STRAIN DISTRIBUTION ON DOZER BLADE CUTTING EDGE OF DIFFERENT GRADES OF ADI USING ASNYS 15.0

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ABSTRACT

In this research work, the calculation of strain in the dozer blade cutting edge of different grades of ADI is done with FEA approach. A 3D model of dozer blade cutting edge is prepared in CATIA V5 with standard dimensions and then it is imported in ANSYS 15.0.The eight-node three-dimensional brick type elements are used during analysis. The properties of different grades of ADI are as per American Society of Testing and Materials ASTM A897M-90 standards. The meshing of dozer blade cutting edge model is done and for the strain the digging forces being applied at the tip of the cutting edge. The calculations of the strain on different grades of ADI are based on the maximum distortion energy theory (MDET).After calculating the strain for the different ADI grades a best suitable grade is suggested for this particular application.

Keywords – ***Dozer Blade, Finite Element Analysis, Austempered Ductile Iron, American Society Of Testing And Materials, Maximum Distortion Energy Theory.***

I. INTRODUCTION

Finite element analysis (FEA) is a very important tool to check the behavior of component after practical application of stress on it. Cutting edges are main working parts on dozer blade. These are the most crucial components on any dozer. They have to sustain with the different kinds of stresses being applied continuously at them during operation. Therefore, cutting edges must be designed accurately and efficiently to avoid the deformation and unwanted halts in the operations.

Moreover, the selection of dozer blade cutting edge material is a very crucial step. Austempered ductile iron (ADI) is well suited for this particular application because of its unmatched properties. ADI has a unique microstructure called ausferrite. This ausferrite microstructure sets ADI apart from as-cast ductile iron, quenched & tempered or surface hardened ductile iron. Excellent property combinations of strength, ductility, and toughness are produced from ausferrite.

The ranges of properties available for ADI are dependent on the choice of heat treatment parameters. In 1990 ASTM established five standard grades of ADI (ASTM 897-90 and 897M-90) which are listed in Table 1.

When normal stresses are applied to an ADI part (dozer blade cutting edge in this case) in service, a localized strain which hardens the material can occur. As a result, ADI exhibits excellent abrasion resistance. This property holds a great importance in digging operation.

Table 1: ASTM A897M-90 Property table for ADI

Grade	Tensile Strength (MPa)	Yield Strength (MPa)	Elongation (%)	Impact Energy (J)	Typical Hardness (HBW)
1	850	550	10	100	269-321
2	1050	700	7	80	302-363
3	1200	850	4	60	341-444
4	1400	1100	1	35	366-477
5	1600	1300	N/A	N/A	444-555

II. METHODOLOGY

In the present work, finite element analysis (FEA) of dozer blade cutting edge is done. A strain at the dozer blade cutting edge tip is found out using maximum distortion energy theory.

The dozer blade cutting edge 3D model is prepared in CATIA V5 and the analysis part is carried out in ANSYS 15.0. The force is applied at tip of dozer blade cutting edge and the magnitude strain is noted down. The strain values are different to the different grades of ADI. The minimum value of strain is checked out among different grades of ADI and therefore, a best suited grade is suggested for this particular application.

Grade	Young's Modulus (GPa)	Poisson's ratio (ν)	Density (Kg/m^3)
1	159.3	0.25	7096.5
2	157.9	0.25	7087.2
3	156.5	0.25	7077.9
4	155.1	0.25	7068.6
5	153.8	0.25	7059.3

Table 2 Values of Young's Modulus, Poisson's ratio and Density for different grades of ADI

III. FINITE ELEMENT MODEL

In this study, a three-dimensional elastic-plastic finite element model is used to simulate the strain in dozer blade cutting edge caused by maximum dozer digging force and simulations are performed using ANSYS 15.0.

The region of interest is the area near the holes where the holes geometry changes sharply and therefore, the maximum strain is observed. We are interested in 'structural analyses' and 'solid' is selected as element type. The dozer blade cutting edge 3D model with standard dimensions on CATIA V5 as shown in Figure 1 and corresponding finite element model after import is shown in Figure 2.

