INVESTIGATION OF THE DRIFT PERFORMANCE OF POINT FIXED GLASS FAÇADE SYSTEMS UNDER VARYING FLEXIBILITY OF SPIDER ARM CONNECTIONS

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Glass façade is a key component in contemporary architecture, offering both aesthetic appeal and structural functionality. Among the various facade systems, Point-Fixed Glass Façade (PFGF) systems stand out for their elegance and adaptability. However, their drift performance when subjected to in-plane racking actions due to seismic and wind forces is a significant concern, particularly in regions with low to moderate seismic risk, where such factors are often neglected during the design phase. Additionally, there is a notable scarcity of research on PFGF systems, particularly concerning parametric studies that explore drift capacity while considering the flexibility of spider arms. This study addresses this gap by presenting an in-depth analysis of the in-plane drift performance of PFGF systems.

A comprehensive Three-Dimensional (3D), non-linear Finite Element (FE) model was meticulously developed using ANSYS software, incorporating non-linear material properties and 3D elements to accurately and realistically represent the behavior of spider arms under loading conditions. To ensure a balance between model accuracy and computational efficiency, a detailed mesh sensitivity analysis was conducted to determine the optimal mesh size. The developed FE model was thoroughly validated against experimental data from previous studies, evaluating key parameters such as pushover curves, drift capacity, and maximum in-plane displacements. The validation demonstrated that the FE model achieved a drift capacity of 2.12% with a corresponding force of 15.97 kN, closely matching the reported experimental results. Additionally, a separate 3D linear FE model was developed to compare the outcomes between linearly and non-linearly modelled spider arms, further highlighting the critical importance of incorporating material nonlinearity in significantly enhancing the accuracy of the developed FE model.

The parametric study conducted on the PFGF system provided valuable insights into its drift performance under various configurations. Findings indicated that reducing the thickness of spider arms significantly improves drift performance, albeit with a minor reduction in allowable force. Similarly, decreasing the width of spider arms enhances drift performance, though at the cost of a noticeable reduction in allowable force. Increasing the diameter of the circular and slotted holes in spider arms improved drift performance, with a slight rise in allowable force. Moreover, decreasing the rotational friction at the base connection of the spider arm led to a modest enhancement in drift performance, with minimal impact on the allowable force. These results provide critical insights for engineers designing PFGF systems, emphasizing the importance of optimizing spider arm configurations to enhance drift capacity. The study underscores the need for considering structural interactions in facade system design to mitigate risks associated with seismic and wind loads. The validated FE model and the derived parametric insights are instrumental in guiding future design practices and improving the resilience of PFGF systems in various loading conditions.

Keywords: Point fixed glass façade, in-plane drift capacity, material non-linearity, spider arm flexibility

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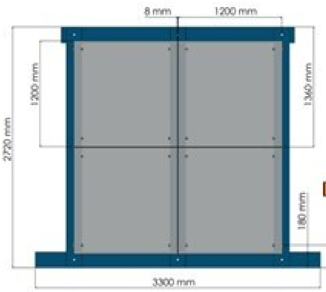
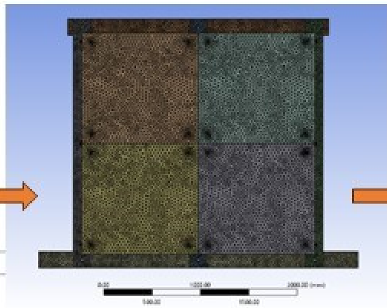
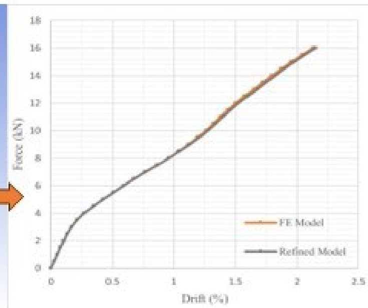


Dimensions of the Model



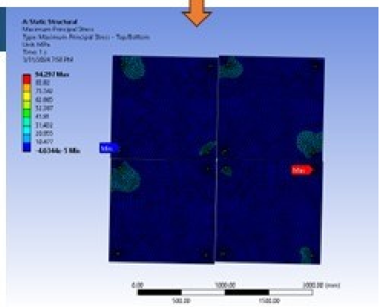
Three-Dimensional (3D), Non-Linear Finite Element (FE) Model

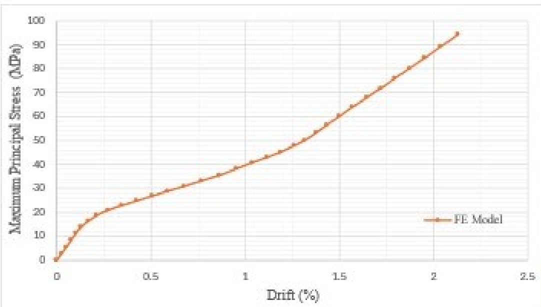


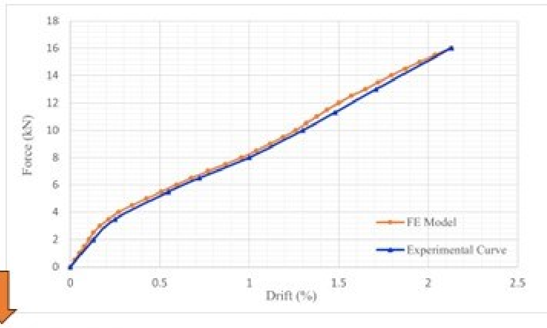
Mesh Sensitivity Analysis

ANALYSIS AND VALIDATION

Results Comparison	Experimental	FE Model	Error (%)
Drift (%)	2.1	2.12	1.13
Displacement (mm)	58	57.76	0.41
Force (kN)	16	15.97	0.18
In-plane glass translation (mm)	51	53.96	7.93







PARAMETRIC STUDY

Results Comparison	FE Model	Spider Arm Thickness		Spider Arm Width		Spider Arm Circular and Slotted Hole Diameter		Rotational Friction of the Spider Arm Base Connection	
		T#1	T#2	T#1	T#2	T#1	T#2	T#1	T#2
		Thickness decreased by 1/5th	Thickness increased by 1/5th	Width decreased by 1/5th	Width increased by 1/5th	Diameter decreased by 1mm	Diameter increased by 1mm	Friction decreased by 1/2nd	Friction increased by 1/2nd
Drift (%)	2.12	2.51	1.94	2.31	2.01	1.93	2.32	2.124	2.124
Displacement (mm)	57.76	68.35	52.72	62.83	54.63	52.56	63.13	57.774	57.759
Force (kN)	15.97	15.10	16.32	14.96	17.07	15.89	16.08	15.971	15.972