could be removed to inspect the floor framing. The joist size and span at that location are adequate to support the current code-specified loading for an office occupancy. We did not observe any cracking, movement, or other indications of distress for the supported floors. It should be noted that there are two areas beneath the first floor with no access for inspection. These areas are located at the west end of the original construction and at the southeast corner of the addition. Both areas are labeled as "unexcavated" on the drawings for the addition. It is not clear if the floors in these areas are constructed of concrete bearing on soil or if there is timber framing over a crawl space. If significant renovations are planned for the building, it is suggested that the floor construction in these areas be exposed to verify the material. If wood framing was used, its condition should be evaluated.

The roof framing for the original building consists of full sized 2x12 rafters at 12 to 14 inches on center spanning in a hip configuration. At the long side of the original building, the rafters are provided with an intermediate support consisting of 8x12 timber beams, with knee braces. Both the beams and the knee braces are supported by brick piers, approximately 20 inches by 20 inches in cross-section. There is some water staining localized where the chimneys project through the roof. The height of the framing at that location made it inaccessible for a close evaluation. Elsewhere the timber framing and the one inch nominal thickness board roof deck were found to be in good condition. At the exterior walls, the rafters bear in pockets in the masonry. This prevents a direct connection between the attic floor and the roof framing. There can be a tendency for rafter ends to absorb moisture and deteriorate when this detail is used. At this time there are no visible signs that such deterioration is taking place. However, our evaluation is limited to what can be seen at the surface. It is possible that a problem could exist in the bearing pockets that we would not have seen.

At the addition the roof is framed with dimensioned lumber in an extension of the hipped roof configuration. Where the new ridge intersects at 90 degrees from the ridge of the original roof, the new rafters bear on the framing and deck of the original construction. Rafters are standard, planed 2x10 members at 14 to 16 inches on center. Rafters are supported at intermediate points by two 8 inch thick brick bearing walls and a timber/tie rod truss perpendicular to the walls. The truss is in a king post configuration with a 4x6 Douglas fir post at midspan, a 1 inch diameter steel rod as a bottom chord, and a top chord consisting of 2 – 1-3/4x9-1/4 timber beams and a 1 inch spacer to facilitate the rod connection at the end. We did not observe any visible indications of deterioration or distress during our evaluation.

Except at the basement and attic, the interior, load-bearing, brick walls are covered by building finishes. Where the interior walls could be observed, they were found to be in good condition. The perimeter brick walls are also load-bearing. There are some stepped cracks between the window jambs and the building corners and at other isolated locations that have been repaired. Such cracking is not uncommon with brick masonry. However, simply repairing the crack may not prevent its recurrence. As an open crack admits water, it will worsen the deterioration and there is potential that it can promote deterioration of joist ends where they are set in the walls. Hence it is critical that the perimeter cracks be repaired and that recurring problems be addressed in order to retain the integrity of the structural system. The brick walls also provide resistance to lateral loads. While there is more than enough resistance to wind loads, the capacity of unreinforced masonry to resist seismic loads is very limited. Hence it is best to have as much uncracked wall available as is possible to provide adequate resistance for a seismic event.

The original building foundation is constructed of a combination of brick and stone. At the addition, cast-in-place concrete was used. No indications of settlement or other movement were observed. It is reported that there is some flooding that occurs in the original basement when the groundwater table is high. Trenches exist in the basement to provide a path for the water to exit. It is suspected that there may not be a perimeter foundation drainage system in place. If any thought is given to upgrading this space, it will be important to install a new foundation drain or repair the existing one so that it is more functional. At the entrance, a cast-in-place concrete ramp was constructed. There is significant spalling and deterioration of the concrete wall of the ramp. At the damaged area, the concrete at the surface appears to be very porous and susceptible to further water absorption, which will promote further deterioration.

Despite the apparent good condition of the structural aspects of this building, there are deficiencies with respect to current code, which may influence future alterations to the building:

- Seismic Load – This is a load case that was not envisioned by the original designers or the designers of the addition. The brittle, yet stiff, nature of unreinforced masonry bearing walls gives them a combination of higher seismic loads and lower resistance to those loads. A seismic analysis of the building is beyond the scope of this study, but based on our experience with similar buildings, we anticipate that there are deficiencies in the board sheathing roof deck diaphragm, the connections of the roof to the perimeter masonry bearing walls, and the perimeter masonry southeast and northwest walls.
- Wind Load – The roof framing members do not have adequate connections to supports to resist wind uplift loads specified by current codes.
- Snow Load – The hip roof configuration relies on a horizontal tie in one direction to retain its stability under snow load. Since the attic floor is not directly connected to the rafters, there is no clear load path by which the attic floor could serve that purpose. No other horizontal tie beams are provided. Hence there is an instability, which could cause failure of the roof system under snow load. Our analysis also indicates that some of the rafters in the original building, and most of the rafters in the addition are overstressed under the unbalanced snow load specified under current code. Last, the king post truss which is part of the addition roof is overstressed at the top chord, and the king post. Details of the connection at the bearing were concealed and therefore could not be evaluated.
- Timber Framing – Lumber observed for the original construction was found to be ungraded. This is standard for older structures. On past projects, where ungraded lumber has been used, close evaluation of the in-place framing has revealed that much of the lumber is substandard, with some members containing defects that should have rendered them unsuitable for structural use. As the strength of wood framing varies significantly with the grade, it should be expected that all floor and roof framing is constructed of materials with varying strength. If modifications are done that would increase the loading, such as adding insulation to the roof, we would recommend that the framing be graded and that any reinforcement be designed based on the actual grade and species of each framing member. Such an evaluation will be more difficult for an increase in floor loading. If this occurs, it will be necessary to remove ceilings below the area to perform a similar evaluation.