# Simulation-driven design for fenestration industry

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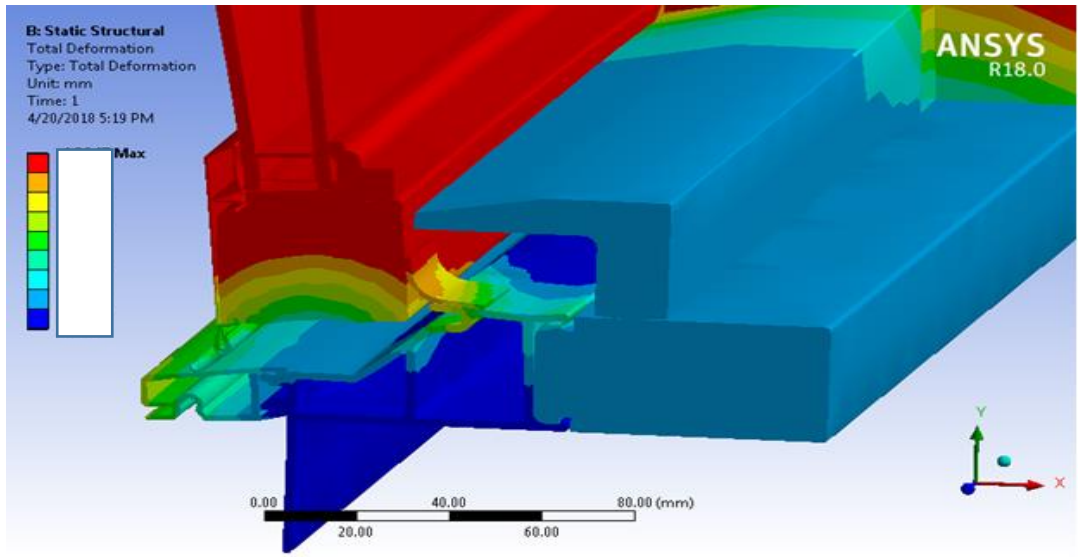
# AES SIMULATION CAPABILITIES IN WINDOW & SLIDING PATIO DOORS

## Structural Analysis and performance study of Models as per ASTM E330-14.




### Frames Structural Analysis:

- FEA analysis is performed to study the overall structure of doors and windows.
- A combined structural and thermal analysis is performed by considering environmental temperature conditions and thermal stress were studied.
- To Capture the stresses in the hardware or local areas such as screws, brackets, etc., sub-model Analysis is performed.

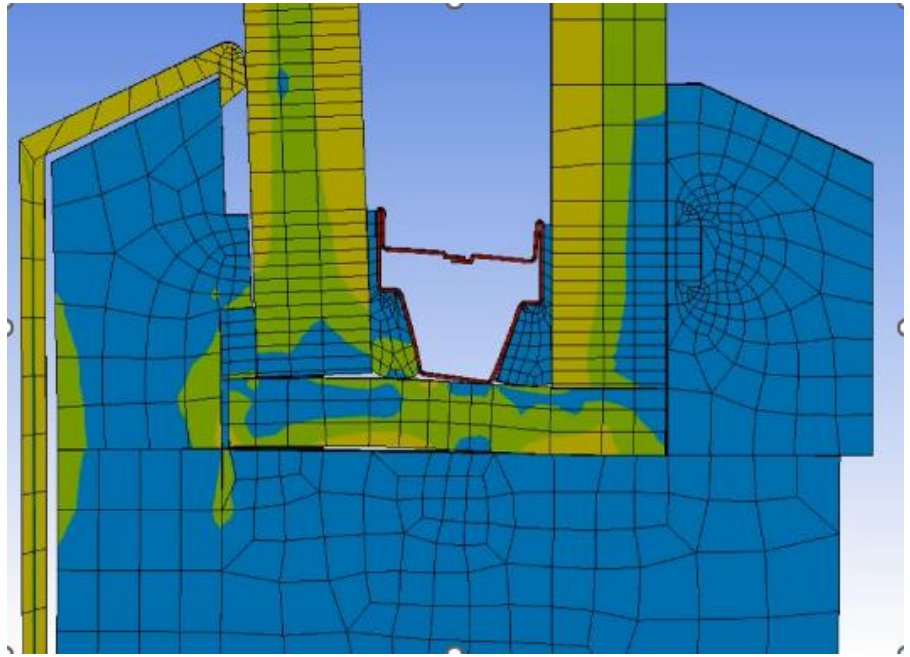
### Benefits:

