POPELKA STRUCTURAL ENGINEERING

2406 BROOKLAWN DR.
TEMPLE, TEXAS 76502
(254) 773-8882 PHONE
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July 30, 2018

Re: Structural Evaluation of the Existing Structure located at 214 South 2nd Street; Temple, Texas

EXECUTIVE SUMMARY

During the months of May, June, and July of this year we have investigated the structure on South 2nd Street. The majority of our observations were non-destructive, but we did chip away minor concrete at the base of one column. The structure was measured and then analyzed to check for conformance to the 2012 International Building Code, as adopted by the City of Temple, Texas.

Our observations indicate that a major fire probably occurred in the east end of the building at some point in the past. Our observations tend to indicate that the roof in at least the first bay collapsed, which caused damage to the truss girder brace. Possible smoke damage can be observed in the wood roof deck and some of the original wood framing has slight charring.

The steel truss girders are adequate to support the minimum loads that are required by the Building Code. However, repair is required a four discrete locations on the truss girders. Additionally, one of the steel girder braces must have the steel angles replaced along the top chord of the truss. Some of this work will require heating the steel, so that protection of the wood roof will be necessary and the Contractor may have to obtain special permits from the City. These repairs will require that the Contractor erect temporary bracing and shoring to assure the structural stability while the repairs are being made.

The concrete columns and beams appear to be in good condition. Minor cracks were observed but do not appear to represent structural defects. I analyzed the concrete columns and frames and they meet the minimum requirements of the Building Code. However, repair to the concrete is required at the top of one of the concrete columns. The extent of this repair is unknown at this time because the steel connection to the truss girder has rusted and additional concrete must be chipped out to fully evaluate the condition of this location.

The wood decking and roof joists are not adequate to support the minimum loads required by the Building Code. The roof joists are visibly sagging under only the weight of the roof deck. If the wood roof shall remain, then all of the roof joists must be reinforced. Since the visual appearance is a concern for the Owner, I designed steel plates that must be lagged on to the sides of the roof joists. The steel plates are approximately the same depth as the joists so that the steel can be painted to match the existing joists and the repair will not have the look of a defective roof. However, this work will be very costly and time consuming, such that the Owner may desire to investigate the cost of constructing a new roof system with light-weight steel joists and steel decking.

The steel storage structure that was added at the North side of the property does not meet the minimum standards of the Building Code. Reinforcing this structure will likely cost more than building a new structure, and given the legal liability of having a grossly inadequate structure on site, I am recommending that this structure be demolished.

Sincerely,

Thomas Popelka IV, P.E.

STATE OF TEXAS
THOMAS POPELKA IV
88612
LICENSED
PROFESSIONAL ENGINEER
07/30/2018

POPELKA STRUCTURAL ENGINEERING

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July 30, 2018

Bruce Bates
Temple Children's Museum
2806 Sleepy Hollow Lane
Temple, Texas 76502

Re: Visual Inspection of Structure
214 S. 2nd Street; Temple, Texas

Mr. Bates,
I am providing you a summary of the observations that I made on May 15 through July 26 at the 214 South 2nd Street building. The level of my investigation is limited to a physical observation, minor field testing, measurements, structural analysis and this report of my findings. This investigation included minor destructive testing and only those items that were exposed to view were observed.

SUMMARY SITE OBSERVATIONS

I observed that this structure is founded on a slab-on-grade foundation. The structure consists of concrete frames with masonry infill, with steel truss girders supporting a wood roof. The structure appears to be approximately 100-years old. The structure faces approximately East.

