

Five Flags Civic Center, Dubuque, Iowa

The roof of the Five Flags Civic Center in Dubuque, Iowa will be renovated as a part of a larger renovation project of the entire building. The renovation will incorporate modern functions of sustainability into the design for environmental, economic, and aesthetic purposes. The roof has three distinct areas. The largest portion of the Civic Center roof houses an arena that was built in 1977 with a supporting steel truss system. A smaller and much older portion of the roof lies above the historic theater, built in the 1920's. The third area of roof lies above an area used as offices and is constructed from hollow-core concrete slabs.

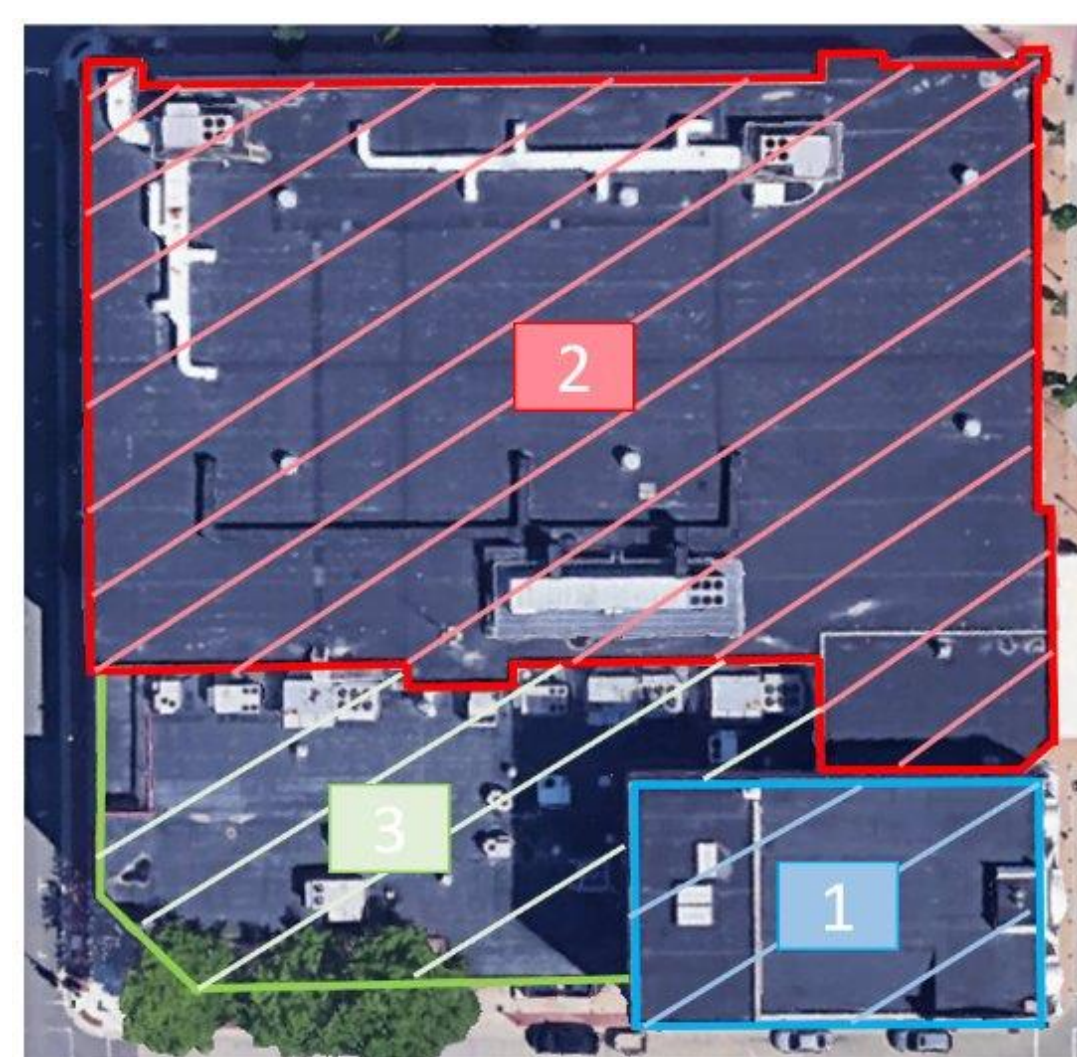


Figure 1. Five Flags Civic Center, Front Façade and Roof

Design Considerations: Loading and Reinforcement

While the additional loading of the new insulation and cool roof covering is relatively negligible and does not need adjustments to their supporting entities, the green roof weighs 35 psf, which requires the truss system in the arena to be reinforced. With this re-design, the girders and columns that support the trusses that are loaded the heaviest must also be re-designed. The final design contains 23 trusses that need reinforcement and 5 trusses that need to be replaced with a more robust unit. Figure 8 shows a truss from this system with the required top and bottom chord reinforcements, enlarged in the images directly below the truss.

