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Simulation and Validation of Glass Railing System Using Structural Analysis on ANSYS

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Abstract
We had invented a glass railing system, in which we had design a Compact Rectangular shape Aluminum base shoe that uses a simple nylon fixture; that makes installation and un-installation of this system in a very simple process. Stainless steel anchors are used to mount in a horizontal base of a shoe and at some distance from each other for mounting on ground. Nylon fixture applies force on glass panel due to which opposite side of the glass panel settles against Polyethylene Plastic compressive section which is on another side of glass panel.

Keywords: *Compact Rectangular Glass Railing, Aluminum base Shoe, Heavy Glass railing, Aluminum Alloy 6063 T6.*

1. Introduction

Compact Rectangular Glass Railing system forms the basis of the engineering industry and is involved either directly or indirectly in the manufacture of nearly every product of our modern civilization. This Compact Glass railing system are constructed primarily of high-strength, high durability molded fiberglass and secondarily it has to be seen that it has to be overcome through an external forces or impacts on it. Since, Aluminum components have several advantageous characteristics such as resistance to corrosion and bad weather, higher mechanical resistance and are relatively light weight. Notably for these reasons, aluminum structure systems are widely used in the construction industry for the external perimeters of balconies, footbridges, staircases, etc. It suits many applications such as platforms, decks, mezzanines, balconies and staircases.

2. Material and Mechanical Properties

In current case study; the Aluminum Alloy 6063 - T6 grade has been used to manufacture of Railing Systems. Since, it allows complex shapes to be formed with very smooth surfaces fit for anodizing and so is popular for visible architectural applications such as window frames, door frames, roofs and sign frames. The chemical composition of the Aluminum Alloy 6063 - T6 grade is as follows:

Table 1: Chemical Composition Aluminum Alloy 6063 - T6

Al	97.5 - 97.6 %	Cu	0.10 %
Cr	0.10 %	Fe	0.35 %
Mg	0.90 %	Mn	0.10 %
Si	0.60 %	Ti	0.10 %
Zn	0.10 %	Other	0.05 - 0.15 %

The mechanical properties of Aluminum Alloy 6063 - T6; Poisson's ratio = 0.33, Modulus of elasticity = 2.1 x 10^{11} Pa and Density = 2700 kg/m^3 is given as data input in isotropic elasticity. The atmospheric temperature is consider 29 ºC. The tensile test results in the load v/s deflection diagram. This load v/s deflection diagram is converted to engineering stress strain curve using the mechanical properties obtained from the load v/s deflection diagram.

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1	Plastic Strain (m m^-1)	Stress (MPa)
2	0	0.0013
3	0.0005	24.953
4	0.0009	51.175
5	0.0012	79.089
6	0.0016	101.51
7	0.0021	129.42
8	0.0024	153.1
9	0.003	175.94
10	0.0031	195.4
11	0.0035	207.66
12	0.004	212.74
13	0.0048	216.54
14	0.006	218.65
15	0.0075	222.87
16	0.0105	226.67
17	0.0133	230.04
18	0.016	232.57
19	0.0194	235.52
20	0.0218	237.63
21	0.0247	240.16
22	0.0296	243.52
23	0.0339	246.47
24	0.0379	248.57
25	0.0452	253.19
26	0.0511	255.71
27	0.0568	257.81
28	0.0631	261.17
29	0.0714	264.52
30	0.0772	265.77

