Computer Aided Design and Finite Element Analysis of Rolling Shutter

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Abstract— In this paper the design and analysis of Large Rolling Shutter is being carried out. The Shutter has to be designed for Hyderabad city. The basic parameters for designing of Rolling Shutter are size of shutter, wind speed of area and position of fixing of shutter. The size of shutter depends upon the requirement of client and the wind speed also depends on the city in which the shutter is going to be installed. Here as shutter is to be installed in Hyderabad city, the wind speed of city is to be considered. The Wind speed in city is 150 Km/Hr. the Initial 2D design of shutter is made on the basis of design information and recommendations of the Company in AutoCAD. The 3D assembly model of same is created in Solid Works. Now the finite element analysis of the design is carried out for a wind load of 150 Km/Hr. In analysis it is found that the stress developed in the design are high than the limiting values. Hence, the shutter is redesigned and the analysis of modified design is performed. It is found out that in the modified design the stresses developed in the design are within limit.

Key words: Rolling Shutter, Wind Speed, 3D Assembly Model

I. INTRODUCTION

The shutter is formed by slats inter linked with each other. The shutter is open and close by raising and lowering of shutter curtain. The curtain travels in the channels provided on either side for opening and closing. The overhanging pipe is provided on which the curtain rolls while closing and opening of shutter. The pipe is supported with the brackets. Different types of shutter are installed depending upon the place, in shops the curtain is made up of slats and grills whereas in warehouses no grills are provided in shutter curtain. The mechanism used depends upon the size of shutter it can either pull push type for small size shutter and a drive mechanism is installed for a large size shutter.

Here we are going to design the shutter as per requirement and the design will be analyzed and an optimized solution will be obtained.

II. LITERATURE SURVEY -

A. Types of Shutter

The shutter is classified depending upon the size, position of installation. Here we will discuss the type based on position of installation of shutter. Soffit level is the clear height of opening of shutter. Figure 1 shows different types of shutter depending upon position of installation of shutter.[2]

IA - Inside and above soffit level.
IB - Inside and below soffit level.
OA - Outside and above soffit level.
OB - Outside and below soffit level.
JPB - Jamb protected and below soffit level.
JEB - Jamb embedded and below soffit level.

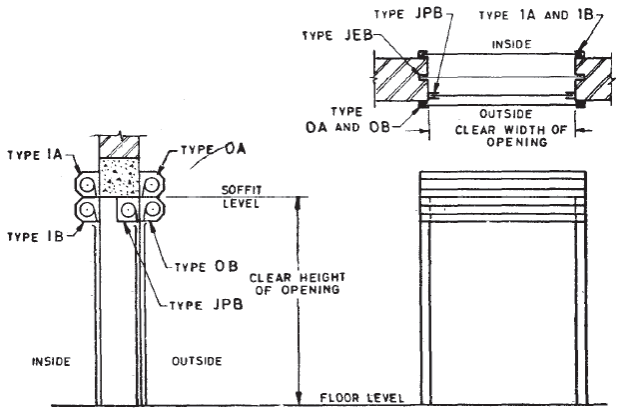

Fig. 1

B. Components of Shutter -

- Slat - Slat is the basic part of the curtain. The shutter curtain is formed by number of slats connected with each other.
- Pipe - The overhanging pipe is installed on which the curtain wounds and un-wounds for opening and closing.
- Guide Channels - Guide channels are provided on either side for travel of curtain while opening and closing of shutter .
- Shaft - The shaft is provide as the link between the pipe and the brackets.
- Other Parts - The cast iron casting are used for roller pulleys, cleats, gears, etc. [2]

C. Drive Mechanism -

The drive mechanism mainly depends upon the size of shutter. Smaller size roller shutter are simple pull push type whereas for large size roller shutter a drive mechanism is installed.

D. Loads -

The designing must be done by considering the loads such as wind load, gust loading etc. The structure is designed for with standing high wind pressure.

E. Analysis Parameters -

The shutter assembly is analysed on the basis of position of fixing of shutter.