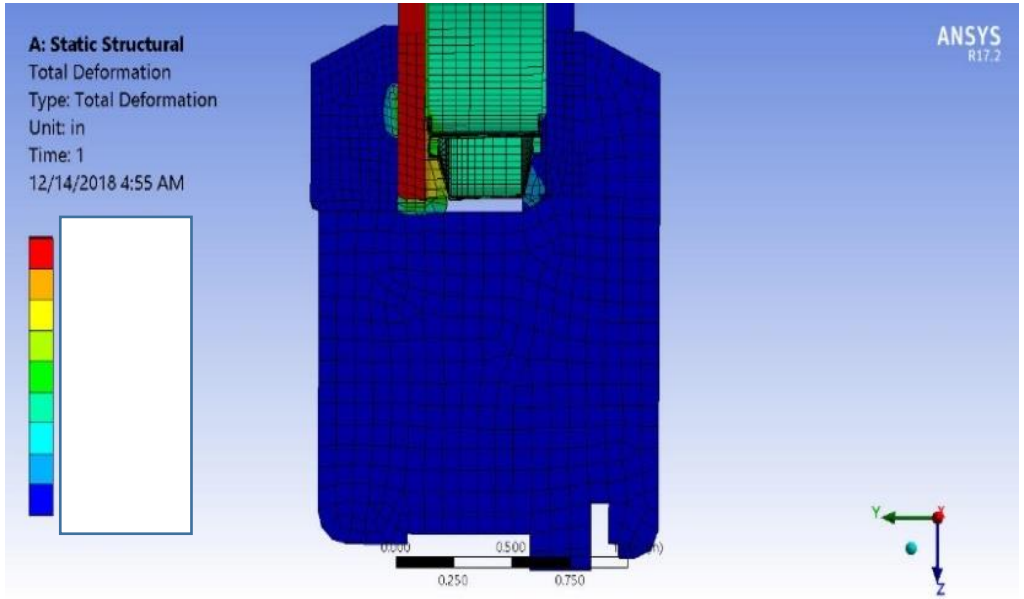
- Stresses are accurately determined. Areas where strengthening are required are suggested and achieved.
- We ensure, the maximum allowable deformation limits are not exceeded.
- Locations of Locks, brackets, hinges, screws and other hardwares are optimally placed so that all members are loaded appropriately.

# AES SIMULATION CAPABILITIES IN WINDOW & SLIDING PATIO DOORS

## Structural Analysis and performance study of IG as per ASTM E330-14.

- **IG Analysis** is performed to ensure the Glass, spacer and spacer sealant are adequate to withstand testing under design pressure.
- Stresses were reduced by proposed viscoelastic and hyper elastic material and found components are safe except the sealant.
- Sealant failure due to high overall deformations in the glasses.






