NEW WAVE OF CAD SYSTEMS AND ITS APPLICATION IN DESIGN

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ABSTRACT

    This paper provides some lighting needed for the implementation of the new wave of CAD systems with emphasis on a general application as well as advanced. It is known that a computational approach is used in both design and education so step-by-step examples are introduced. Although the CAD systems are available but it needs a sound knowledge of many subjects such that: strength of materials and machine design. This work depends on the torsion theory but the input geometry was done inside the SolidWorks environment. The proper use of the CAD tool needs to start from a published case and construct many models in order to reach the final one. The process was done by exporting the geometry to other sophisticated engineering tools: ANSYS The adequacy of the obtained results was obtained by comparing with the theoretical data. Complex cases in both geometry and materials properties like plasticity are presented. Combining these systems with the teaching subjects deepens the engineering knowledge in the design and education.

KEYWORDS: CAD Systems, SolidWorks, ANSYS, Design.

الموجه الجديدة لانظمه الكاد وتطبيقها في التصميم

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الخلاصه

يسلط هذا البحث الضوء على استخدام الموجة الجديدة من انظمة الكاد بامثلة عامة واخرى متقدمة.

كما هو معروف إن المقاربة العددية يمكن استخدامها في التصميم والتعليم لذا استخدمت امثلة متدرجة .

يرغم من توفر هذه الانظمة إلا إنها تستند على معرفة عميقة في مواضيع عدة مثل مقاومة المواد وتـصميم المكائن . يعتمد هذا البحث على نظريه الالتواء لكن الابعاد تم انجازها في بينـة الـصولدوركس . يكـون الاستخدام الافضل للكاد بالانطلاق من نتائج منشورة تم تكوين نماذج عديدة حتى الوصـول إلـى النمـودج النهائي .

انجزت العملية بتصدير النمودج إلى نظام متطور جدا في التحليل وهو الانسيس .حسبت دقة النتائج بمقارنتها مع المعطيات النظرية . قدمت نماذج معقدة في الجيومتري واخرى في خواص المواد كاللدونة .دمـج هـذه الانظمة مع المواضيع التدريسية يعمق المعرفة الهندسية في التصميم والتعليم .

NOMENCLATURE

σ_{eq} : Equivalent stress (N/m^2)

σ_{xy} σ_{yz} σ_{zx} : Normal stresses on the axises (N/m^2)

τ_{xy} τ_{yz} τ_{zx}: Normal shear on the axises (N/m^2)

σ_1 σ_3 σ_2 : Principal stresses (N/m^2)

Ø : Shear strain (-)

θ: Angle of rotation (rad)

r: Radius of shaft (m)

L: Length of the shaft (m)

INTRODUCTION

The simplicity of the new CAD systems and its high advanced simulation in much practical application make these systems to be an engineering design tool. Although they depend on the finite element method (FEM) as background for solution they can be used with minimum knowledge of the method. The theory of the FEM stands behind the stage to enable the domination of the engineering sense.

The direct link between the CAD geometry and the finite element package meshing and analysis is a powerful step in design. The output graphic contours give a very good indication to modify or accept the design

Liking the geometry from CAD system According to (solid work2007) with the high –level of the work like (**Ansys ll 2009**)is the key for many engineering analysis

STRESS CRITERIA

The criteria of failure of the design like maximum acceptable deformation, minimum natural frequency and maximum stress level are our indications in designing a component. The stress criteria are the essential player. Since the yield stress taken from stress-strain curve can be compared directly to the equivalent stress taken from the stress criteria, a safety factor of the whole component immediately appears.

Many useful books likes them of (**George E.Dieter, 1988**) linked the materials properties

The best stress criterion in the metal design is the Von –Mises. It can be calculated from the state of stresses at any point as:

$$\sigma_{eq} = \sqrt{0.5 * [(\sigma_x - \sigma_y)^2 + (\sigma_y - \sigma_z)^2 + (\sigma_z - \sigma_x)^2] + 3 * (\tau_{xy}^2 + \tau_{yz}^2 + \tau_{zx}^2)} \qquad (1)$$

Or from the principal stresses as:

$$\sigma_{eq} = \sqrt{0.5 * [(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2]} \qquad (2)$$

Assuming the material behaves with direct relation between the stress and the strain as in the **Figure(1)**, the only material parameters we need to input are the modulus of elasticity and the Poisson's ratio.

