Methods for Reinforcing Large, Flat, Mineral Fiber Panels

Overview
Current building design trends are moving away from 2 x 2 [ft.] and 2 x 4 [ft.] suspended ceiling panels towards larger tiles. As panel sizes increase, gravity induced deflections will greatly increase. Additionally, due to the composition of these ceiling panels, they are extremely susceptible to humidity induced deflection. The goal of this project is to design a 5 x 5 [ft.] ceiling panel that does not sag more than 0.125 [in.] under humid conditions.

Objectives
- Add Reinforcements to panel to limit deflection to 0.125 [in.] at 90% [rH] and 82 [F]
- Additional direct cost must not exceed 0.40 [USD/ft²]
- Maintain Fire Resistance and Acoustic Absorption properties of existing mineral fiber board

Approach
- Customer needs were determined to assess the scope and goals of the project.
- Multiple design concepts were generated to accomplish the determined objectives.
- By heavily weighting the most important customer needs, a design concept was chosen.
- Through independent research, reinforcement materials were selected by the team.
- The design concept was simulated using Abaqus CAE Finite Element Analysis software.
- Prototypes were constructed using mineral fiber samples provided by Armstrong and reinforcement members ordered by the team.
- Prototypes were tested in a humidity chamber built by the students. The humidity chamber raised relative humidity to over 70%, and prototypes were left for 48 hours to determine the gravity induced sagging. Upon opening the chamber, maximum deflection was measured.
- Multiple prototypes were tested utilizing different materials and different assembly methods to attempt to reach the predetermined goals. Results were recorded and compared to other prototype designs.

Outcomes
- The team was unable to reduce deflection below 0.125 [in.]. The minimum deflection achieved by the team was 0.669 [in.].
- All prototype ideas were provided to Armstrong and were compatible with Armstrong’s existing T-bar suspension framework.
- The team stayed within the allotted 1000 [USD] budget, returning over 650 [UDS].
- Future design concept recommendations have been made to Armstrong regarding reinforcement structure.