Total deformation Plot

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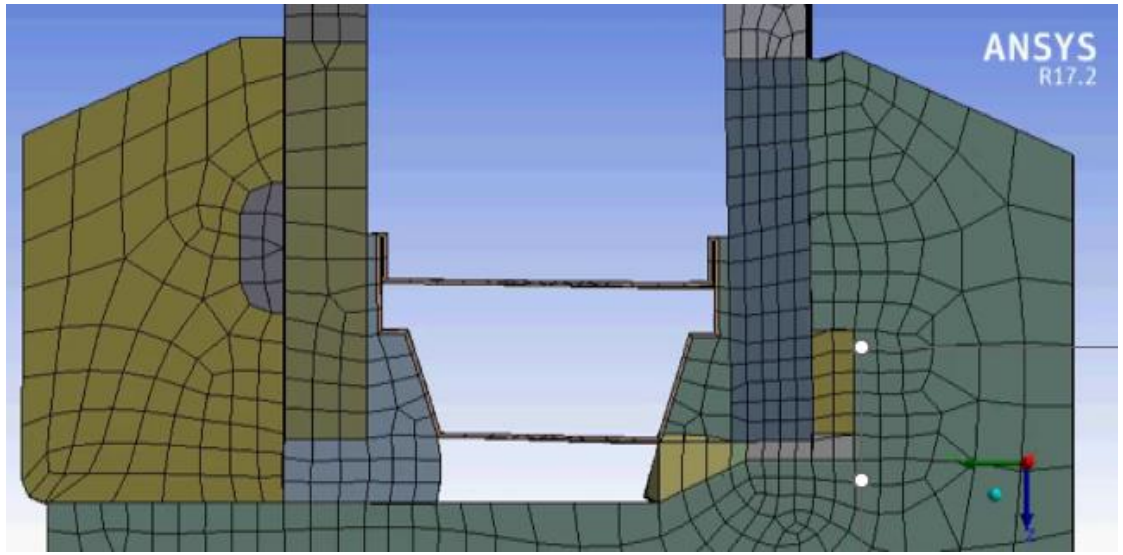
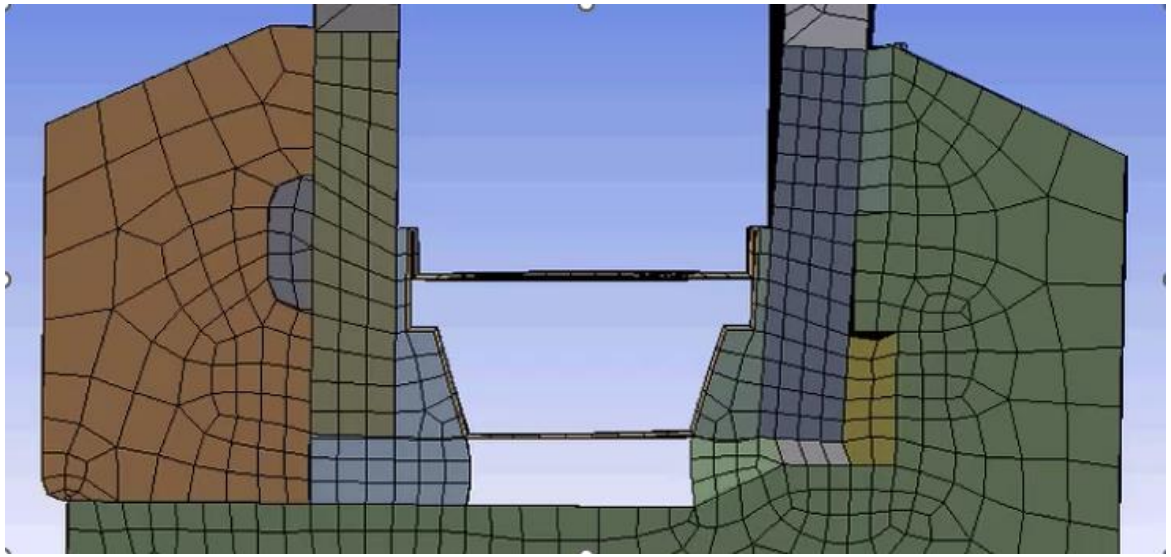



Simulation shows Positive pressure Impact on ****** model



Simulation shows Negative pressure Impact on ******* model

## Benefits:

- The quantity of sealants are optimized.
- The thicknesses of reinforcements and frames are optimized.
- Hardware components location are properly determined so as to take evenly distributed forces.

| Temperature ($^0$F) | Deformation in Z direction for Glass ( in) | Max. Equivalent Stress (psi) | | | | | Stress on Glass face over rabbit (psi) |
|---|---|---|---|---|---|---|---|
| | | Glass | Spacer | Spacer Sealant | Wood | Dow Corning | |
| 78.8 | | | | | | | |
| 86.0 | | | | | | | |
| 93.2 | | | | | | | |
| 100.4 | | | | | | | |
| 107.6 | | | | | | | |
| 114.8 | | | | | | | |
| 122.0 | | | | | | | |
| 129.2 | | | | | | | |
| 136.4 | | | | | | | |
| 143.6 | | | | | | | |
| 150.8 | | | | | | | |