Fig. 1 Data of Stress v/s Strain

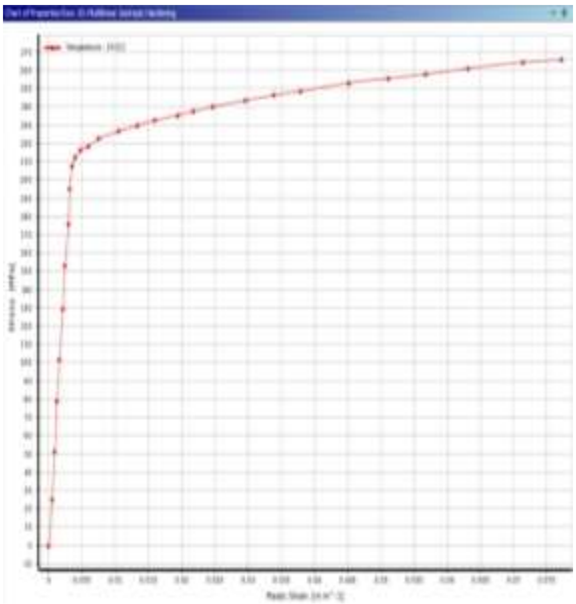

Fig. 2 Graphical representation of Stress v/s Strain Curve

From the above data, we came to know that ultimate tensile load is 265.77 MPa

3. Detail of System

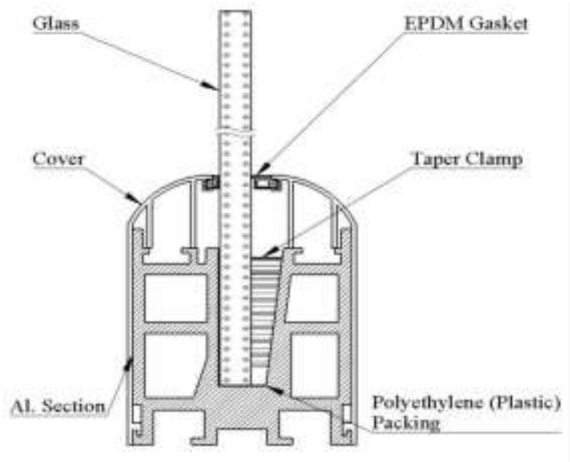

Fig. 3 Heavy Duty Glass Railing System 2D View

3.1 Gasket

EPDM Rubber (ethylene propylene diene monomer (M-class) rubber) material has been used for packing the gaps which has form after installation. EPDM rubber is a terpolymer of ethylene, propylene and diene-component. The ethylene content is around 45% - 85 %. The higher the ethylene content, higher the loading possibilities of the polymer, better mixing and extrusion.

3.2 Taper Clamp

Taper clamp is made up of Nylon 69. This packing's i.e. clamp; are made up of hard, though slightly resilient material, so as to permit a very limited degree of turning movement of the edge region of the panel in the holder under an applied transverse load, the nature of the packing material being such that it does not damage or abrade the panel while undergoing slight compressive deformation, but yet it can be fully restored to its original shape in the channel when the panel is unloaded.

3.3 Anchor

The anchor and fastener has been used to mount this system. Those anchors are made up of SS 202 and SS 316 material. Since, density of Stainless Steel is on higher side with respect to Aluminum, so it is preferable to go with application of SS Anchors.

3.4 Polyethylene Plastic (Packing)

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The Polyethylene plastic is used is between glass surface and section i.e. its base and wall. Due to which there will be a minimum amount of chances of glass panel to get damage. It acts like a protective film for glass panel.

4. Heavy Duty Glass Railing System

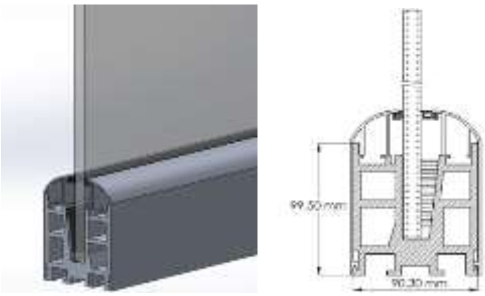

Fig. 4 Heavy Duty Glass Railing System 2D Dimensional View and 3D Model View

4.1 Geometry of Heavy Duty Glass Railing System

Properties of this Heavy Duty Glass Railing System (1000 mm) :

Table 2: Properties of this heavy duty glass railing system : Aluminum Alloy 6063 - T6

Mass	3915 Grams
Density	2700 Kg/m^3
Young's Modulus	71250 MPa
Poisson's Ratio	0.33
Tensile Yield Strength	214 MPa
Tensile Ultimate Strength	241 MPa

4.2 Meshing of Heavy Duty Glass Railing System

Initially a relatively medium mesh is generated with 56 thousand nodes. This mesh contains cells (Hexahedral cells) having quadrilateral faces at the boundaries. Care is taken to use structured cells (Hexahedral) as much as possible, for this reason the geometry is divided into several parts for using automatic methods available in the ANSYS 18.2 meshing client. It is meant to reduce numerical diffusion as much as possible by structuring the mesh in a well manner, particularly near the wall region.

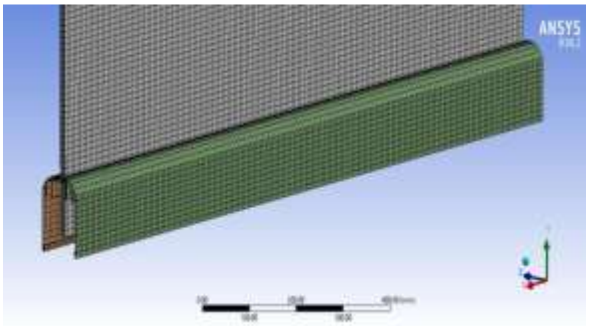

Fig. 5 Meshing diagram of Heavy Duty Glass Railing

4.3 Boundary Condition of Heavy Duty Glass Railing System

The force has been applied perpendicular to the glass panel of 3800 N. Since the base has been kept fixed and gravitational force is acting in negative Y direction.