3-D TORSION

When a beam or shaft subjected to twisting moment (torque), the torsion is the stresses of that load. The main features of the torsion problem are the shear stresses, the angle of rotation and the angle of twist.

So, the 3-d stress analysis is the general procedure to find out the real response of the beam. There are many direct stress formula to calculate the torsion but for uniform cross-section. The use of

torsion machine test monitors the angle of twist and other parameters but it is limited as it is a lab work.

A practical examples of torsion are demonstrated here as a 3-d stress analysis.

The book by (**Paul M. Kurowisky 2005**) given many useful examples but it needs more advance approach for engineering problems

TORSION OF BEAM BOX

Four beams each of square cross section of 150 inches in length constructing a beam box of 1500 inches and a thickness of 3 inches. The torque applied is 300 lb.inches.

Figure(2) shows the geometry of the beam box.

A good study of torsional behavior of rectangular hollow section by (**Daniel J Ridley-Ellis, John S Owen & Gwynne Davies, 2002**)

The mesh of the box beam is shown in **figure (3)**

The shear stresses are shown in **figure (4)**

Figure (5) shows the total deformations of the model

The angle of rotation is given by

$$\theta = \sin^{-1}(2s/r) \tag{3}$$

The relation between angle of twist and angle of rotation is taken from the strength of material subject

$$\phi = r\phi/l \tag{4}$$

R.S. Khurmi,2010).

Where s is the total deformation, r and L as shown in the **figure (6)**

BAR OF TRIANGULAR CROSS-SECTION

The sketch of 300mm cantilever bar cross-section is shown in **figure (7)**

The mesh of the this bar is shown in **figure(8)**

The steel bar was subjected to a torque of 2MN.mm

The equivalent stresses are shown in **figure (9)**

ELASTOPLASTIC ANALYSIS

In elastoplastic analysis, we have to introduce the stress-strain curve, This analysis is an advanced tool which need a special treatment books of (**Timoshenko, 1983**) deals with the case of exceeding the elastic limit

The bilinear isotropic hardening type of plasticity was considered to cantilever bar as shown in **figure** (10).

The plastic strain are shown in **figure** (11)

DISCUSSION OF RESULS

The stress analysis tool used is claimed to be aimed to students and designers. It is supposed to help during the modeling work and not to be used as a final calculations tool. This work shows that this is the case. The main advantage in this software is that it is very easy to use. The modeling is very fast, although the solving time can be very long, especially when using result convergence. To get the exact values of the stresses it is shown that one need to use the result out of analytic case with as in the case of the torsion of the box beam.

Changing the cross-section area of the beam to another shape is a straight forwards task as in the torsion of triangular cross-section beam.

During the early modeling work it is therefore always necessary to use a simple start. When students use the analysis tool to get a hint if the model works, the exact published values are so

interesting to get out of modeling. It is shown here that the software gives very good results when it comes to non-linear analysis. The problem of plasticity could be analyzed by introducing the real stress-strain curve or even by using an approximate curve as the bilinear isotropic curve used with the cantilever bar. There is one remark with this software. One cannot control the real mesh size, only the relative size. It is a good custom to start with the default mesh of the software then refining the mesh and checking the results until convergence specially with complicated shape models.

CONCLUSION

The method presented in this paper makes it possible to compute the torsion parameters without of any control of elements or nodes. Importing of complex geometry from the CAD package can be performed immediately. It has lots of automation for applying complex, realistic load and boundary conditions easily.
. There is no limit of the applications of these CAD systems in design. The practical importance of the procedure lies in the simplicity and integrity