Stress table at various outside temperatures

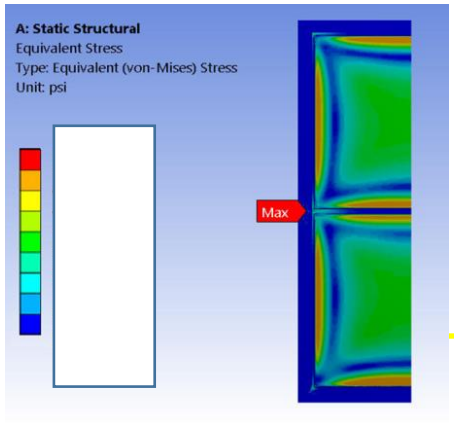
# AES SIMULATION CAPABILITIES IN WINDOW & SLIDING PATIO DOORS

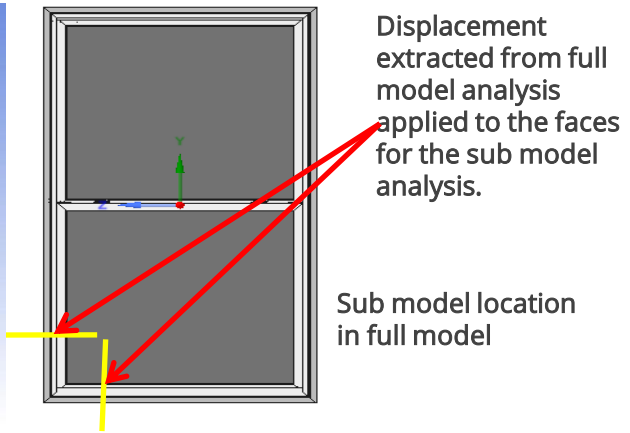
## Structural Analysis and effect of hardware on frames

### Hardware Analysis:

- In doors and windows hardware components that comes in contact with the frame are prone to failure.
- Localized areas were studied in detail to capture stresses and material behavior.

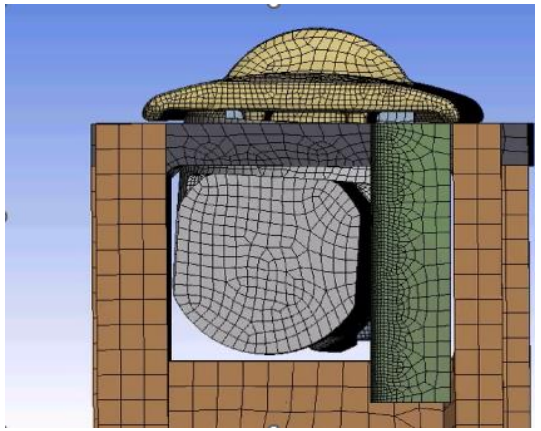
**Benefits:** Contact stresses can be determined, and remedial actions can be simulated before building a prototype.



