ENGINEERING VENTURES PC

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August 19, 2014

Town of Plainfield, NH
Attn.: Michael O'Leary
110 Main St.
Meriden, NH 03770

EV #14208

Re: Town Highway Garage Roof Structural Evaluation – Solar Project

Dear Michael:

The following is a brief summary of my observations/assumptions and recommendations from my June 24th site visit, review of existing project documents as they relate to the structure, and structural analysis work. The intent of the project is to assist in the Town's feasibility investigation for implementation of roof-mounted solar equipment on a portion of the building. A proposed layout of the roof-top solar equipment on the roof is shown in Figure 1.

Observations and Assumptions:

- This evaluation is limited to the roof trusses. No other portions of the structure were evaluated.
- According to project document provided by the Town, the highway garage was constructed in 1983.
- The roof is framed with prefabricated gable-style wood trusses, which span 50 ft. and are spaced at 2'-0" on center, (o.c.).
- The roofing consists of standing seam metal roof, and it is the original roofing. Beneath the roofing is a layer of asphalt paper, and beneath that are wood strapping members.
- Corrosion of the roofing was observed in places, however, moisture intrusion was not observed.
- The trusses members top and bottom chords are constructed from 2x6's and the web members are all 2x4's. The members are southern pine, with varying grades of lumber being utilized for the truss members.
- No truss web bridging was observed.

Discussion and Recommendations:

- A model of the truss was analyzed utilizing current code required gravity loadings, (ie. dead load, snow load). A dead load of 5 pounds per square foot, (psf) was assumed for the solar panels, and the weight was distributed onto one side of the truss in order to simulate the layout shown in Figure 1. The assumed solar panel weight will have to be confirmed with the selected solar panel vendor. No other solar module layouts were considered. A lateral force, (ie., wind force) analysis was not completed because current building codes permit the lateral force resisting elements to remain unaltered if the increase in demand to capacity ratio on the lateral force resisting elements due to the alteration falls below a minimum percentage, as is the case in this situation.
- The analysis results are summarized in Figure 2. As per this figure, the truss top chords were found to be overstressed by approximately 30% near their ends. Four of the truss web members were also found to be significantly overstressed. In order to support current code-required loadings in addition to the solar modules, the overstressed region of the truss top chords will need to be reinforced. Two of the overstressed web members can be reinforced via the addition of continuous web bridging running along the length of the members and attached to the mid-length of the members. Two of the other web members will need to be reinforced, either alone or in combination with continuous bridging, and end connections strengthened. A proposal for design of wood truss reinforcement structural details can be provided upon request.
- Regarding attachment of solar modules to the existing structure, several different types of clips are available for fastening to standing seam metal roofing. An example of one type of clip manufactured by S-5! Attachment Solutions is shown in Figure 3. In general, a sufficient number of clips should be used to attach the modules to the structure without subjecting it to excessive point loads. A solar module layout and proposed fastening layout should be submitted to us for review and approval prior to installation of the equipment.
- I recommend that the metal roofing be replaced prior to the installation of solar equipment. It is currently at the end of its design life and corrosion was observed. It will be easier to replace this now than after solar modules have been installed, and attachment provisions to new roofing will be simplified in comparision to attachment to the existing roofing. I recommend implementation of a metal roofing profile for which the chosen clip manufacturer has completed testing. Using the example of the S-5 products, they list load test results for their products on roofing of several different types and manufacturers, (http://www.s-5.com/clamps/index_99.cfmS-5).
- Lastly, additional screw attachment of the existing wood strapping to the wood trusses may be needed in order to withstand concentrated wind uplift loads at the clip locations. The fastening of the strapping could not be observed however. This will need to be checked, possibly during the process of roof replacement.

Thank you for the opportunity to be of assistance. Please feel free to contact me with any questions regarding the above.