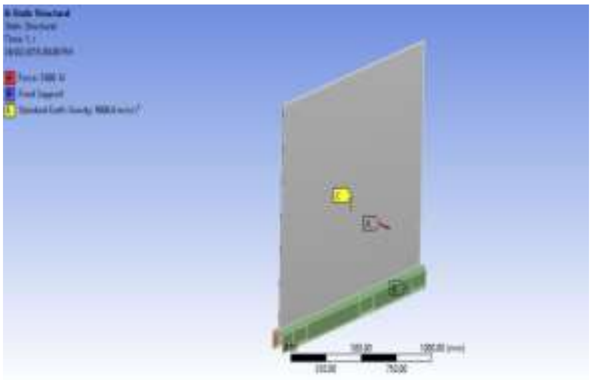

Fig. 6 Boundary Condition diagram of Heavy Duty Glass Railing

4.4 Analysis of Heavy Duty Glass Railing System

After the analysis done which has been done on Ansys 18.2. The Maximum Stress which has been occur is 46.03 Mpa.

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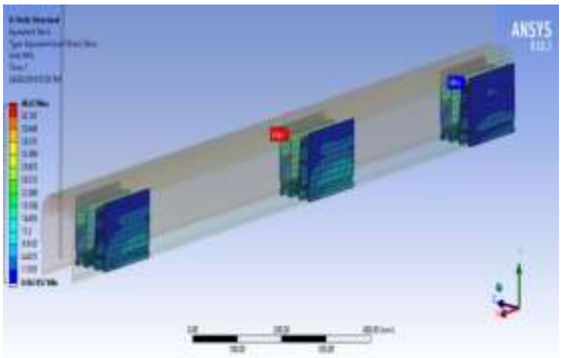

Fig. 7 Equivalent Stress diagram of Heavy Duty Glass Railing

5. Compact Rectangular Glass Railing Systems

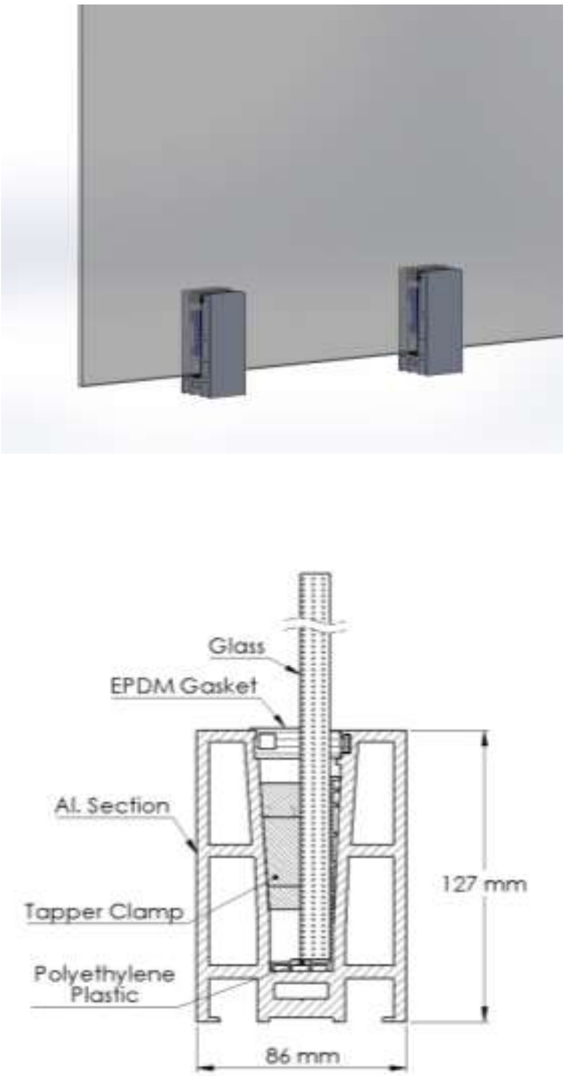

Fig. 8 Compact Rectangular Glass Railing System 2D Dimensional View and 3D Model View

5.1 Geometry of Compact Rectangular Glass Railing System

Properties of this Compact Rectangular Glass Railing System (1000 mm) :