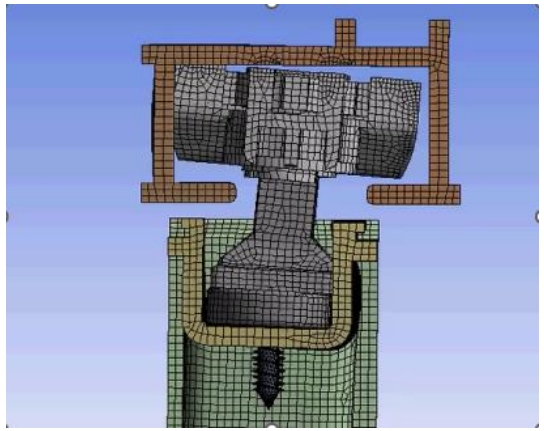



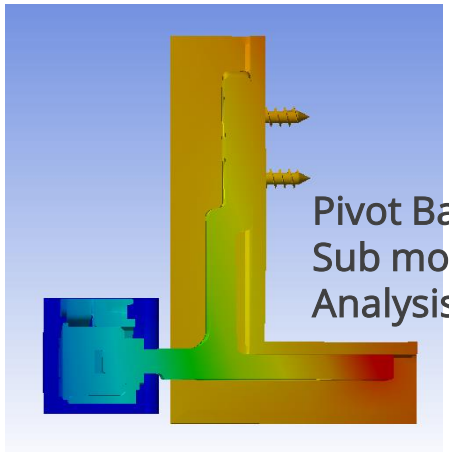

Full model

Tilt latch Sub model Analysis side View



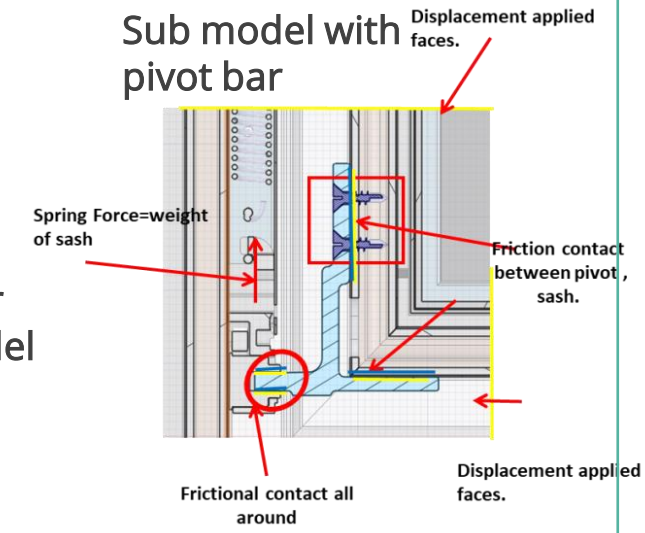
Pivot Bar Sub model Analysis Top View





Pivot Bar Sub model Analysis

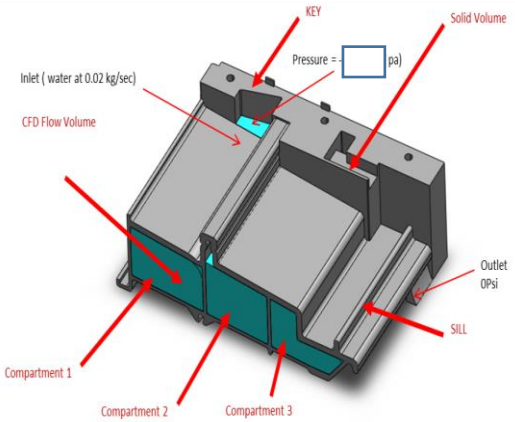
Sub model with pivot bar



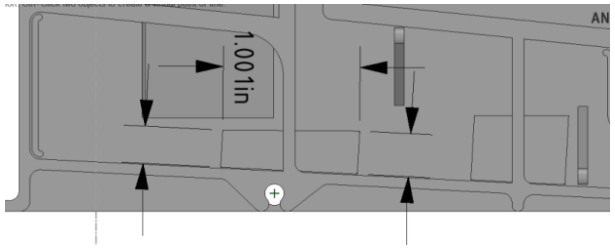
# AES SIMULATION CAPABILITIES IN WINDOW & SLIDING PATIO DOORS

**CFD analysis of Water Weep system:**

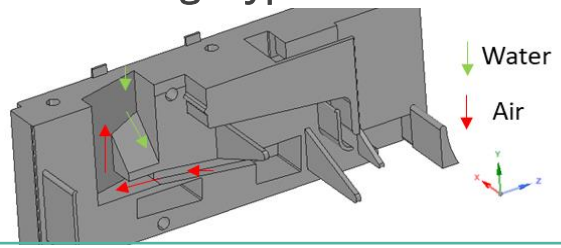
- A standard test where a vacuum pressure(6 psf) is applied at inlet and fluid (water) is made to p through the system and to ensure that water does not remain stagnant in the system.
- Different Design Iterations are run to ensure best flow rate is achieved.
- 3D printing of the models are done and tested, compared with the CFD results.