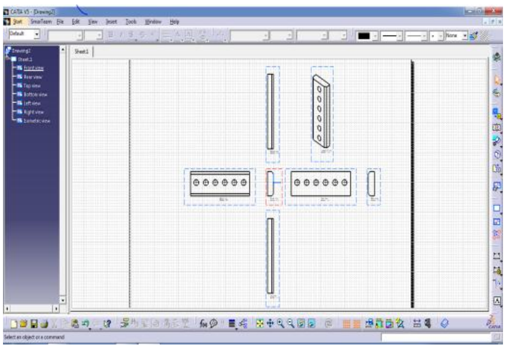

Fig.1.Dozer blade cutting edge model on CATIA V5

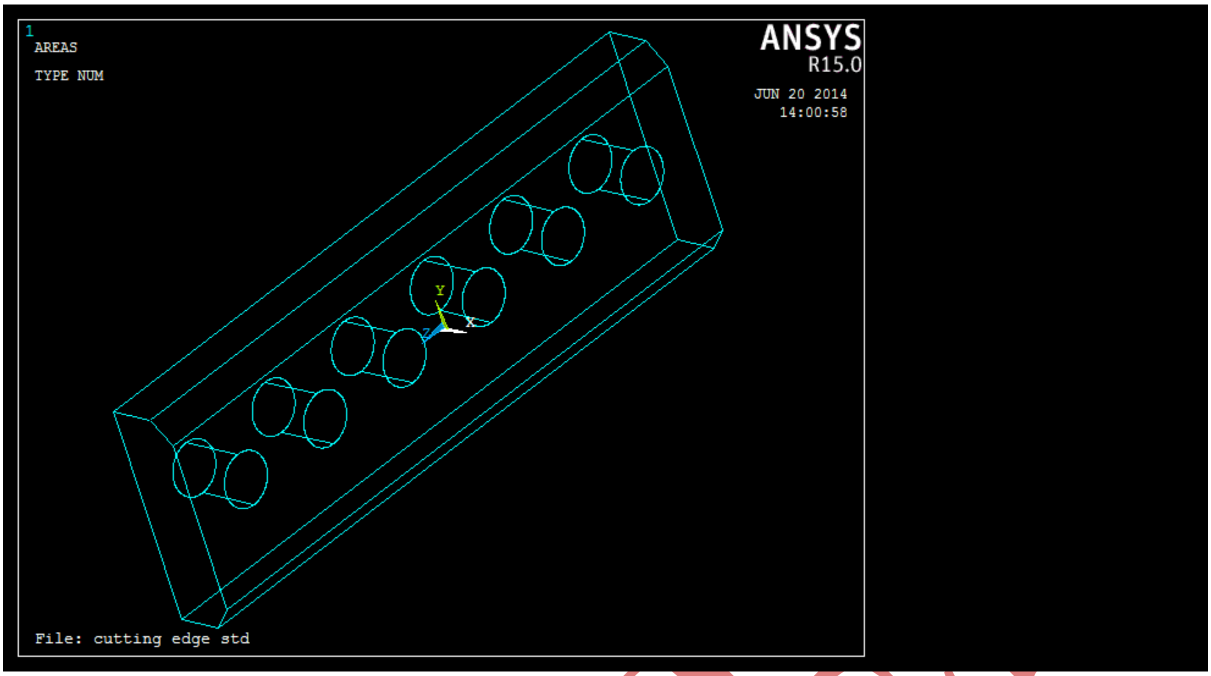

Fig. 2 Dozer blade cutting edge model after import on ANSYS 15.0

After meshing the cutting edge model as shown in Figure 3 meshing is done by using eight-node three-dimensional brick elements. To explore the effect of digging forces on the cutting edge geometry, a pressure of -241 bar is applied at tip of the dozer blade cutting edge.

