International Journal of Engineering Research
Volume No.6, Issue No.6, pp : 317-318
ISSN:2319-6890 (online),2347-5013(print)
1 June 2017

Finite Element Analysis on Electrostatic Precipitator Steel Structures

Luyu Huang, Yang Gao
High Professional Institute, University of Since and Technology Liaoning, Anshan 114051, Chin
agy5520444@163.com,b244454379@qq.com

Abstract. The paper established a finite element model including a main structure component of a type electrostatic precipitator by using the finite element analysis software ANSYS, Calculated the structure stress and displacement of the electrostatic precipitator on a variety of loads effect, after the main steel structures of the model was built according to the frontal solution method. The modeling and the computational Method has been proved the reasonableness of precision, and can be further used for structure analysis and so it has reference value of other electrical precipitator steel structures.

Keywords: Electrostatic precipitator；Finite element；Mathematical model； Stress.

Introduction

The society concerns about environmental protection issues. Electrostatic precipitator has extensive market prospect with wide utilization in metallurgy, cement, power plant boiler, chemical industry, light industry and other industries, for the advantages of high temperature dust removal, high efficiency of dust collection, and low energy consumption. But because our country's study on large electrostatic precipitator's steel structure started relatively late on optimization design with precise calculation of less attention, some enterprises proceeded simple analogy design to similar foreign product blindly with too much attention to experience. For the reason that the adaptation with too conservative design in order to ensure structure strength, stiffness and stability requirements, the structure of design cost too much materials which influenced the economy and ornamental value of the structure [1].Therefore, the reasonable design of the steel structure of the electrostatic precipitator in order to save materials, reduce costs and improve the market competitiveness of enterprises [2].

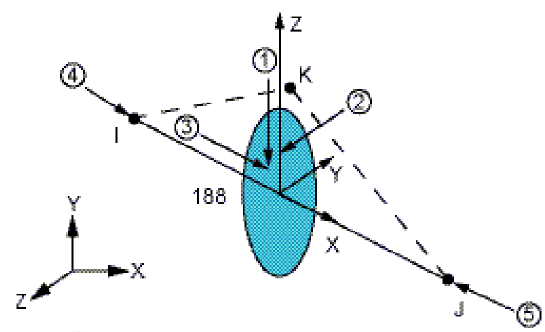
Establishment of the Model of Electrostatic Precipitator Main Steel Structure

The structure of the electrostatic precipitator is generally composed of several parts of the steel frames, siding, dust bucket and accessories. Steel frames include bottom beams, roof beams, columns and support. According to the structural characteristics of the electrostatic precipitator of a particular model, we use ANSYS finite element analysis software to build mathematical model for simplified main steel structure of the electrostatic precipitators.

To thinking of the actual situation, the overall structure of the dust collector is large steel structure. When building model, the combination of BEAM188 and SHELL63 board - beam is established. 3-node quadratic linear unit BEAM188 of the choice of unit type were selected to simulate the beam element, each node has six degrees of freedom to define the actual size of the various beam cross-sections[3], as shown in figure 1.Selecting the SHELL63 unit to simulate the steel plate. SHELL63 unit has 4 nodes (I, J, K, L), each node has six degrees of freedom[4], as shown in figure 2. The mathematical model shown in Fig 3.

This model electrostatic precipitator bears the load: working pressure 20Kpa, snow load 0.5Kpa, wind load 0.6Kpa, fouling load of cold top 4Kpa, hot top fouling load 2Kpa,transformer load 19.6Kpa, anode plate weight 179264Kg ,cathode board weight 64689Kg.The steel structure is the Q235. The Young's modulus of the material is 2.1 × 1011 Pa, density 7850 kg/m3, Poisson's ratio is 0.3.

According to the drawing's design requirements and model's actual situation, the four corners of the end of the beam spot are bound in Z translational and rotational degrees of freedom, releasing X and Y translational and rotational degrees of freedom. All nodes in bottom side of the beam are connected by columns and steel frames in practical work, so the nodes' degrees of freedom should be constrained.



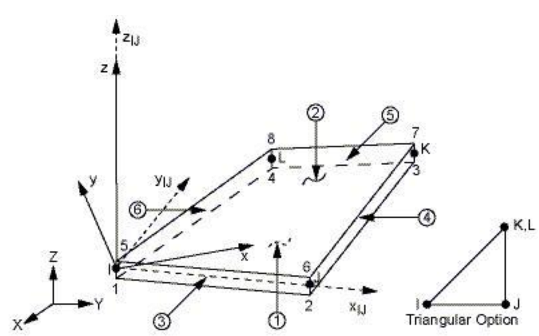


Fig.1 BEAMl88 Fig.2 SHELL63

International Journal of Engineering Research
Volume No.6, Issue No.6, pp : 317-318

ISSN:2319-6890 (online),2347-5013(print)
1 June 2017

The entire model totally has of 6788 nodes, 18,715 units; 7128 faces and 13967 line-bear-load.10 nodes are constrained all degrees of freedom.15 nodes are constrained local degrees of freedom.