CASE 1: Height increased by 20% model

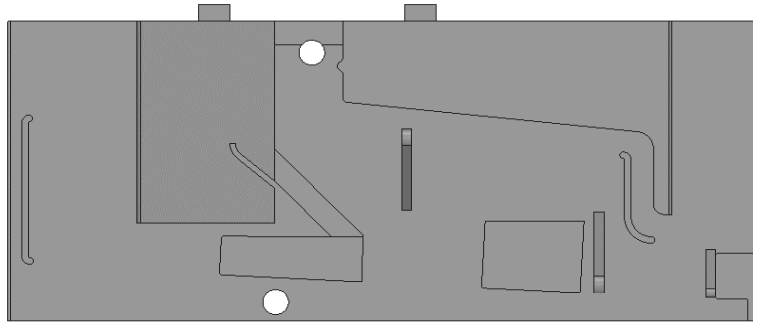



CASE 2- Wedge type model

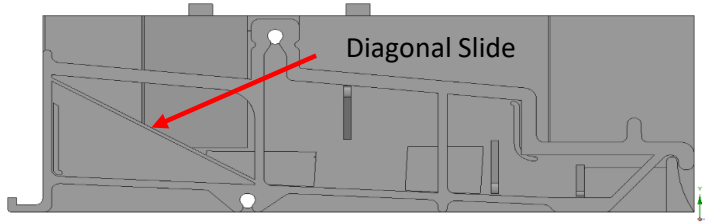



KEY & SILL GEOMETRY VARIATIONS

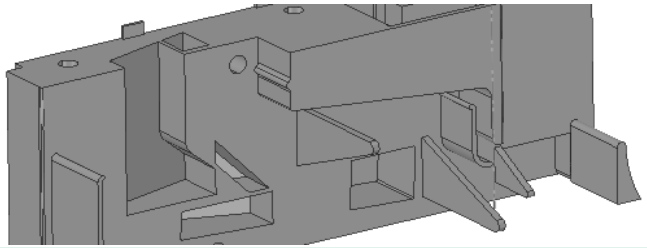
CASE 3- Baffle Plate model



CASE 4- Diagonal slide model




CASE 5- Inlet divided model

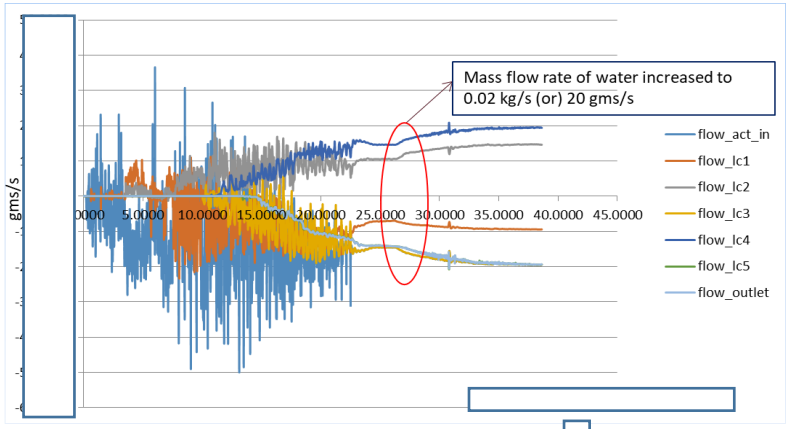


# AES SIMULATION CAPABILITIES IN WINDOW & SLIDING PATIO DOORS

## CFD analysis of the Water Weep system

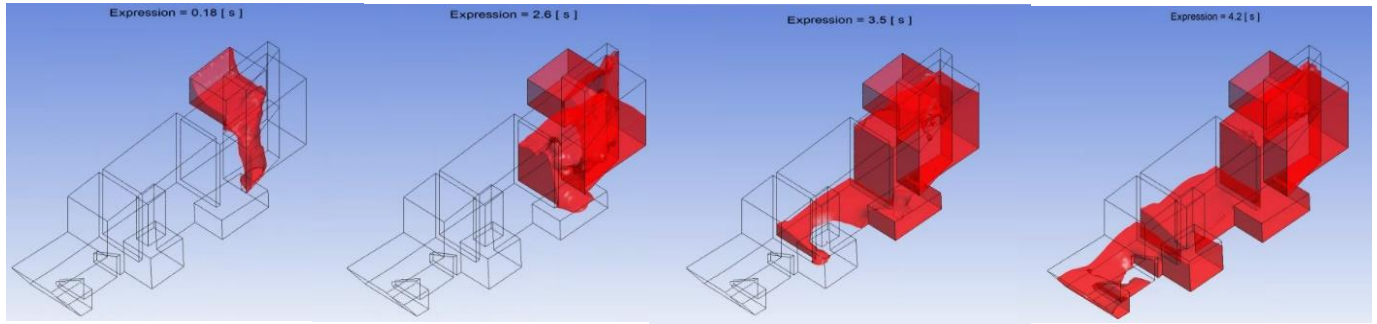
