**Comment on data variability of data from provided dataset vs my own dataset.**

From an initial overlook of the scatter plots, the general trends of both stress distribution and displacement results share a common trend across all datasets. However, a notable outlier in my runs—specifically in the Hole Beams test—appears to be the primary factor contributing to higher variability in my dataset compared to the provided datasets.

STRESS:

A screenshot of a computer

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From the calculated Mean Stress, Standard Deviation, and Coefficient of Variation for the Max Stress runs, my dataset exhibits higher mean stress for the Hole Beams compared to the provided datasets, particularly in the 1mm runs.

Additionally, my dataset shows a higher standard deviation and coefficient of variation for the Hole Beams across both setups. This increased variability likely results from the geometric configuration within the beam—specifically, a void placed too close to the beam's edge, which creates a large deviation in stress values

A screenshot of a graph

Description automatically generated

The box plots provide a visual representation of variability and distributions across datasets. For the **Hole Beams 1mm run**, my dataset has noticeably greater variability than Data Set 1 and Data Set 2. The **5mm run**, in contrast, has a similar stress distribution among all datasets, though my dataset still shows slightly higher variability.

For the **Material A Beam 1mm run**, variability in my dataset is also higher, though the mean stress value remains close to those in Data Set 1 and Data Set 2. Interestingly enough, across all datasets, the variability is the smallest for the Material B runs, which is not unusual, given Material B is the stiffest material.

A group of graphs on a white background

Description automatically generated

A detailed look at the scatter plots reveals that my runs follow similar trendlines as the provided datasets. However, an unusual variance occurs around the **0.45 volume fraction**, likely due to a void being too close to the beam’s edge, leading to an unrealistic stress value. When the stiffest material (Material B) is applied, my data tends to align more closely with the general trend, likely due to improved stiffness in the beam.

A blue and black rectangular object with circles

Description automatically generated

DISPLACEMENT:

It should be noted that, when it came to comparing datasets for displacement, it was only possible to compare Data Set 2 runs with my own data runs, since the displacement measured was the magnitude U, whereas Data Set 1 utilized U U2 Displacement.

A screenshot of a computer

Description automatically generated

The displacement mean and standard deviation values were much closer between my dataset and the given dataset than they were in the stress analysis. This reduced variation might be attributed to the lower overall magnitudes of displacement compared to stress values.

A screenshot of a graph

Description automatically generated

Again, visually, the data variability trends for both datasets, decreased as the voids got filled with stiffer material. The lowest variability was found in the Material B runs, like the Stress simulation runs.

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Visually, the data variability trends across all datasets show a decrease as voids are filled with stiffer material. The lowest variability occurs in the **Material B run**, consistent with the stress simulation findings.

For the **Hole Beams runs**, my displacement values diverge from Data Set 2, especially at **higher volume fractions (>0.6)**, where my dataset exhibits larger displacement values. While the overall trends are similar, the divergence is more pronounced under higher loads.

For the **Material A Beam runs**, displacement values closely align with Data Set 2, with minor variations beginning around **volume fractions greater than 0.6**.

For the **Material B Beam runs**, variability is minimal compared to the other setups, likely due to the increased stiffness ensuring a consistent load-carrying capacity. This reduces sensitivity to imperfections, such as voids being positioned too close to the edge of the beam.

Across all runs, Material B beams exhibit less variability, most likely due to high stiffness ensuring a **consistent load-carrying capacity**, reduces sensitivity to imperfections such as being too close to the edge of the beam. In contrast, Material A and void beams are less stiff and more susceptible to **localized effects** and geometric discontinuities, leading to greater variability in both displacement and stress results.

CORRELATION ANALYSIS

To determine the appropriate correlation coefficient, several factors were considered, including the relationship between void density and stress/displacement results, as well as skewness in the data distribution.

**Skewness, Distribution Considerations**

An analysis of skew coefficients across the datasets revealed that the raw data exhibited both left and right skewness, indicating that it does not fully follow to a normal distribution. This is relevant because the Pearson correlation assumes normally distributed data, whereas Spearman correlation does not.

**Pearson vs. Spearman Decision**

Both Pearson and Spearman correlation coefficients were calculated and compared. The absolute values of each coefficient were examined across all columns. The primary decision rule used was:

* If **|Spearman| > |Pearson|**, the relationship is **monotonic but not exactly linear**.
* If **|Pearson| > |Spearman|**, the relationship is **linear**.

From this analysis, my Stress dataset predominantly exhibited a **monotonic relationship**, whereas the two provided datasets were dominated by a **linear relationship**. This further suggests that the void near the beam’s edge in my runs created an unrealistic stress distribution.

For the **displacement runs**, an interesting observation was that a **monotonic relationship dominated all datasets**, reinforcing the consistency of this trend.

The comprehensive tables that contain more information is in the Raw Data Excel sheet and briefly discussed in detail.

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Description automatically generated with medium confidence

A table with numbers and a red and green text

Description automatically generated with medium confidence

A table with numbers and letters

Description automatically generated

The following three tables are for the Stress runs, and my dataset has a primary Monotonic relationship, but Data Set 1 and 2 were primarily a Linear relationship.

A table with numbers and lines

Description automatically generatedA table with numbers and lines

Description automatically generated

A table with numbers and letters

Description automatically generatedA spreadsheet with numbers and lines

Description automatically generatedFor displacement runs, all three datasets demonstrated a Monotonic relationship, and this was rather consistent across all runs and setups.

Displacement exhibited a consistently monotonic relationship across all datasets, likely due to its dependence on stiffness. As material stiffness increased, displacement decreased in a predictable manner, making it less sensitive to localized void placement and unrealistic geometry displacements in one case.

In contrast, stress showed a mix of linear and monotonic relationships. The provided datasets followed a more linear trend, suggesting a proportional response to void fraction. However, my dataset exhibited stronger monotonic behavior due to stress concentrations caused by voids placed near the beam’s edge. These localized effects introduced greater variability in stress results, whereas displacement, as a global structural response, remained more stable.

Overall, stress demonstrated higher variability than displacement due to its sensitivity to localized geometric changes, while displacement followed a smoother trend dictated by material stiffness.