EXTERIOR OBSERVATIONS

At the exterior of the structure I observed the following:

1. The general topography consists of gently rolling hills. The geography consists of expansive clay that is underlain by limestone at shallow depth.
    a. *The soil at this site appears to consist of clay topsoils and is underlain by limestone at shallow depth; no more than 10-feet is anticipated.*
    b. *This area of the county tends to have a small to moderate probability of expansive soils and foundation settling.*
2. The exterior of the building has a mortar covering the clay masonry infill, and some clay brick is exposed at the parapet
3. The roofing over the main building consists of a single ply of black felt material. This material has been damaged at the south side of the building and allows significant water leaks to penetrate the structure.
4. At the north side of the building, over the lean-to structure that forms the "north bay," I observed water ponding on the roof on the day after heavy rains.
5. At the West side of the roof, at the roof access hatch, I observed that concrete blocks were being used to hold down the felt roofing. In addition to the roofing defect, the extra weight of these blocks appears to be contributing to the deflection in the roof structure at the roof hatch.
6. At the North wall, on the day after a heavy rain, I observed that the base of the north wall was wet at both the interior and exterior sides.

Damaged Roofing Felt at the South Side of the Main Roof

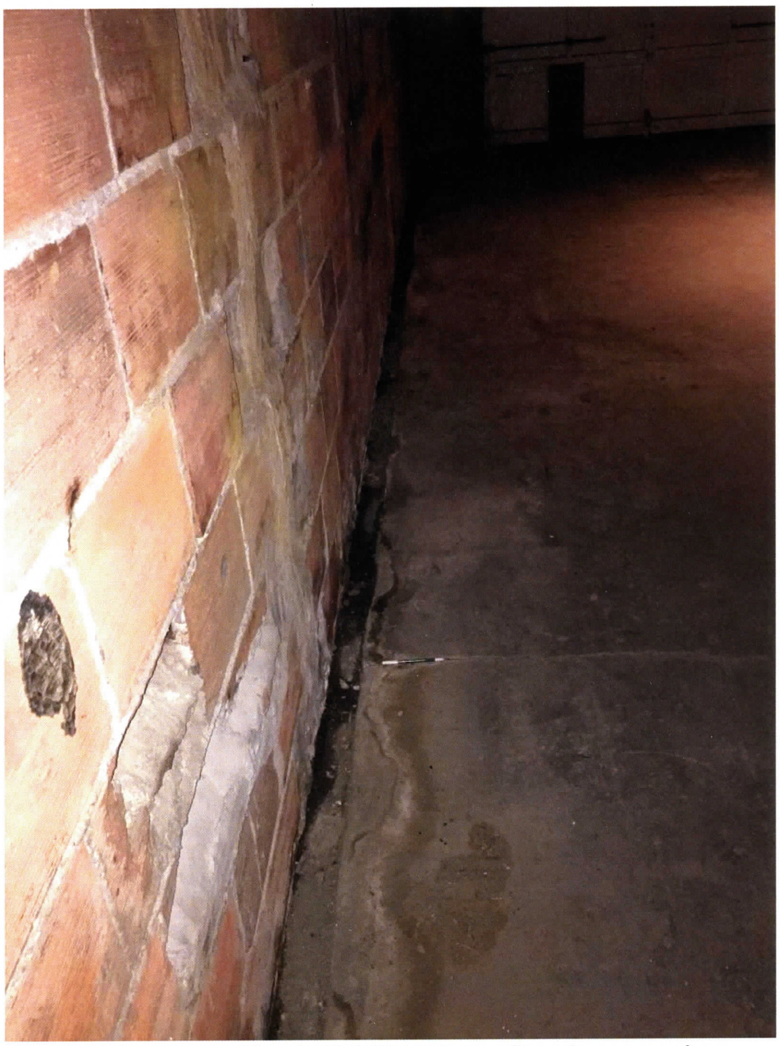
Water from Leak at South Roof; 1 day after heavy rain