III. DESIGN AND ANALYSIS OF SHUTTER

Based upon the constraints a design of shutter is prepared and analysed for a wind load of about 150 km/hr (about 50 KN load).[4]

Component	Material	Yield Stress
Slat, Channel	ASTM A366	207 Mpa
Pipe	ASTM A500	315 MPa
Shaft, Bracket	I.S. Grade 15	140 MPa

Table 1: Material [1][3]

A. Initial Design -

The CAD model of initial design is,

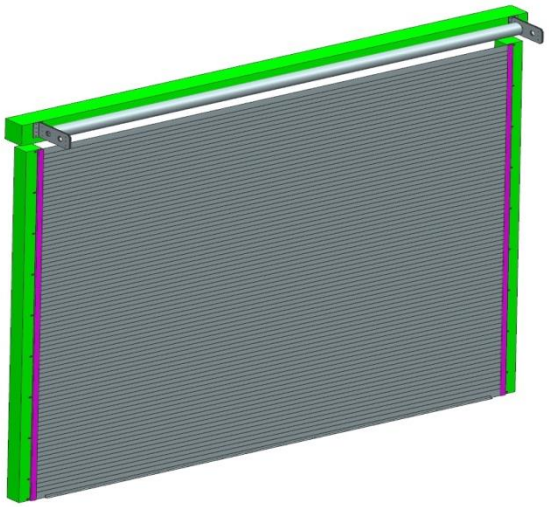

Fig. 2: CAD Model.

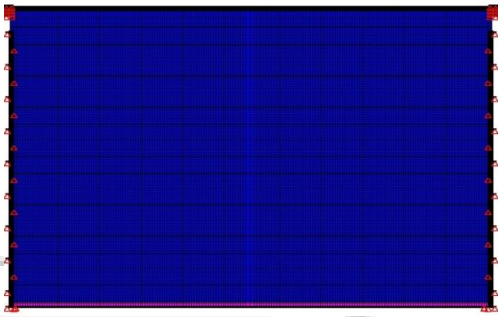

Fig. 3: Meshed Model

The above structure is analysed for a wind load of about 150 km/hr. The results for different parts are as follows,

Channel

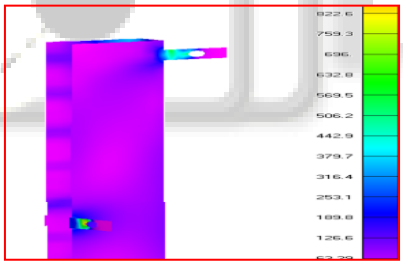

Fig. 4: Analysis of Channel

Failing at cleats stress = 500MPa

Slat

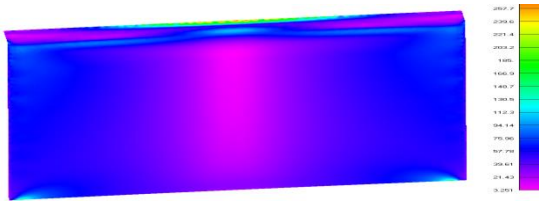

Fig. 5: Analysis of Slat

Induced Stress less than 207 MPa (Safe)

Shaft

Fig. 6: Analysis of Shaft

Induced Stress = 100 MPa (Safe)

Pipe

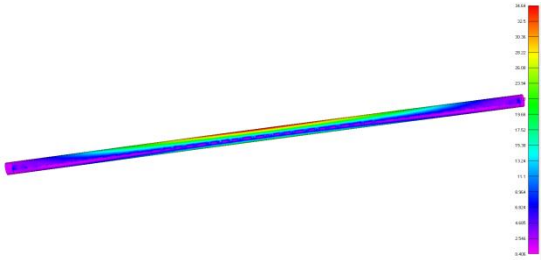

Fig. 7: Analysis of Pipe

Induced Stress = 25 MPa (Safe)

Bracket

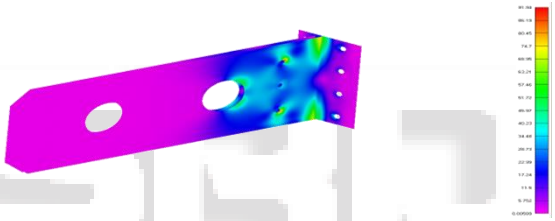

Fig. 8: Analysis of Bracket

Induced Stress = 75 MPa (Safe)

