

# Design and Optimization of Miniaturized Actuation System with Systematic Dual-Output Compliant Displacement Amplification

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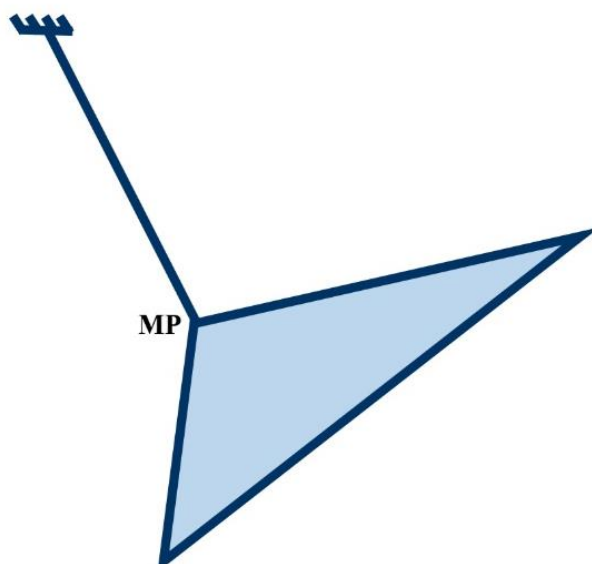
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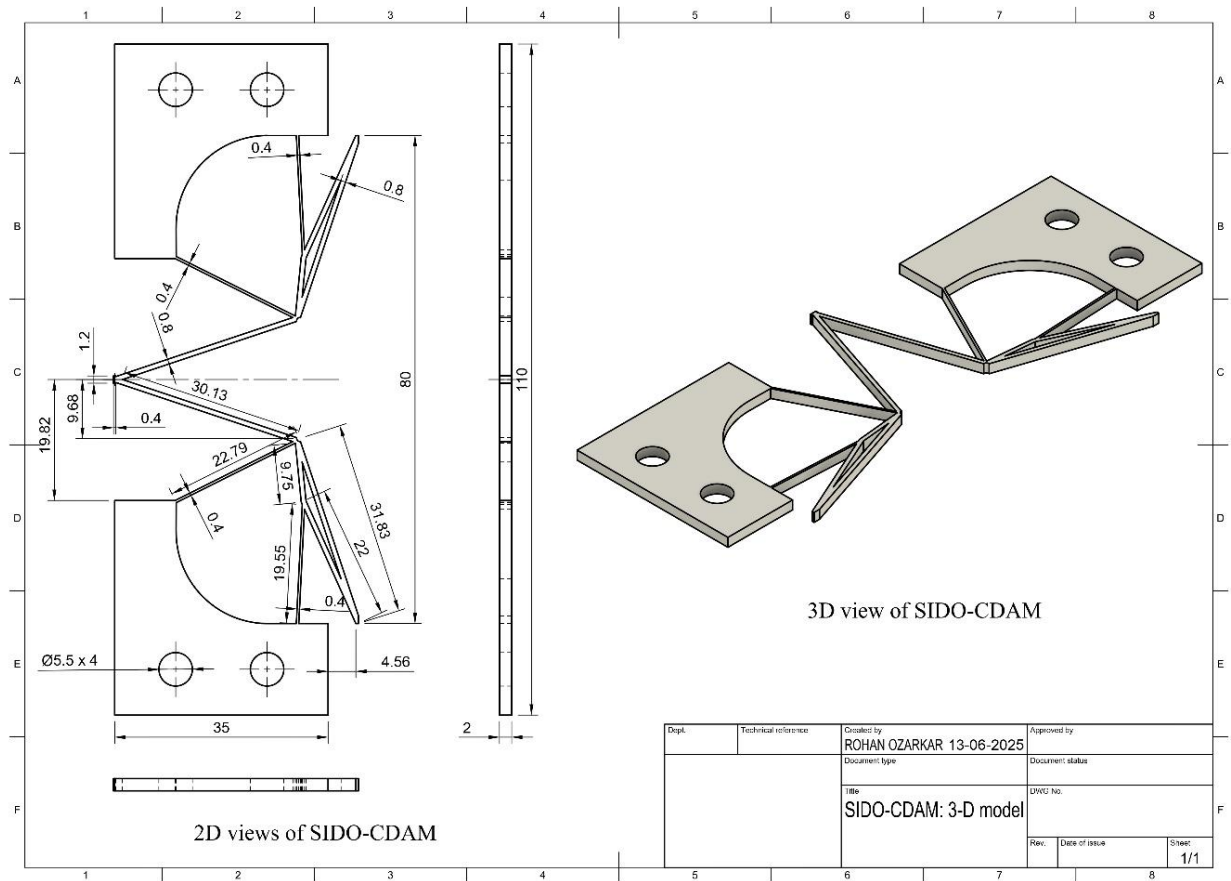
## Electronic Supporting Information