The roof area below the solar panels was analyzed and was found to have adequate capacity to carry the existing loads plus the additional solar panel weight.

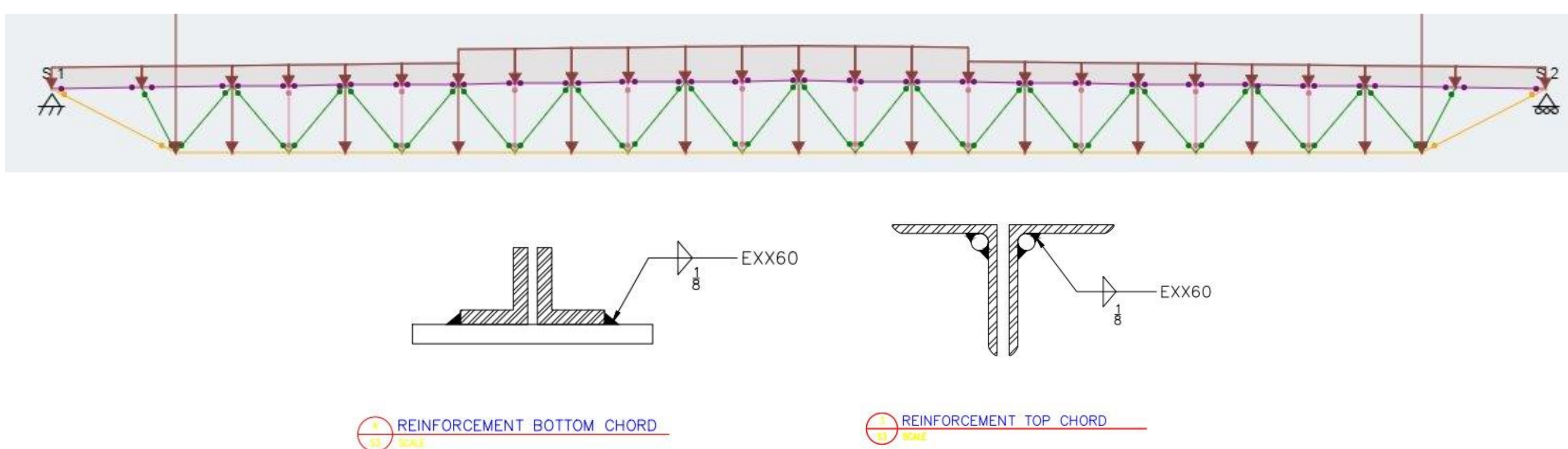


Figure 4. Truss Reinforcement

References

Steel Construction Manual 15th Edition, PCI Manual, IBC 2021, IEBC 2015, IEBC 2021, City of Dubuque Adopted Codes IBC and IEBC

Two Design Alternatives: Cool Roof and Integrated Roof Design

In both designs, new insulation will be installed on the entire roof to increase the R-value to current standards and maximize energy efficiency. In the cool roof design, a single membrane will be installed over the entire roof area on top of the new insulation.

For the integrated design, the roof was designed to support the loading from all three different sustainable roofing options: cool roof, green roof, and solar paneling. The cool roof and green roof will be installed on top of the new insulation in their respective areas, as seen in Figure 4. The location of the green roof was chosen to minimize the number of trusses in need of reinforcement and to avoid the current locations of the mechanical systems.