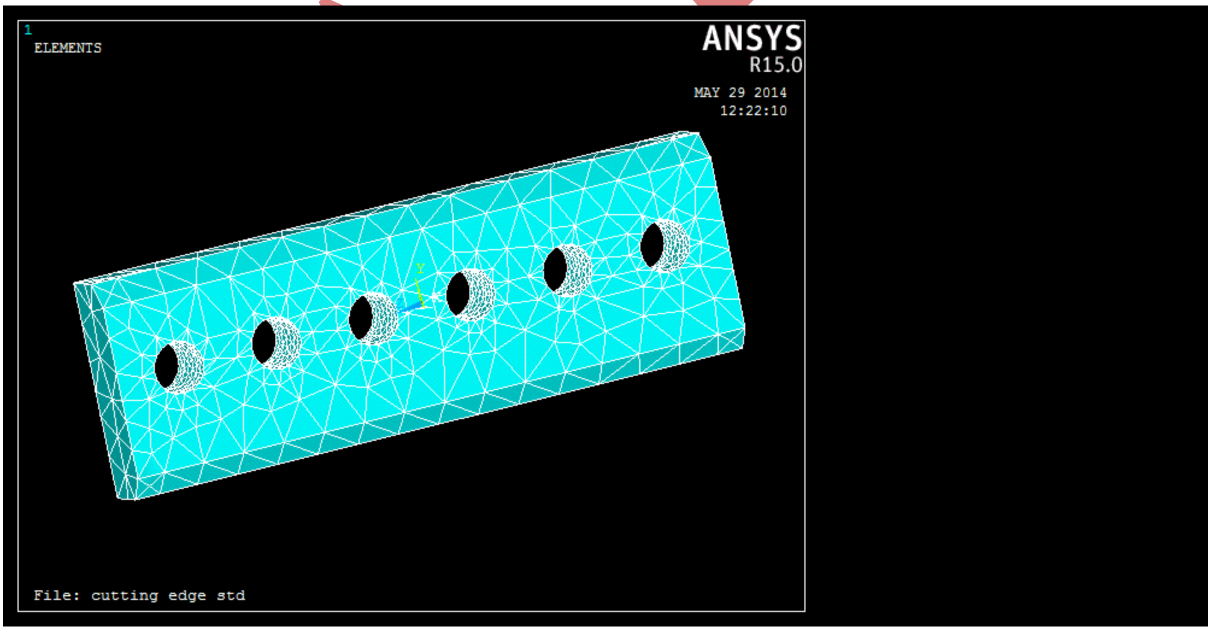

Fig. 3 Dozer blade cutting edge model after meshing

IV. RESULTS AND DISCUSSIONS

In the results, a static elastic-plastic finite element model is employed to study the distribution of strain due to digging stresses in the cutting edge geometry. Figures 4-5-6-7-8 shows the strain developed on different grades of ADI and also represents major and minor strain induced areas. The strain intensity increases from blue to red as in the color strip in the pictures. The regions showing with red color are major strain induced areas and blue colored regions are minors strain induced regions.