Table 3: Properties of this Compact Rectangular Glass Railing System :- Aluminum Alloy 6063 - T6

Mass	784 Grams
Density	2700 Kg/m^3
Young's Modulus	71250 MPa
Poisson's Ratio	0.33
Tensile Yield Strength	214 MPa
Tensile Ultimate Strength	241 MPa

5.2 Meshing of Compact Rectangular Glass Railing System

Initially a relatively medium mesh is generated with 23 thousand nodes. This mesh contains cells (Hexahedral cells) having quadrilateral faces at the boundaries. Care is taken to use structured cells (Hexahedral) as much as possible, for this reason the geometry is divided into several parts for using automatic methods available in the ANSYS 18.2 meshing client. It is meant to reduce numerical diffusion as much as possible by structuring the mesh in a well manner, particularly near the wall region.

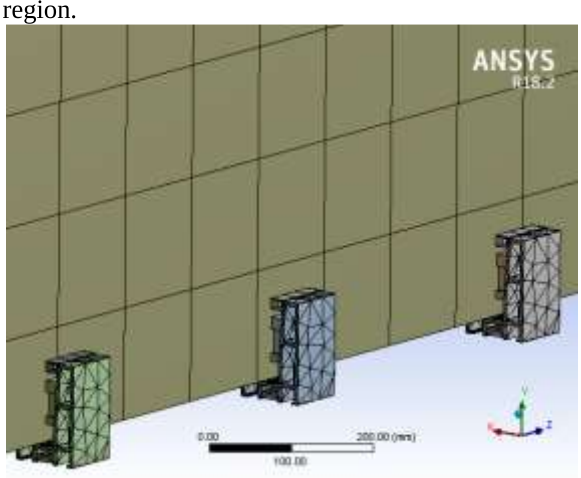

Fig. 9 Meshing diagram of Compact Rectangular Glass Railing System

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5.3 Boundary Condition of Compact Rectangular Glass Railing System

The force has been applied perpendicular to the glass panel of 3800 N. Since the base has been kept fixed and gravitational force is acting in negative Y direction.

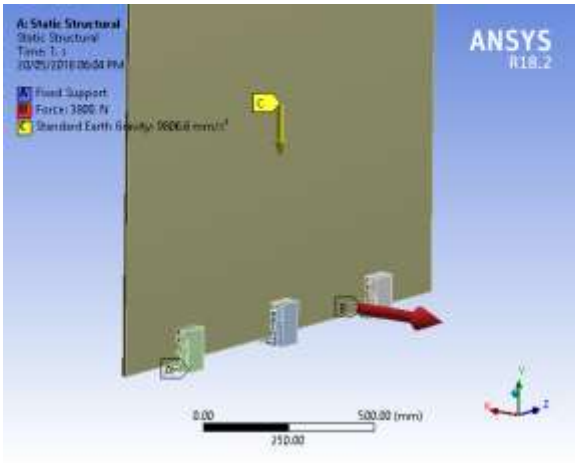

Fig. 10 Boundary Condition diagram of Compact Rectangular Glass Railing System

5.4 Analysis of Compact Rectangular Glass Railing System

After the analysis done which has been done on Ansys 18.2. The Maximum Stress which has been occur is 130.04 Mpa.

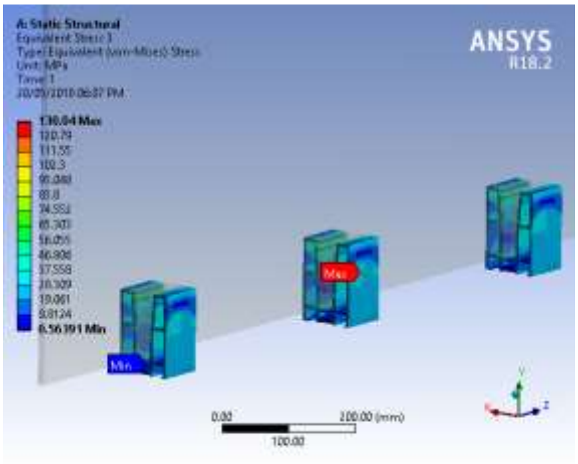

Fig. 11 Equivalent Stress diagram of Compact Rectangular Glass Railing System

6. Results and Discussion

As per result of analysis, came to know that the Stresses generated after the whole process is less than that of Ultimate tensile stress of the Material. So, there is no chance of failure of system.