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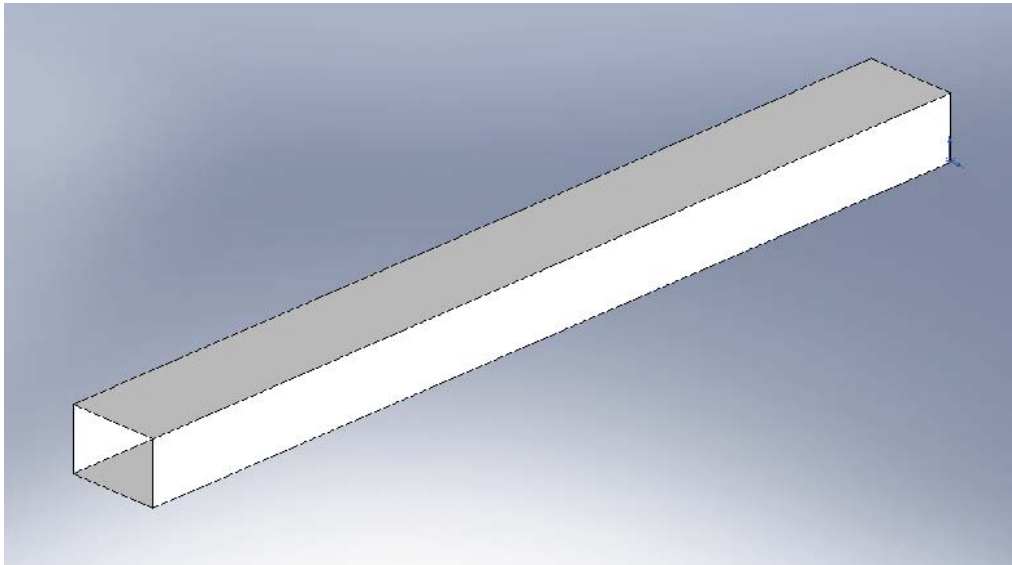
Fig. (1) elastic and elastoplastic stress-strain curve
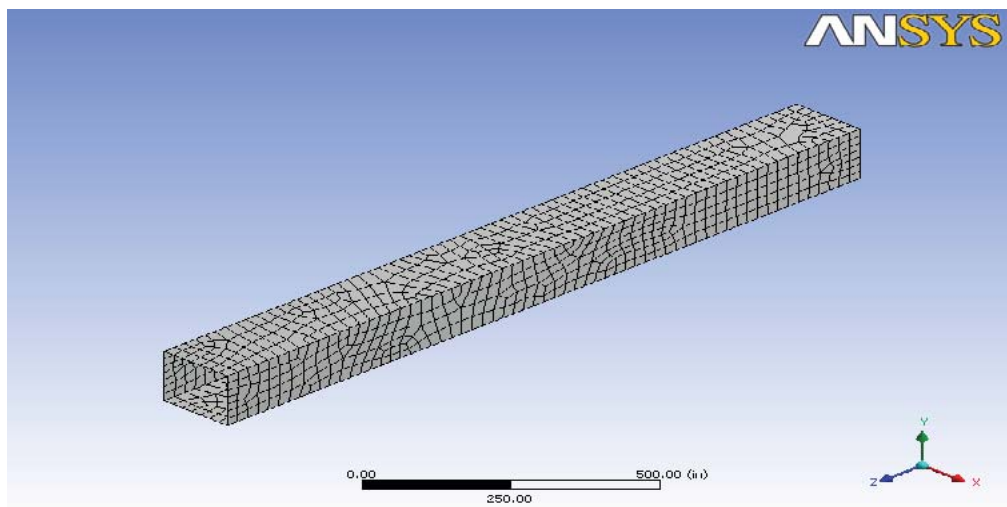
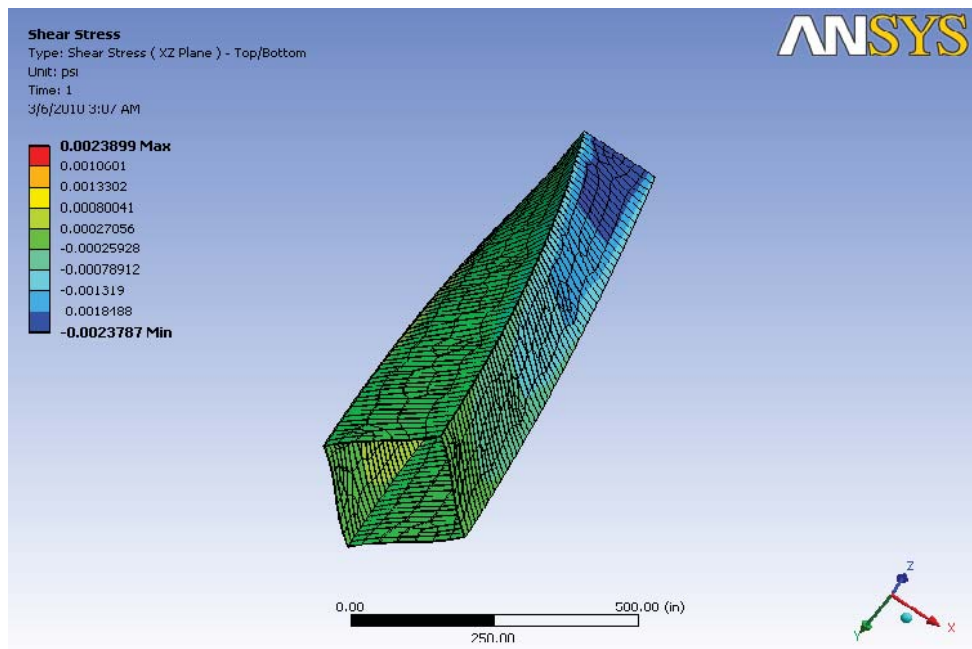**Figure** (**2**) The beam box