**Benefits:**

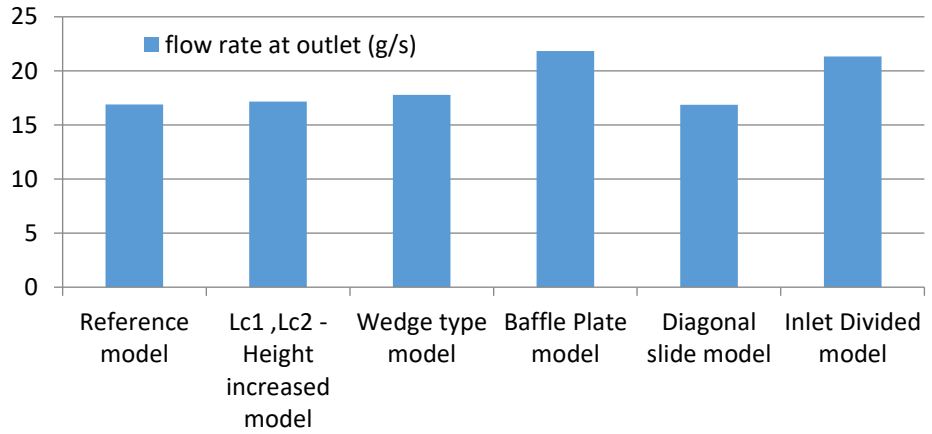
59% increase in flow rate (from ***gms/sec to ***gms/sec) was achieved by means of the suggested modification of a baffle plate model.

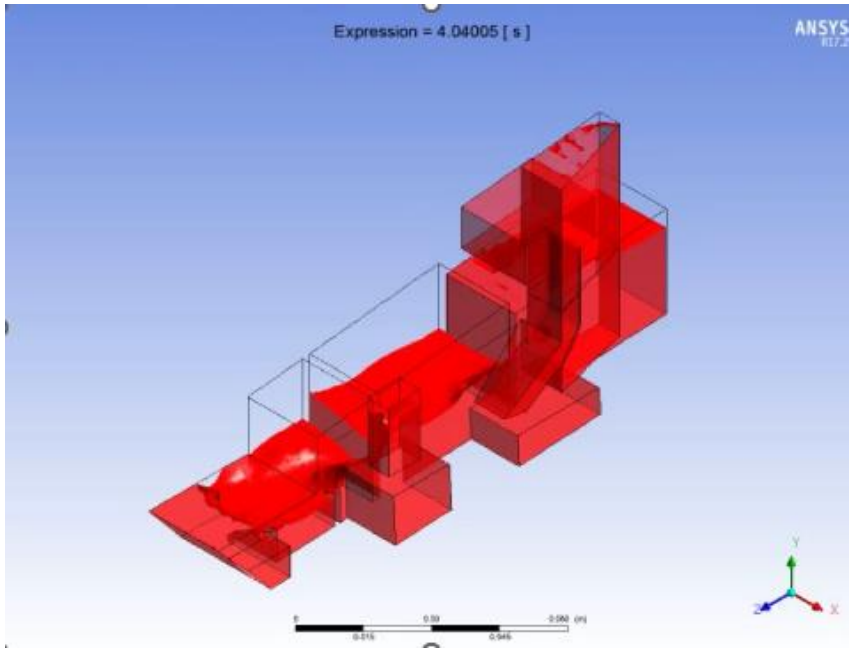



**Steady state flow rate across the system = 0.0194 kg/s (or) 19.4 g/s**

**Steady state flow rate achieved at 37 s**



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THANK YOU