**Figure S1.** Typical compliant dyad building blocks (CDBs): Definition

**Table S1.** The coordinates of the key points of the conceptual configuration as shown in Figure 2.

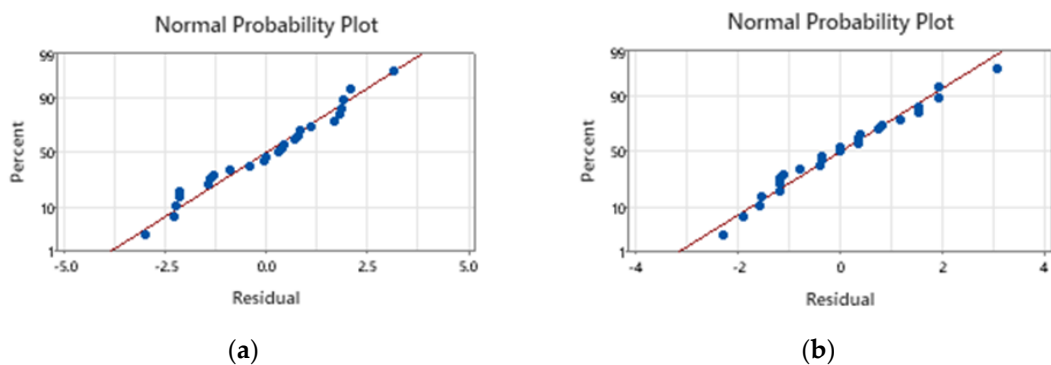
| Key points | Co-ordinates   |
|------------|----------------|
| IP1        | (0,0)          |
| D1         | (30,9.75)      |
| D2         | (30,-9.75)     |
| OP1        | (39.75,-39.75) |
| OP2        | (39.75,-39.75) |
| F1         | (9.75,20)      |
| F2         | (30, 39.75)    |
| F3         | (9.75,-20)     |
| F4         | (30, -39.75)   |
| MP1        | (29.75,29.75)  |
| MP2        | (29.75,-29.75) |



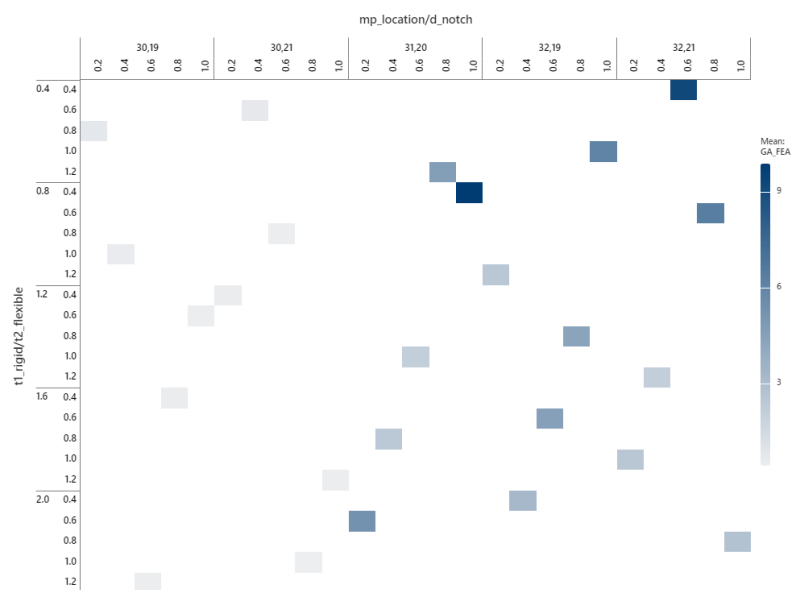
**Figure S2.** 2D Orthogonal and 3D views of the realized SIDO-CDAM