Water Ponding at North Bay; Looking East

Water Ponding at North Bay; Looking West

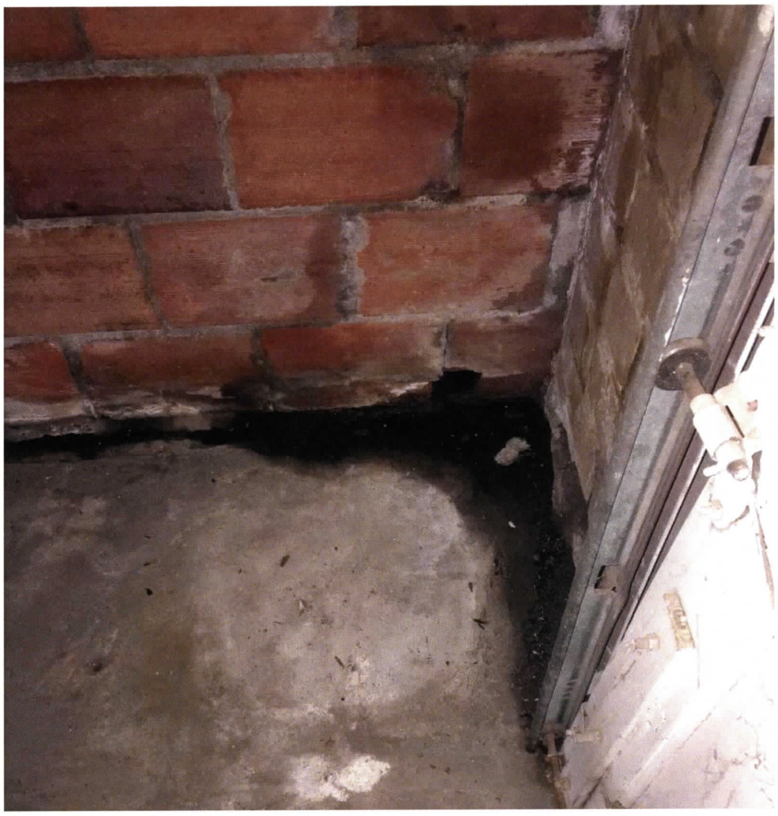
Concrete Blocks at Roof Access Hatch; at Southwest corner

Minor Ponding and Moisture at North Wall; 1 day after heavy rain



Moisture at North Wall; 1 day after heavy rain

Minor Ponding and Moisture at Northeast Corner; 1 day after heavy rain



Minor Ponding and Moisture at Northeast Corner; 1 day after heavy rain

General Interior Observations

The structure is framed with steel truss girders that support wood roof joists and 1x wood decking. There is evidence of numerous leaks in the roof where the wood structure has been discolored. The primary walls consist of reinforced concrete frames that are infilled with clay masonry. The foundation was constructed in sections and shows evidence of some damage that was presumable caused by heavy manufacturing loads, but I did not observe any evidence of structural defect in the foundation.

At the east end bay, I observed what I think is evidence of a fire that occurred in the building at some time in the past. The primary evidence for this is that the roof joists have been cut at the east wall (Grid 1) at approximately 18-24 inches away from the wall, and new wood joists have been lagged on to the side of the original joists. I scraped some of the original stubs of the joists and found black soot beneath the paint. Also, the roof deck is discolored to a grayish-yellow color, which may be smoke damage but could also be attributed to mildew growth. I did not try to establish the cause of this discoloration. Thirdly, I found damage at the first truss girder at Grid 2 and also damage to the girder brace that suggest heat damage and possible overstress due to a roof collapse.

In general, all of the roof joists appear to be sagging under the weight of only the dead weight of the decking and roof felt. This is not a good indication that the roof joists will be adequate to meet the requirements of the Building Code. (The structure was analyzed for conformance with the 2012 International Building Code, as adopted by the City of Temple, Texas.)

Discoloration of Paint and Discoloration due to Smoke and Water Leaks

Original Stub Joists with New Joists Lagged at one side

Charred Wood at Original Stub Joist at East Wall

WOOD ROOF JOISTS AND DECKING

At numerous locations, I observed rotting wood in the roof decking that was primarily located at the north and south walls of the main structure. Even where the decking was in good shape at 6-inches away from the wall, the edges of the roof deck were rotted so that the nailed connection to the roof joist was ineffective. This is a critical flaw in the structure in that these particular nailed connections transfer horizontal loads from the roof to the wall. Therefore, the decking along the edges of the roof must be replaced. The replacement decking should be long enough to span across 3 joist spaces, so that the area of deck replacement will extend approximately 6-feet into the building from the wall.