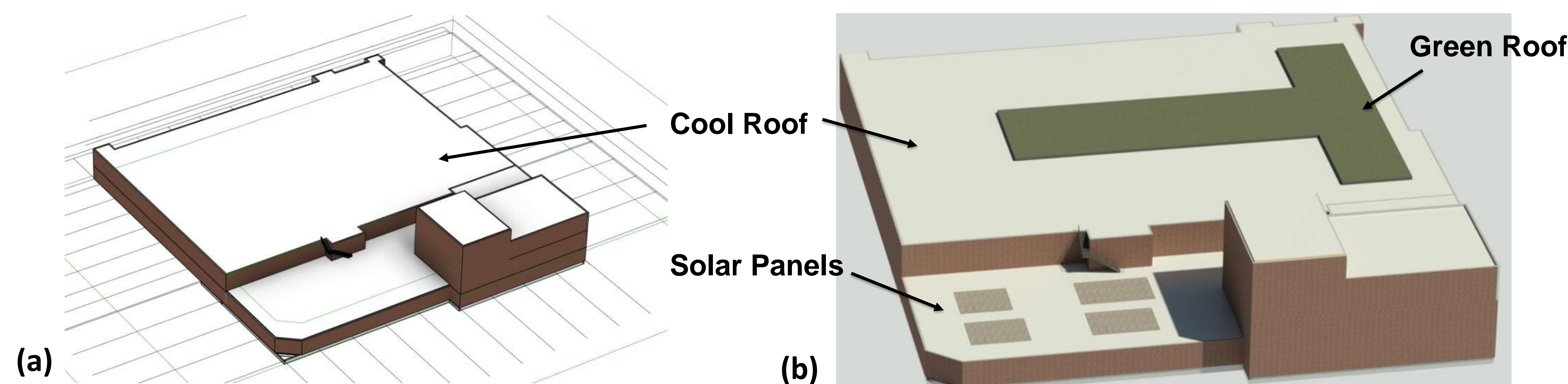


Figure 2. (a) Cool Roof Design; (b) Integrated Roof Design



Figure 3. Examples of (a) Green, (b) Cool, and (c) Solar Components of the Roof Design

Sustainable Renovation

The roof of the Five Flags Civic Center was designed to exceed the IBEC standard of energy efficiency for its geographic zone. The renovation of the roof using modern insulation and materials increases the lifespan of the building, the cool and green roofs dissipate heat island effects and conserve energy use throughout the building, and the solar panels proactively generate electricity for the Civic Center. The total cost of construction for the cool roof only renovation is \$1,035,710 with a payback period of 43 years. The total cost of construction for the integrated roof design is \$1,768,190 with a payback period of 46 years. The figures below show how the roof materials affect the thermal properties of the roof. Lighter colors indicate warmer surfaces while darker colors indicate cooler surfaces.

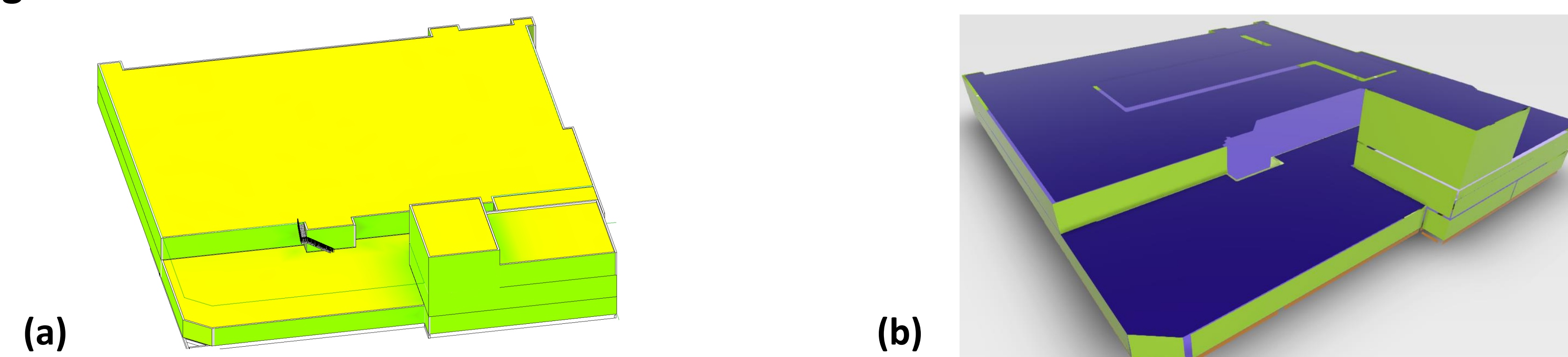


Figure 5. (a) Existing Roof Thermal Map

(b) Cool and Green Roof Thermal Map