**Table S2.** Effect of mesh density on GA and von Mises stress.

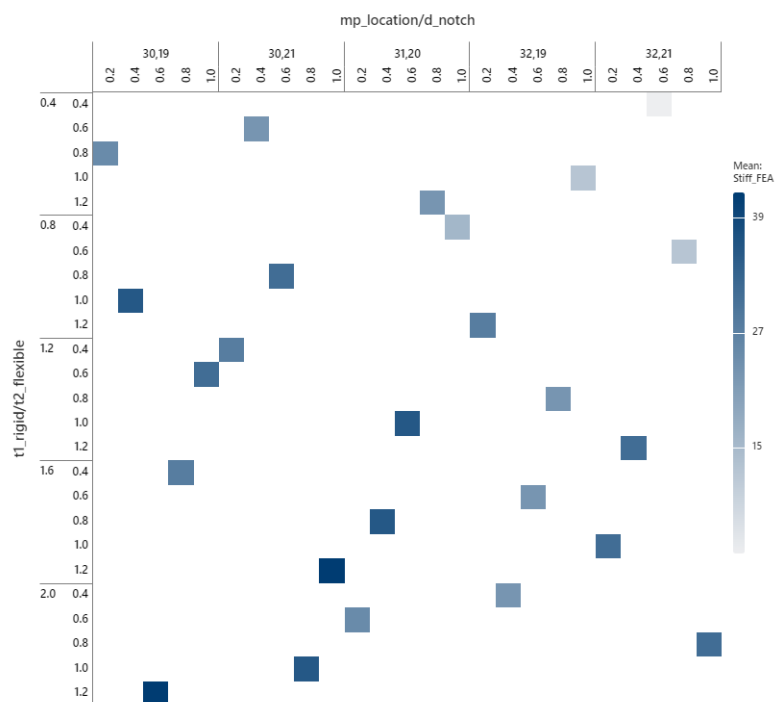
| Level | No. Elements | Element size | Max von Mises Stress (MPa) | Geometrical Advantage (GA) | Stiffness (Ki) (N/mm) |
|-------|--------------|--------------|----------------------------|----------------------------|-----------------------|
| 1     | 16578.00     | 1.50         | 0.820                      | 11.214                     | 17.857                |
| 2     | 29492.00     | 1.25         | 0.932                      | 10.600                     | 16.667                |
| 3     | 30484.00     | 1.00         | 0.793                      | 10.533                     | 16.667                |
| 4     | 75513.00     | 0.75         | 0.789                      | 9.875                      | 15.625                |
| 5     | 205860.00    | 0.50         | 0.785                      | 9.875                      | 15.625                |
| 6     | 1368261.00   | 0.25         | 0.784                      | 9.875                      | 15.625                |



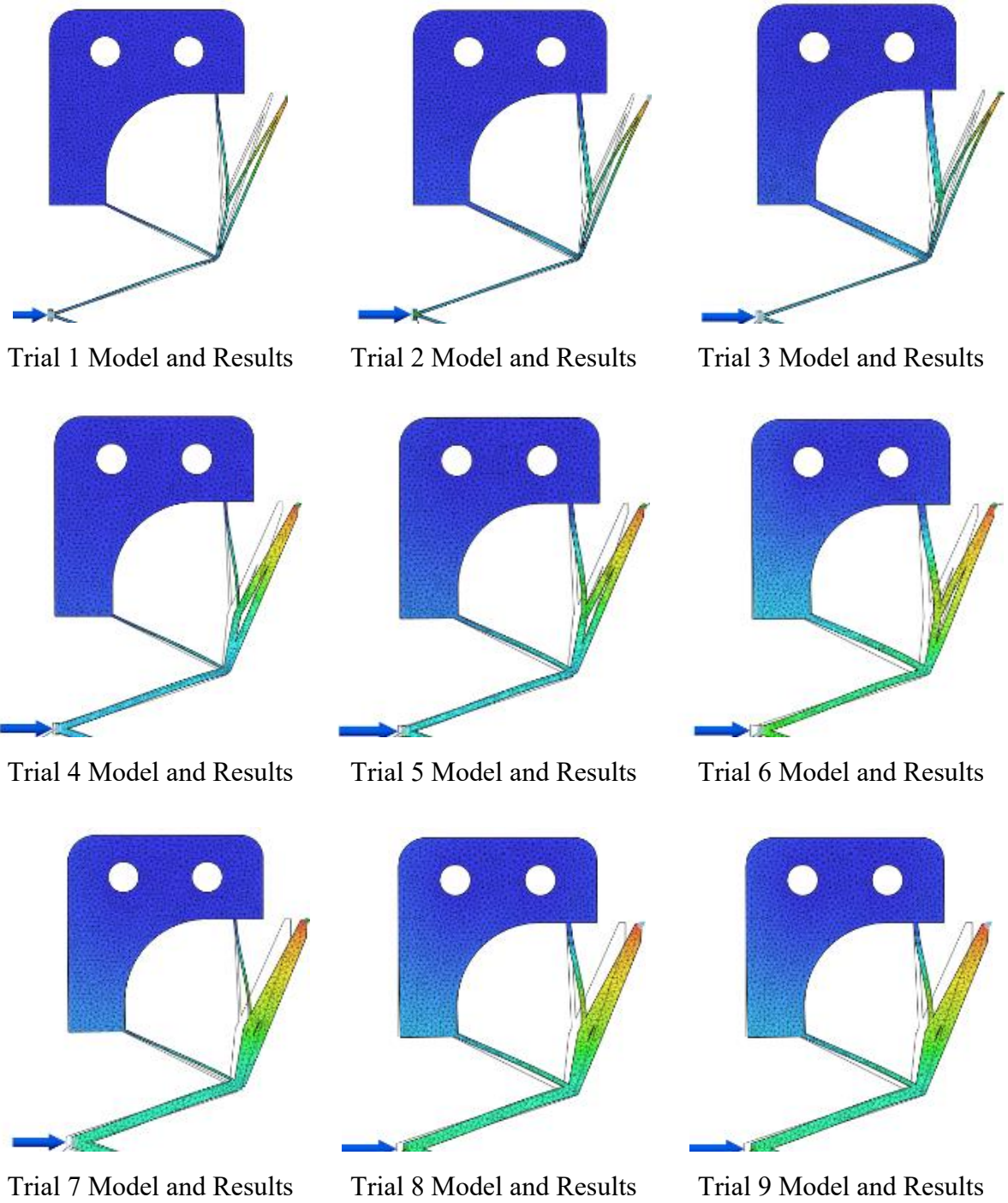
**Figure S3.** Normal probability plots of residuals for Stage-1 regression models (a) for GA\_FEA, (b) for stiff\_FEA.