In various places, I observed rot in the roof joists that are obvious. These joists obviously require replacement. At questionable areas I also checked the joists with a pocket knife and found the wood to be intact. Therefore, in order to properly repair this roof, the joists must be checked individually to verify material integrity.

As noted previously, the joists are sagging under only the dead weight of the roof. The dead weight of the decking and felt are relatively minor and in my calculations I estimated it to be 4 pounds per square foot (psf). The Building Code requires that a Live Load of 20 psf also be applied when calculating the capacity of the joists, and it was no surprise to find that the roof joists are not adequate for the required loads. I calculated that in order to reinforce all of the wood joists for conformance with the Building Code, a steel plate 1/8"x8" must be lagged onto the side of each and every joist. This will be a large expense item for the labor only as well as a significant amount of steel to be purchased and fabricated. A detail for this Work is provided in the Structural Drawings that are attached to this document.

At the North Bay of the building, I observed that the roof joists appear to be performing well and do not appear to be sagging. However, there are areas along the edge of the roof where the deck appears to have rotted, and these areas must be repaired. Specifications are provided in the Drawings to address the decking repairs. Also, I analyzed the roof joists in this area and found that they must be reinforced in order to meet the load requirements of the Building Code. These joists must be reinforced with a steel plate 1/4"x5" along the length of each joist. A detail for this Work is provided in the Structural Drawings that are attached to this document.

The roof structure at the roof hatch at the southwest corner is notably sagging under the weight of the deck and the concrete blocks that are on the roof. The weight of the concrete blocks does contribute to the sagging, but their weight is significantly less that the Code-required Live Load that the structure must support in this area. I calculated the required reinforcement and find that a steel plate 1/4"x8" must be lagged onto the side of the side of the supporting joists in order to conform to the Building Code. Where the existing construction has lagged another 2x8 to the side of the support truss for only approximately 8-feet, please be aware that the required steel plate must be used along the entire length of the support truss. A detail for this Work is provided in the Structural Drawings that are attached to this document.

At the East wall (Grid 1) and at the West wall (Grid 6), where the original wood joists have been cut and a new joist has been lagged onto the side, I have calculated the required fasteners to conform to the Building Code. A detail for this Work is provided in the Structural Drawings that are attached to this document.

I inspected the clerestory structure that runs along the peak of the roof. I found that this structure appears to be sound in its current condition. I observed that the windows at the clerestory were racking, but that a secondary structure that consists of a stud wall and plywood was constructed at the outside of the original structure. Overall, the structure is performing well. However, I calculated the capacity of the (3) 2x8 support beams that support the original portion of the clerestory and found that these beams will require reinforcement. I calculated that a steel plate 3/8"x8" must be lagged onto one side of the beam group in order to satisfy the requirements of the Building Code. A detail for this Work is provided in the Structural Drawings that are attached to this document.

Overall, the repair of the existing roof joists and decking will prove to be very expensive. A lot of labor will be required to jack the existing joists into a plumb condition to remove the existing deflection, and then significant labor will be required to lag the steel reinforcing to each and every roof joist. For this reason you may find that it may be cost effective to remove the existing wood roof material and replace it with new steel framing.

Rot at the Roof Edge

Rot at Roof Joist

Roof Hatch at Southwest Corner of Main Roof

STEEL TRUSS GIRDERS AND GIRDER BRACES

The steel truss girders were observed and measured with a measuring tape and a micrometer. The thicknesses of the framing members were adjusted downward to match steel sizes that are currently manufactured. This adjustment was made for several reasons, which include the fact that I could not remove all of the rust scale from the surface of the steel, so that rounding down was the appropriate action. Also, for analysis purposes, rounding the thicknesses down produced a conservative analysis. Using current thicknesses also allowed for a faster analysis which saved engineering fees.

The truss girders consist of steel angle construction with flat plates installed at connection points. The shop-fabricated connections are constructed with steel rivets. The truss girders were manufactured in two sections that were field-bolted at the center of the truss.