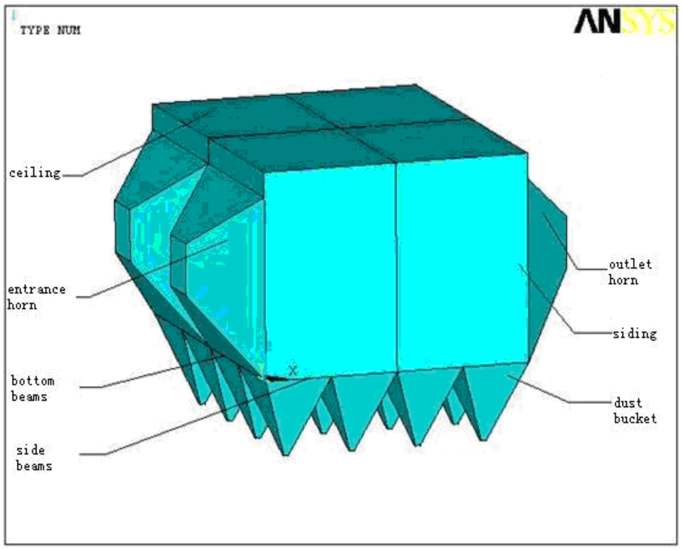


Fig.3 Mathematic Model of Electrical Dust Precipitator

Results

The process of analysis and calculation can be solved by wave front served by ANSYS. Checking the consequence can use the ANSYS program's universal post processor. The stress and displacement of the entire structure of the solution results for more information see Table 1and Fig 4.

Table1 The precipitator's main steel maximum stress is 130MPa. The maximum displacement is 28.3mm.

Stress	X orientation	Y orientation	Z orientation	Equal Stress
maximum/MPa	45.1	106	60.2	130
displacement	X orientation	Y orientation	Z orientation	SUM
maximum/mm	8.9	22.3	10.8	28.3

Electrostatic precipitator main steel material is the Q235. The material yield strength σs is 185-235MPa.Therefore, the main steel structure of the type electrostatic precipitators in all directions" normal stress, equel stress is far less than Q235' yield strength σs. The maximum displacement is 28.3mm. Compared to a total length of 15.8m of the models, the ratio is only 0.17%, but also in stiffness within the range allowed. Due to the dust collector body structural support in a rigid stand on the ground, with a little rigid connection. This result is consistent with the actual situation and the load. Thus, the model electrostatic precipitator main steel work in a safe state.

The established model can be seen from Figure 4 Stress cloud is very reasonable. The stress distribution is also law only a small range of stress concentration at the bottom of the hopper, but quickly decays out. The model structure is very stable. The maximum equivalent stress (at the bottom of the ash hopper) of the steel structure electrostatic precipitators is only 130MPa, and other parts of the stress value is only a dozen MPa to tens of MPa which far less than the limit yield strength of Q235. So we can judge the safety performance of the model of the main steel structure of the electrostatic precipitator is too high, a conservative design, resulting in great waste of steel. Therefore, most of the components of this steel have much room for optimization.

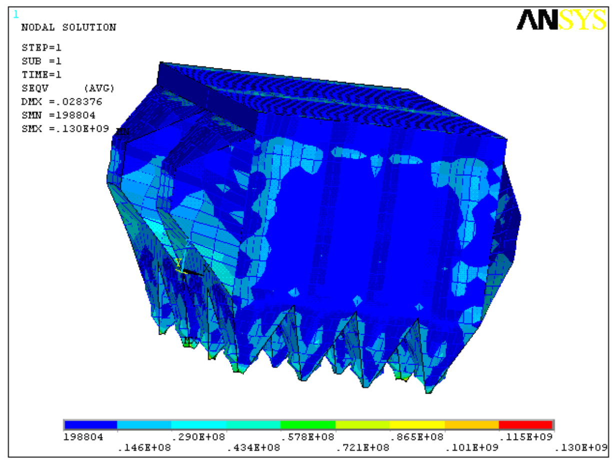


Fig.4 Stress Result Photograph of Nodes

References

i. *Wang Xianlong. The New Application of Electrostatic and the Development Trend. Industrial Safety and Environmental Protection (2003), Vol.29, pp.3-6.*

ii. *Suriyawong, A.; Hogan, C.J.; Jiang, J.K. et al. Charged Fraction and Electrostatic Collection of Ultrafine and Submicrometer Particles Formed during O_2-CO_2 Coal Combustion; Fuel Vol. 87 (2008), p. 673.*

iii. *Chen Jingyi. ANSYS Engineering Analysis Instance tutorial. China Railway Press (2007)*

iv. *Zhang Chaohui, Li Shukui. Finite Element Analysis Theory and Engineering Application of ANSYS 11.0. Electronic Industry Press (2008)*