**Figure S4.** Heat plot for Stage-1 GA\_FEA vs Control parameters



**Figure S5.** Heat plot for Stage-1 Stiff\_FEA vs Control parameters



**Figure S6.** FEA Simulation trial results of the deformed and undeformed models for Stage-2

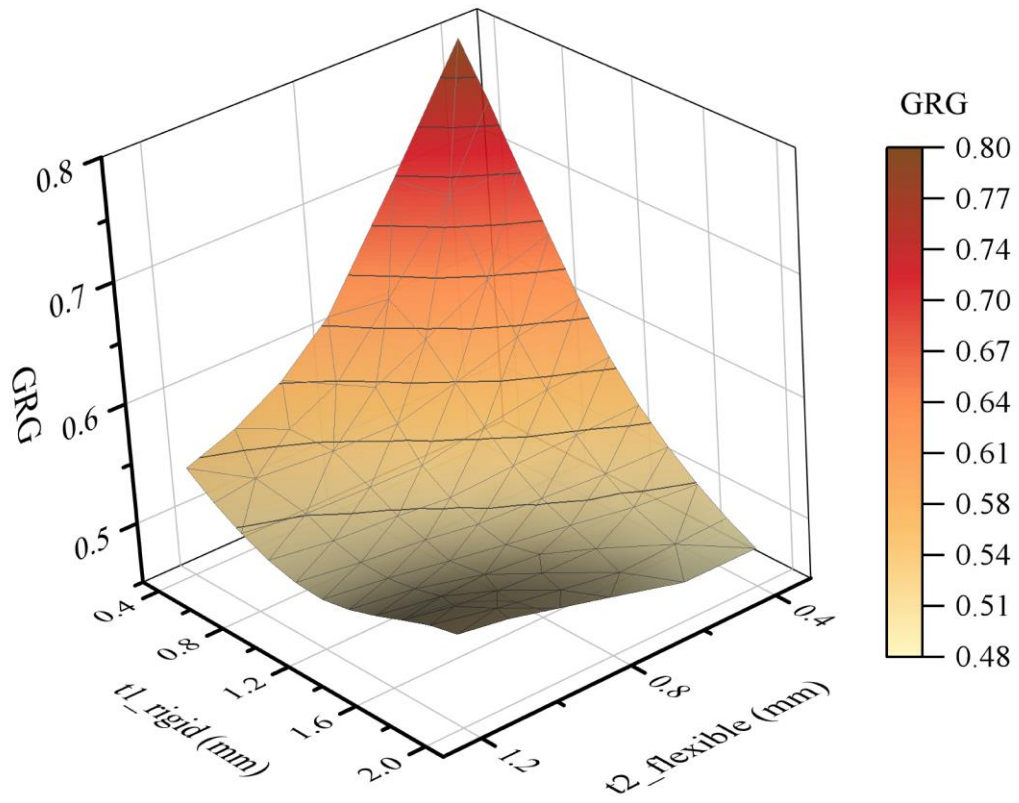