The general condition of the truss girders appears to be good, especially considering the age of the building. The south half of the trusses have much more rusting, while the north half of the trusses retain the paint coating. The truss girder at Grid 2 (near the east end of the building) has more rusting.

I observed significant rusting at the truss girder at Grid 2 at the bottom center connection. The bottom connection plate appears to be deteriorated, and this may indicate that the rivets and bolts along the bottom chord have also been compromised in this connection. The cause of this deterioration may have started with the presumed fire in the building and then exacerbated by roof leaks that allowed water to pond on the bottom chord. I am recommending that the bottom connection plate and the connection bolts/rivets at the bottom chord be replaced at this connection.

Deterioration at Truss Girder 2C

At Grid 3E, I observed damage at the bearing plate and concrete column at the truss connection. At this location, I observed concrete spalling at the top of the column which reduced the bearing area for the steel bearing plate. I also observed significant rusting in the steel base plate, which also causes concern for the condition of the anchor into the concrete. Since this condition was observed at the edge of the roof, where evidence of long-term roof leaks have been observed, the cause for this damage is likely to be water intrusion. I am recommending that the concrete be further chipped out to reveal the full extent of the rust at the steel plate and at the anchor. When the full extent of the rusting can be evaluated, then it is possible that the steel plate and anchor may need to be replaced.

Damage at Truss Girder at Grid 3E

At Grids 3 and 4, at the top center connection, I observed that the top connection plates and/or the top chord had been bent or warped. I suspect that this damage may have been caused at the time of original construction and should have been corrected at that time. Since the top chord and the connection plates are not in contact, the connection bolts are likely to have stresses that they were not designed to resist. For that reason I am recommending that these connections be repaired, and heating the steel will be required. Please be aware that if the wood roof structure is in place when this work is performed that a portion of the roof decking will probably have to be removed temporarily and that the Contractor will also have to obtain special permits from the City due to the fire hazard associated with this work.

Connection Plate Warping at Grid 3

Connection Plate Warping at Grid 4

At the girder brace between Grids 2-3, at the south side, I observed that the top chord of this truss had been deformed. Significant stresses had obviously been applied to this brace at some time in the past to produce this amount of deformation. I have the opinion that a fire had occurred in the east end bay of the building (between Grids 1 & 2), and that the roof joists in this area have been replaced. The combination of heat and the collapse of the wood roof structure at the end bay appear to be the logical cause of this deformation. The top chord of this girder brace must be replaced so that it can perform its necessary structural function.

Deformation at Girder Brace between Grids 2-3

Deformation at Girder Brace between Grids 2-3

Analysis of the truss girders indicates that the stress levels are below the Code-specified allowable stresses when the minimum loads that are required by the Building Code are applied. The stress in the top chord is approximately 88% of the allowable stress, while the stresses at the bottom chord are only about 20% of the allowable stress. The diagonal braces do not exceed 60% of the allowable stress. The loads were applied with the assumption that the existing wood decking will remain in place. If a new steel deck is constructed, then I expect that the stresses in the truss girders will be slightly lower.

The girder braces were analyzed for the loads that they incur as they stabilize the truss girders. These loads are actually small in comparison to the size of the girder braces. My analysis indicates that loads applied to the girder braces only represent approximately 10% of the structural capacity. Therefore, the girder braces are adequate to support the loads for which they are intended.

The original plan for this investigation included the removal and laboratory testing of the rivets. However, I was able to locate historical research regarding the typical strength steel rivets that were produced in the early 1900's. Also, my analysis indicated that at the worst case, the rivets were stressed to only 45% of the allowable stress. Therefore, the laboratory testing was not performed and the rivets appear to be adequate to support the structural loads that are required by the Building Code.

Therefore, my analysis indicates that the steel framing is adequate to support the structural loads that are required by the Building Code after the above-mentioned defects have been remedied.

Concrete Columns & Beams

The walls of this building are framed with concrete columns and beams, which are then infilled with clay masonry. At the north side of the main building, the trusses appear to be supported by the concrete columns, whereas on the south side of the building the trusses are supported primarily on steel columns and also on concrete columns.