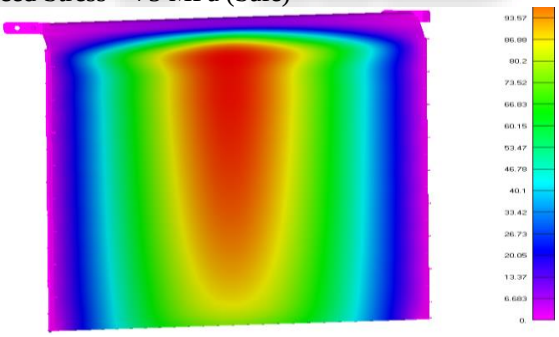

Fig. 9: Analysis of Assembly (Failing at Cleats)

Above Analysis result shows that the cleats are failing as the stresses developed in cleats is very high, stress developed in rest of the parts are within design stress limits. Here boundary conditions were provided on the basis of IA type of shutter.

Hence the shutter has to be re-designed.

B. Modified Design -

Now the new boundary conditions are provided on the basis OA type of shutter and solution is obtained.

Analysis results of Modified design are as follows-

Channel

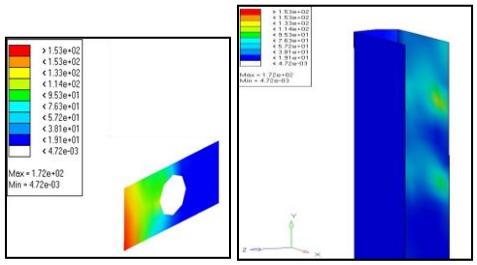

Fig. 10: Analysis of Channel

Induced Stress = 170 MPa (Safe)

Shutter Curtain

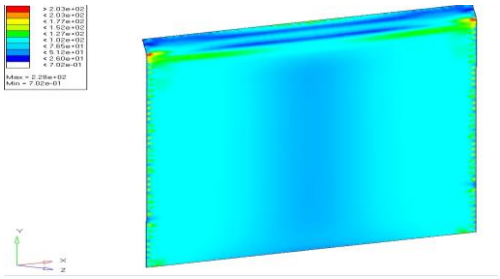

Fig. 11: Analysis of Slat

Induced Stress less than 207 MPa (Safe)

Shaft

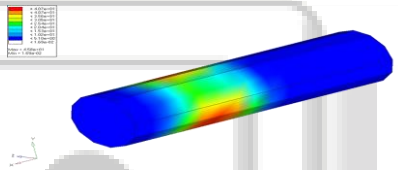

Fig. 12: Analysis of Shaft

Induced Stress = 50 MPa (Safe)

Pipe

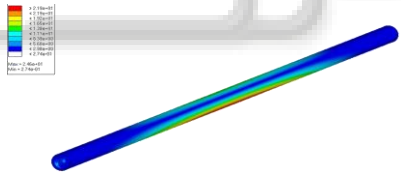

Fig. 13: Analysis of Pipe

Induced Stress = 25 MPa (Safe)

Bracket

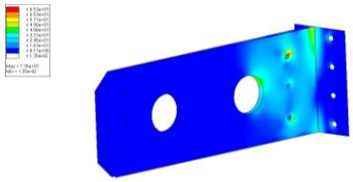

Fig. 14: Analysis of Bracket

Induced Stress = 75 MPa (Safe)

IV. CONCLUSION

Component	Yield Stress	Initial Design Stress	Modified Design Stress
Channel	207 MPa	500 MPa	170 MPa
Shutter Curtain	207 MPa	Less than 207 MPa	Less than 207 MPa
Shaft	140 MPa	100 MPa	50 MPa
Pipe	315 Mpa	25 MPa	25 MPa
Bracket	140 MPa	75 MPa	75 MPa

From above results we conclude that the shutter assembly must be installed on the outer surface of the column so that the load will be transferred from the channel to column directly. So that the stresses in all the components of assembly will be within limit.

REFERENCES

(1) B. D. Shiwalkar 'Design Data For Machine Elements'; Page 1,2,35,125,150; 2010.
(2) Shri T. S. Narayana Rao; "Specification for metal rolling shutters and rolling grills"; IS : 6248 - 1979; 1997.
(3) J.R. Davis, Davis & Associates ;'ASM Specialty Handbook - Carbon and Alloy Steels'; J.R. Davis, Davis & Associates, ASM International, Metals Park, OH, (1996).
(4) Dr. Prem Krishna, 'Wind Loads on Buildings and Structures', IITK-GSDMA.