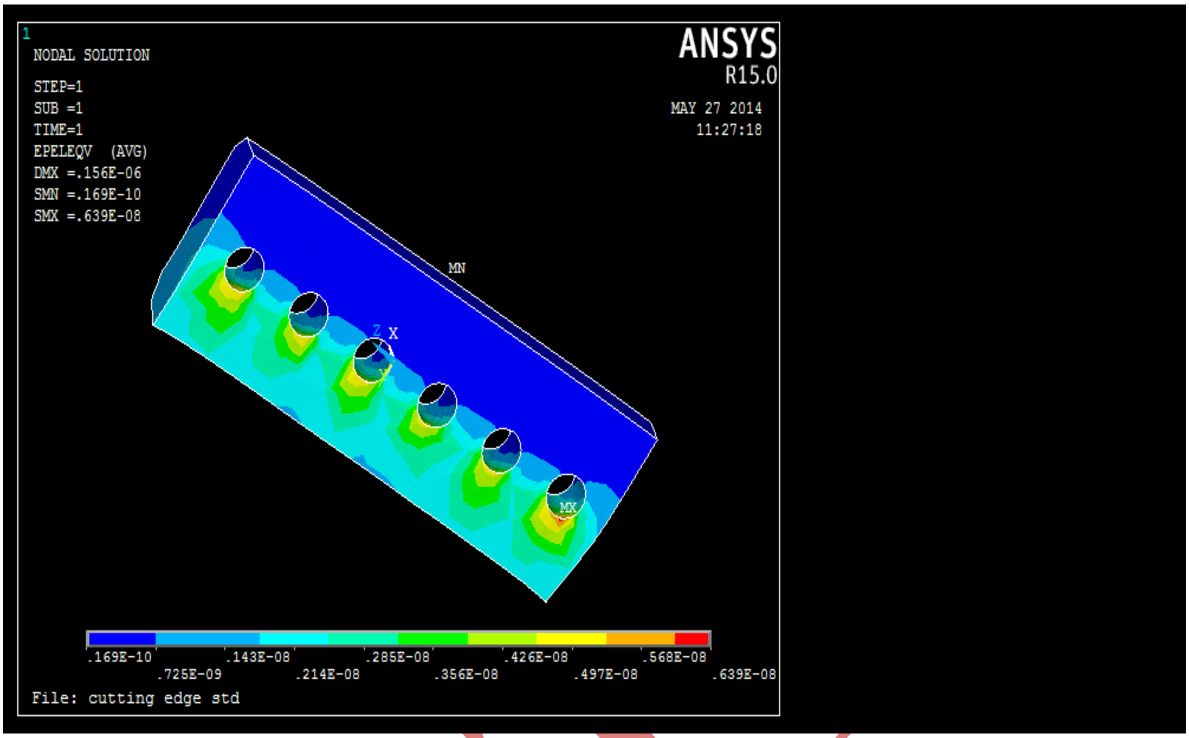

Fig.4 Strain developed on ADI grade I

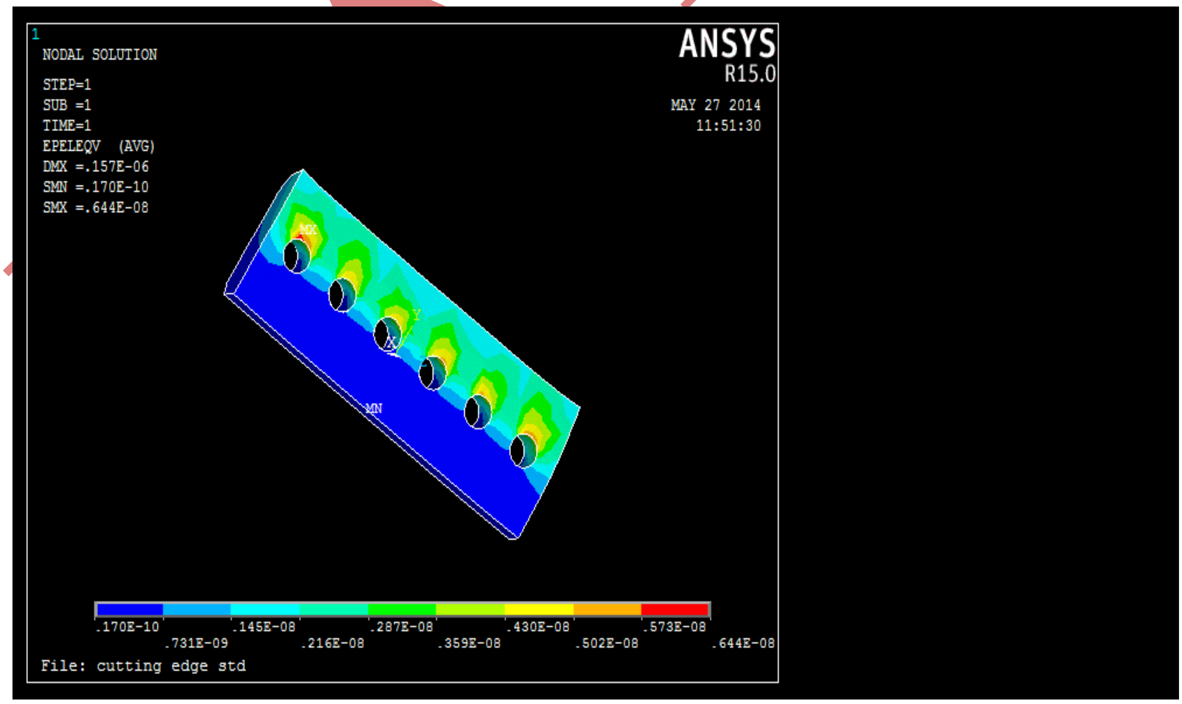

Fig.5 Strain developed on ADI grade II

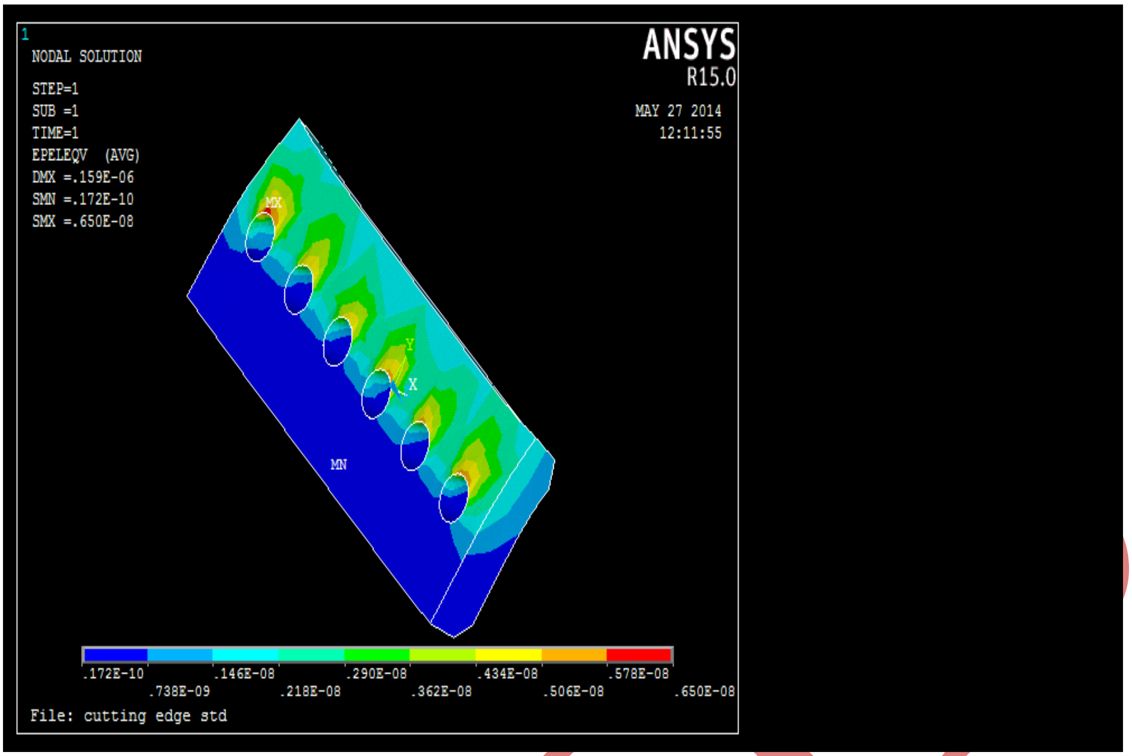

Fig.6 Strain developed on ADI grade III

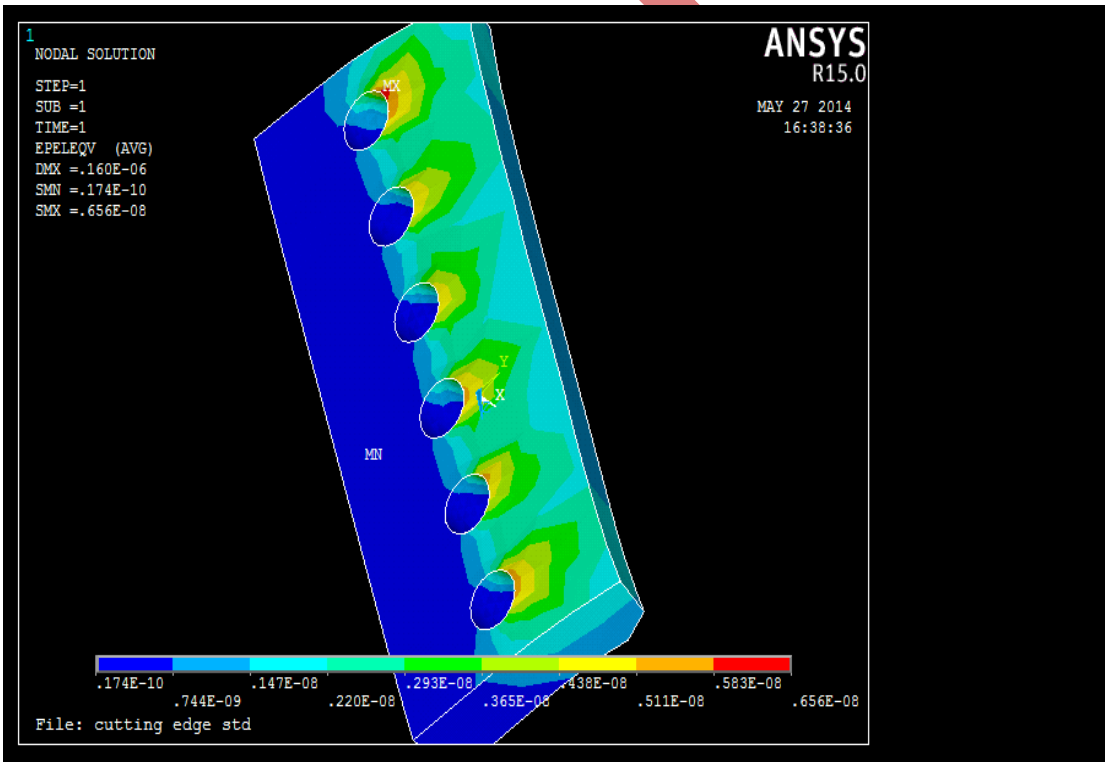

Fig.7 Strain developed on ADI grade IV

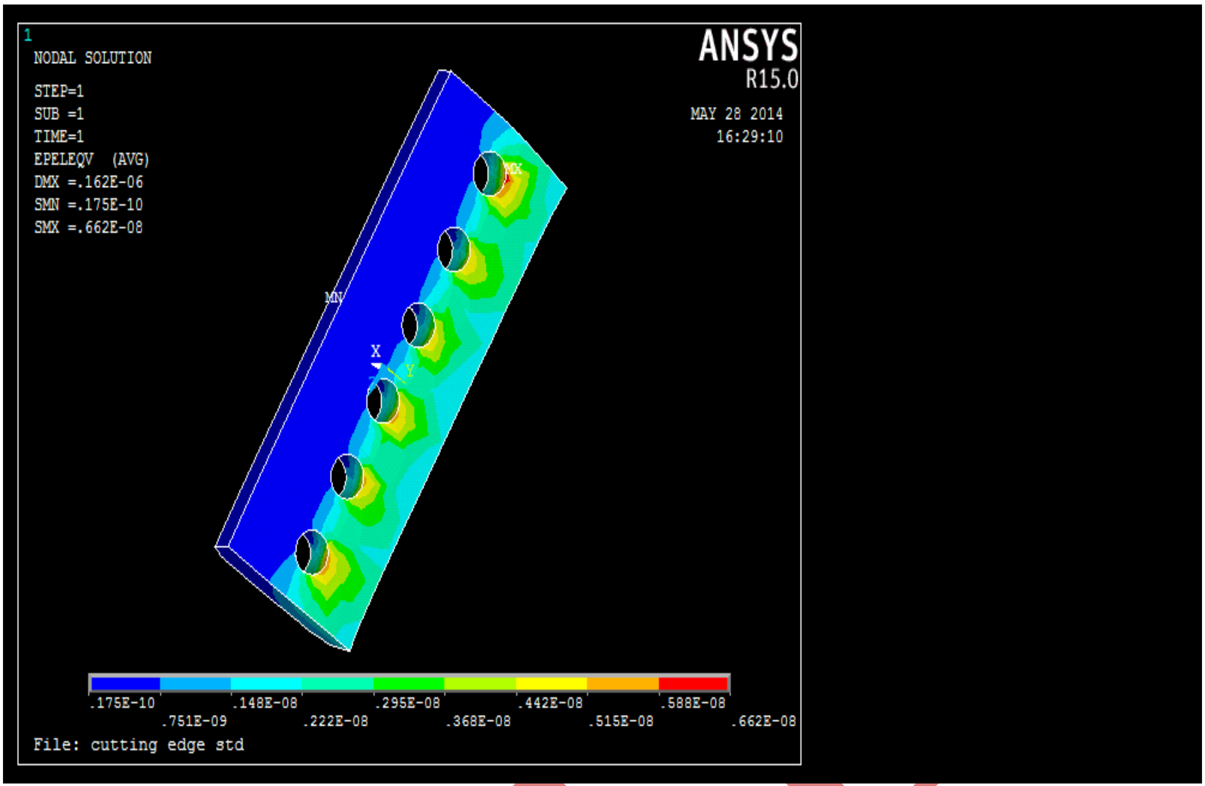

Fig.8 Strain developed on ADI grade V

V. CONCLUSION AND FUTURE SCOPE

Following conclusions and future recommendations are made from the present research work.

- The grade V of ADI is best suitable as a cutting gdge material for this particular and typical application of dozer blade cutting edge.
- Material selections for the solid bodies greatly influence the mechanical behavior of the parts under loading conditions.
- Research based on both industry and university could eliminate the lack of data in the analysis and help to obtain more realistic simulation results.
- Fracture and fatigue analysis on the components could be beneficial to investigate the working life of the dozer blade cutting edge. Therefore, more sensitive performance calculations could be made.
- Virtual reality studies for the dozer operator could be useful for the future work.
- Research on materials other than ADI with different mechanical properties may be used for analysis.

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