At discrete concrete column and beam locations, I used a hammer to "ping" the concrete to check for hollow places. The only hollow concrete that I encountered was at the base of the column at Grid 4A. At this location, I observed diagonal cracks that extended from the base of the steel column out to the pedestal corners. I was concerned about the integrity of this concrete so I chipped out the hollow concrete with a hammer. I discovered that the concrete that I chipped out appears to have been a previous concrete patch that did not bond to the original concrete. Therefore, I am satisfied that the concrete at this location is adequate. I have provided Specifications in the Drawings to address the repair to the concrete at this location.

At Grid 3E, as discussed in the Steel Truss Girder section, I observed that the top of the concrete column had been damaged and will require repair. Before this repair is performed, additional concrete should be chipped out to fully reveal the extent of the damage to the steel bearing plate. To accomplish this, the steel truss girder should be shored and braced to support the steel structure and to prevent any movement. This Work should be addressed with the Contractor and will likely be a cost-plus activity.

At the concrete columns and beam locations, I also used a Rebound Hammer to estimate the strength of the concrete. At all locations the concrete compressive strength exceeded 3,000 psi, and I used a value of 3,000 psi concrete strength for my analysis.

I attempted to locate the steel reinforcing in the concrete columns at the north wall. The R-Meter sends a small electric current into the concrete to check for conductivity in the steel reinforcing. My readings indicated that the columns at the north wall are reinforced with 4-#5 vertical steel bars. My analysis indicates that the concrete columns at the north wall have a very low stress when the minimum loads required by the Building Code are applied, so these columns appear to be adequate. At the south side of the building, the majority of the load from the truss girders is borne by the steel column, so I did not check the south columns.

The concrete beams at the north and south walls do not support very much weight since the roof joists are supported by the steel truss girders. The capacity of the concrete beams is not critical at these walls. At the east/west walls, the concrete and masonry support roof loads and I evaluated the columns and beams at these walls. My analysis indicates that the concrete structure is capable of supporting the minimum loads required by the Building Code. However, these concrete frames would experience significant horizontal movement from wind or seismic loads without the masonry infill walls. Therefore, before adding any significant openings in the perimeter walls, I recommend that you seek guidance from an engineer.

The concrete columns and beams are adequate to support the Code-specified loads. Attention is drawn to the repairs that are required at the top of the concrete column at Grid 3E.

Masonry Infill Walls

The masonry infill walls in this building are not necessary for supporting the roof loads. However, as previously noted, the masonry provides lateral stiffness that prevents horizontal movement in the structure. Therefore, removal of any of the masonry should only occur with the advice of an engineer.

The strength of the masonry could not be tested with non-destructive methods. Therefore, this evaluation is based solely on the observations that I made. I did not observe any masonry that indicated that the walls had shifted due to lateral forces. These walls have been in place for a long period of time and appear to provide the structural stiffness that is necessary for this building. So my qualified opinion is that the masonry walls appear to be adequate for their intended structural purpose.

Steel Storage Structure

At the north end of the property, an open-walled steel storage building was constructed. This structure is almost entirely independent of the original building. The building system consists of material that is commonly used for pre-engineered metal buildings, similar to the construction that is manufactured by Mueller Buildings, Butler Manufacturing, or other name brand manufacturers. However, I observed that the material used is grossly undersized and misused. Based on my 28 years of experience in designing pre-engineered metal buildings, I did not need to perform any calculations to determine that this structure does not meet the minimum standards of the Building Code.

This structure appears to have been in place for more than 10 years, based on the rusting that I observed. This structure has probably withstood several severe storms without collapse. However, this structure cannot support the Code-specified roof loads. Given the legal environment in which we now live, this structure could be a legal liability for the Owner. If any employees or visitors are injured in this area, it would not be difficult for an engineer to prove that this structure is not safe for use as defined by the Building Code. Therefore, I recommend that this storage building not be used and that it be scheduled for demolition. I also recommend that you consult with your attorney regarding this structure.