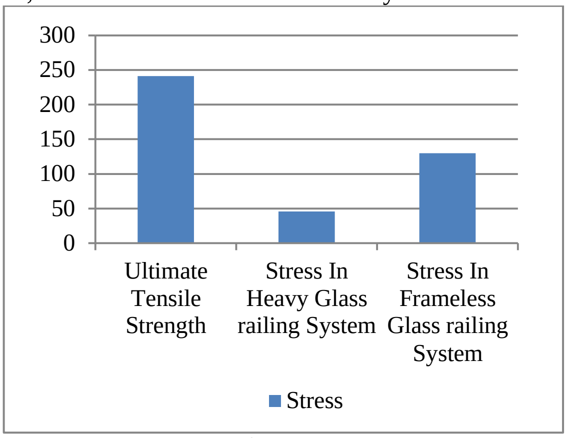

Fig. 12 Graph of Ultimate Tensile Stress

Mass of the existing heavy glass railing system is 3915 Grams and there is reduction of mass in new frameless glass railing system which has been noted as 784 Grams so there is mass reduction of 3131 Grams i.e. saving of 3.131 kg in every 1000 mm of the system.

7. Conclusion

In this case study, Aluminum 6063 - T6 has been used for manufacturing of glass railing system. From the above result, we came to know that there are some changes can be occurs after the application of new frameless glass system.
Following important conclusions can be drawn from the results of the case study:

1. There is increase in Maximum Stress of new frameless glass railing system as compare to Heavy glass railing system but the Stress value of New Glass Railing System is very low compare to Ultimate tensile strength of the material; hence, there is very low chances of failure of the system.
2. There is mass reduction of about 78% to 79% in new frameless glass railing system as compare to Heavy glass railing system. So, we can say that there has been material save. Due to which cost has been reduced for manufacturing and retail purpose.

Acknowledgments

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Reference

[1] Jason Poma, Justin Poma and Frank Poma, "Glass Railing Anchor System", U.S. Patent 8,820,721 B1, (2014).

[2] Alan C. Nash, "Partition Mounting System and Clamp Assembly for Mounting Partition", U.S. Patent 8,181,405 B2, (2012).

[3] Tracy C. Hansen, "Stanchion Base Shoe Support for Railings", U.S. Patent 7,866,636 B1, (2011).

[4] Mark Evans and Tracy C. Hansen, "Structural Glass Railing Base Shoe Corson Design", U.S. Patent 7,559,536 B1, (2009).

[5] Lucas Anthony Gregg and Tracy C. Hansen, "fascia-mounted aluminum railing system", U.S. Patent 7,497,057 B1, (2009).

[6] Tracy C. Hansen, "vertical panel glass wall", U.S. Patent 7,434,790 B1, (2008).

[7] John D. Shepherd, "Railing Assembly", U.S. Patent 7,036,799 B2, (2006).

[8] Tracy C. Hansen, "Suspended Glass Panel Railing System", U.S. Patent 6,964,410 B1, (2005).

[9] Wayne Austin, "Device for and method of, supporting a glass panel for forming a frameless glass panel fence", U.S. Patent 2005/0246981 A1, (2005).

[10] Paul Robert Zen and Sergio Luigi Zen, "Railing System", U.S. Patent 6,752,385 B2, (2004).

[11] John D. Shepherd, "Railing Assembly", U.S. Patent 6,517,056 B2, (2003).

[12] John D. Shepherd, "Railing Assembly", U.S. Patent 6,419,209 B1, (2002).

[13] Kenneth G. Budinski, Michael K. Budinski, Engineering Materials: Properties and Selection, 7th edition, Prentice Hall, New Jersey, pp. 643 - 648, (2002).

[14] Domenico Murdaca, "Railing Assembly", U.S. Patent 6,029,954, (2000).

[15] Jack S. Junell, "Modular Fiberglass Railing System", U.S. Patent 5,967,498, (1999).

[16] Tamara H. Dandrea, "Child's safety barrier for railing system", U.S. Patent 5,533,715, (1996).

[17] Neill E. Baker, "Aluminum railing Apparatus", U.S. Patent 5,200,240, (1993).

[18] William J. Hooper, "Ornamental Handrail System", U.S. Patent 4,920,717, (1990).

[19] Laurence B. Hansos, "Support Frame for Glass Panel", U.S. Patent 4,914,888, (1990).

[20] Jeffrey Hogg and Joseph T. Harwood, "Glass Panel Mounting Assembly", U.S. Patent 4,841,697, (1989).

[21] Roy W. Batcheller, "Panel Rail System", U.S. Patent 4,690,383, (1987).