Sincerely,

Miles Stetson

Miles Stetson, PE
Project Engineer
Engineering Ventures, PC

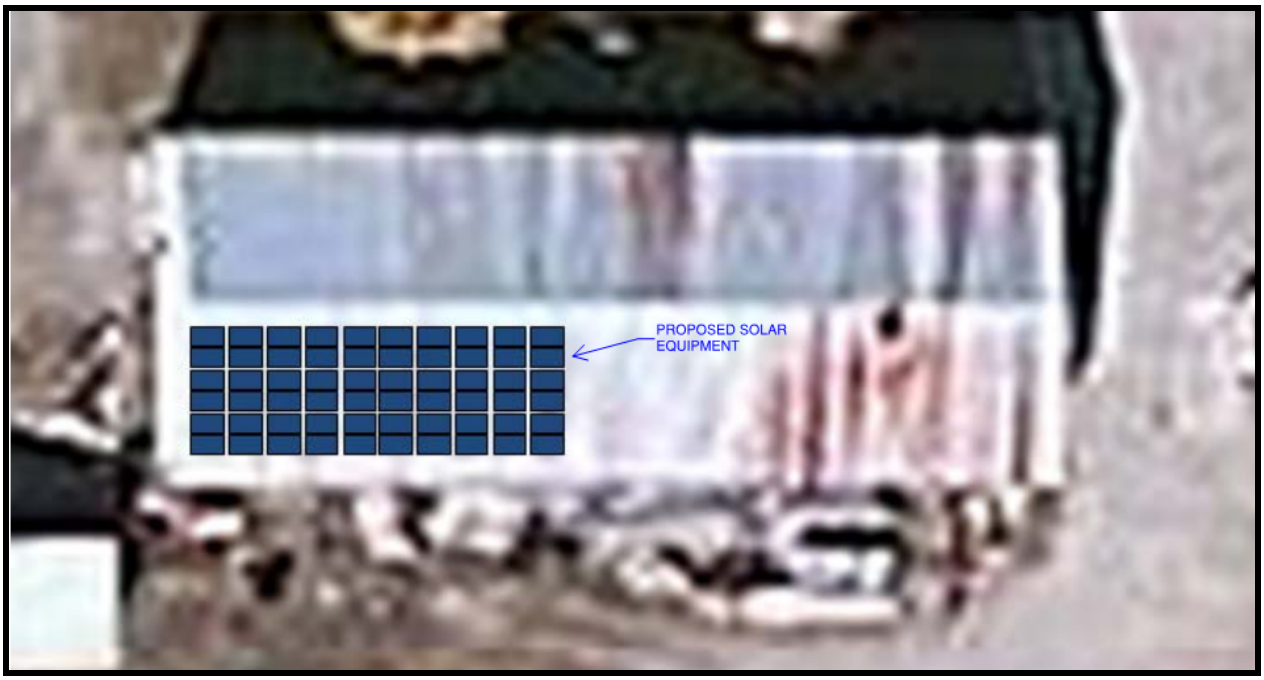

Figure 1 – Aerial image of roof of structure with overlay of proposed solar equipment.

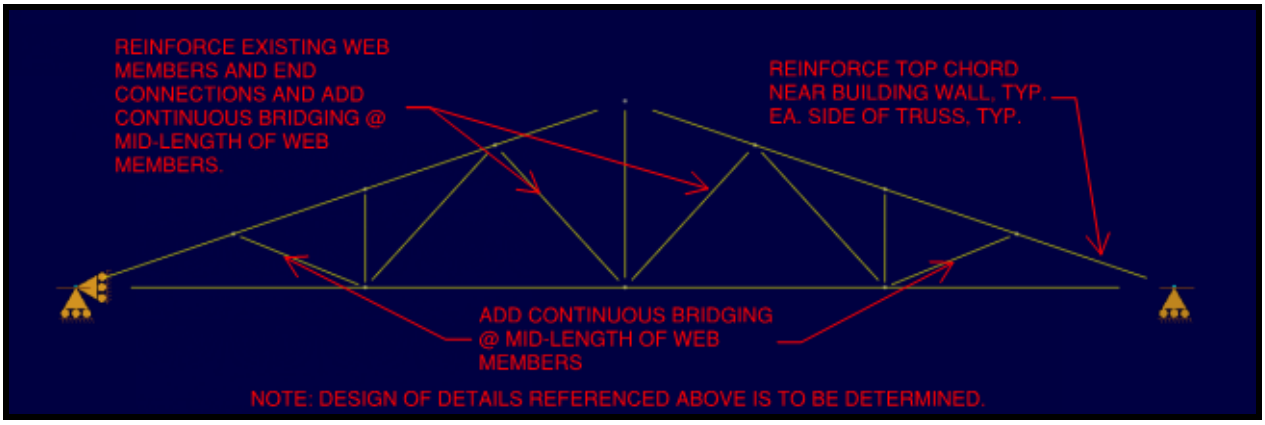

Figure 2 – Truss diagram with general analysis conclusions.

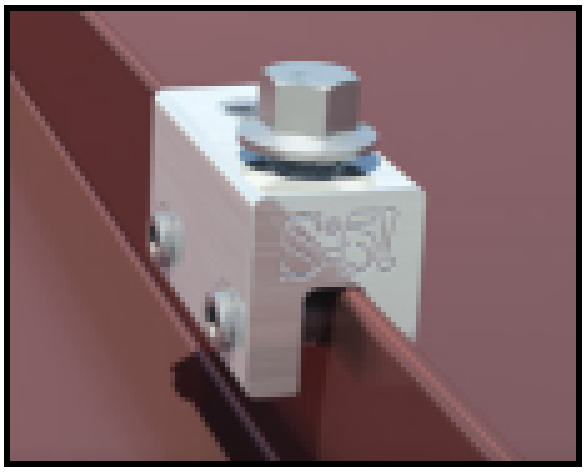

Figure 3 – Example of attachment provisions for solar modules to standing seam roof. Shown is the S-5-E clip manufactured by by S-5! Attachment Solutions