Discussion

When the structural integrity of a residence is in question, the following visible indications will likely be present:

- Separation of exterior wall framing
- Rotating or buckling of masonry veneer panels
- Cracking of concrete foundations
- Separation of walls from ceilings or floors
- Separation of structural framing or deteriorating materials
- Deflecting, deforming, or tilting of structural elements

The roof joists and decking in the Main Building and in the North Bay have rot at discrete locations. Almost all of the roof joists are deflecting in the Main Building. These are obvious signs that the structural integrity of the building has been compromised. Specifications and Details have been provided in the Drawings to describe the necessary reinforcing that must be installed to all of the roof joists. As previously discussed, repairing the existing wood roof will be very expensive and time consuming, such that replacing the wood roof framing with a light-weight steel roof may prove to be cost effective.

At this building, I observed defects in the truss girders at Grids 2, 3, and 4. I also observed defects in the Girder Brace that is located between Grids 2-3. These defects in the steel framing must be remedied in order to certify the structure for use. These repairs should not prove to be grossly expensive, and the most expensive repair might be straightening the connection plates at the roof (to include fire prevention and special permits) if the wood roof is to remain in place. Other than the defects described at these discrete locations, the overall steel framing in the Main Building is adequate for service.

The steel storage building that was added to the north side of the property does not even come close to meeting the requirements of the Building Code. Although the structure is not deflecting (except at the roof framing over the overhead door), the poor design of this structure might prove to be a legal liability. The cost of repair would likely exceed the cost of building a new structure, such that removal of this structure is recommended.

RECOMMENDATIONS

Based on the observations that I made at this house, I make the following recommendations:

1. At the Grid 2 truss girder, at the bottom center connection, the bottom connection plate should be replaced. The connection bolts and rivets along the bottom chord should also be replaced. Proper shoring and bracing should be constructed to assure the stability of the truss girder while these repairs are made.
2. At Grids 3 and 4, at the top connection of the truss girders, the steel plates and framing should be straightened so that the connection plate can mount flush to the frame. If the wood roof is in place while this repair is made, the area around the connection must be protected from heat and flame since heat must be applied to accomplish this Work. Also, the City may require special permits for working with welding equipment adjacent to the flammable roof material.
3. At Grid 3E, the top of the column has been damaged with rust to the steel girder truss connection and spalling at the top of the concrete column. Further destructive work must be done to fully evaluate the extent of the rust, such that more of the concrete must be chipped away at the steel connection plate. This work will cause instability at the truss girder, so the Contractor must construct bracing and shoring to support the truss girder while the investigative work is done.
4. At the Girder Brace, between Grids 2-3 and at the south side of the building, the top chord of this truss has been badly deformed and the top chord must be replaced. This work will require cutting the existing rivets out. If the rivets can be removed by grinding, then only minor precautions are necessary to prevent a fire hazard. However, if a welding torch used to cut the rivets, then the wood roof must be protected from heat and fire and special permits may be required from the City.
5. If the Owner elects to maintain the existing wood roof, then all of the wood joists must be reinforced with steel side plates. This will likely be an expensive and time consuming activity.
6. The steel storage structure at the north end of the property should be demolished and removed in order to protect the Owner from legal liability.

Note: Structural Drawings S1.0, S2.0, S2.1, S3,0, S3.1, and S3.2 shall remain with and form a part of this document.

Please be aware that these opinions expressed in this report are based only on the visual observations on the days that I visited the site. If any hidden defects exist, or if conditions are changed, then these opinions may be modified. These opinions do not represent a guarantee of future performance or a certification of this structure. If you desire a more definitive opinion, then physical and/or destructive testing will be required.

If you have any questions regarding these issues, I am available to discuss these during normal office hours.

Sincerely,

Thomas Popelka IV, P.E.

STATE OF TEXAS
THOMAS POPELKA IV
88612
LICENSED
PROFESSIONAL ENGINEER
07/30/2018

Encl: Structural Drawings S1.0, S2.0, S2.1, S3,0, S3.1, S3.2