Figure S7. Stage-2 GRG vs.  $t1\_rigid$  vs.  $t2\_flexible$

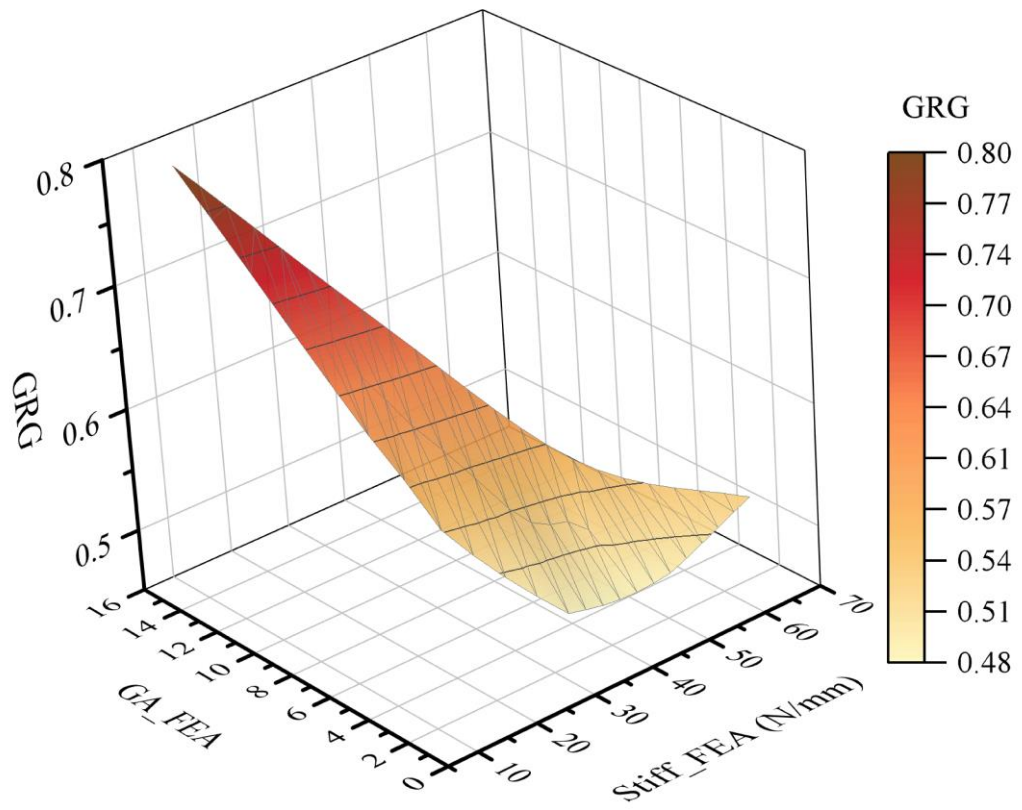
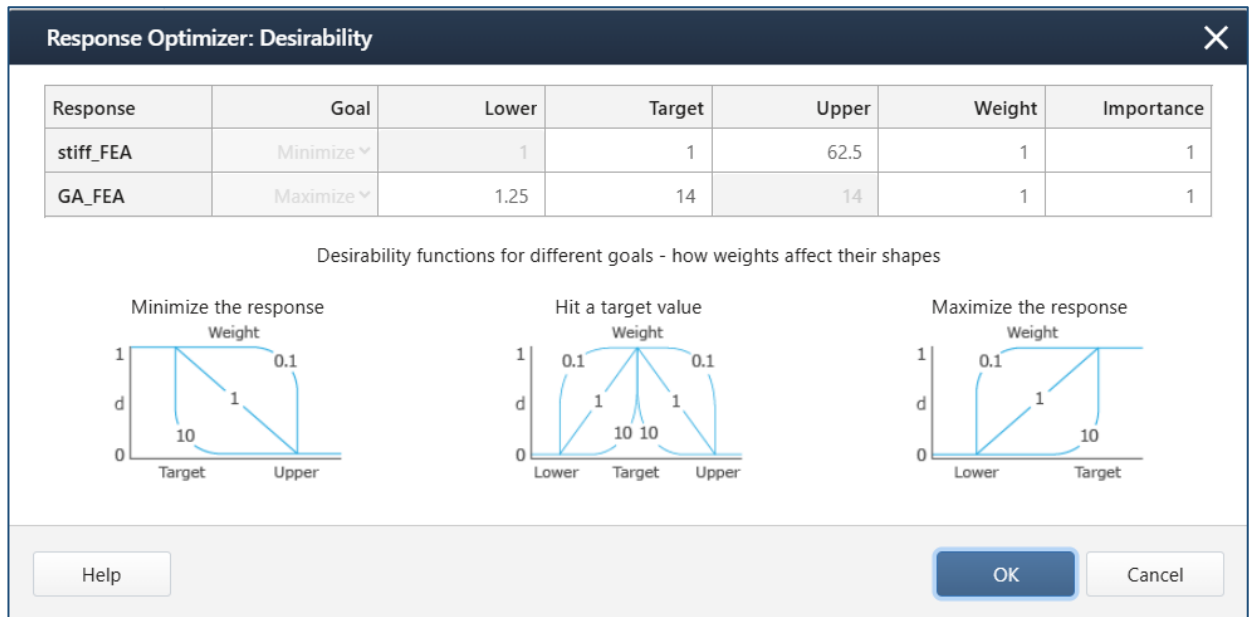
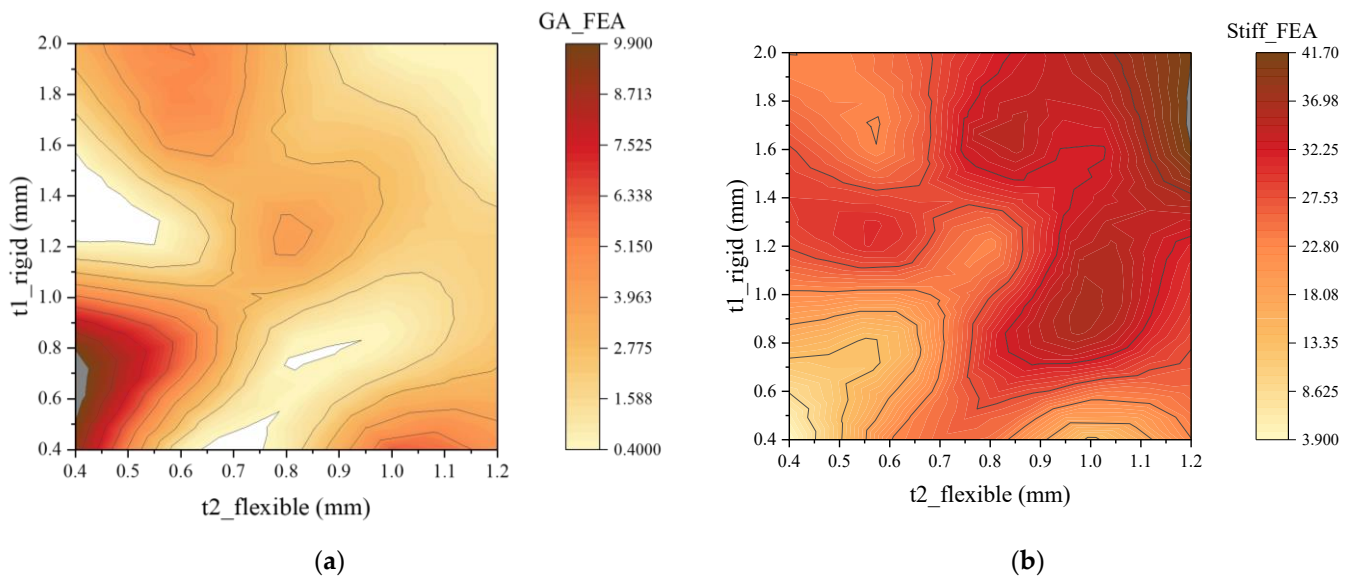


Figure S8. Stage-2 GRG vs.  $GA\_FEA$  vs.  $stiff\_FEA$



**Figure S9.** Minitab response optimizer setup for response parameters



**Figure S10.** (a) Contour Plot Stage-1 GA\_FEA vs. t1\_rigid vs. t2\_flexible, (b). Contour Plot Stage-1 stiff\_FEA vs. t1\_rigid vs. t2\_flexible