Fig. (3) mesh of the beam box

Figure (4) The shear stresses in the x-z plane
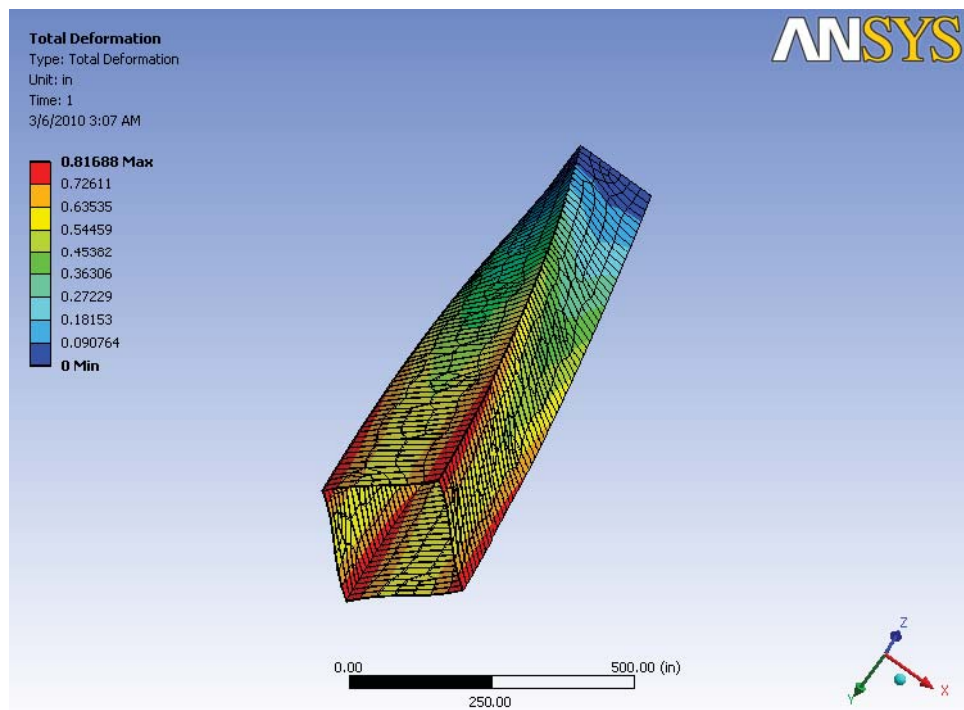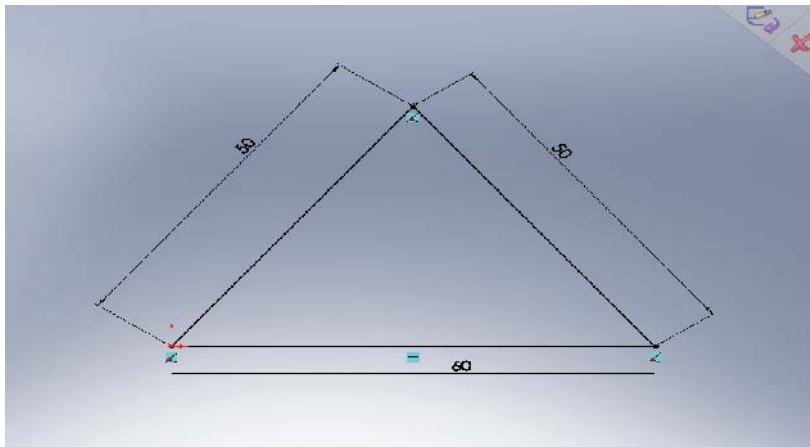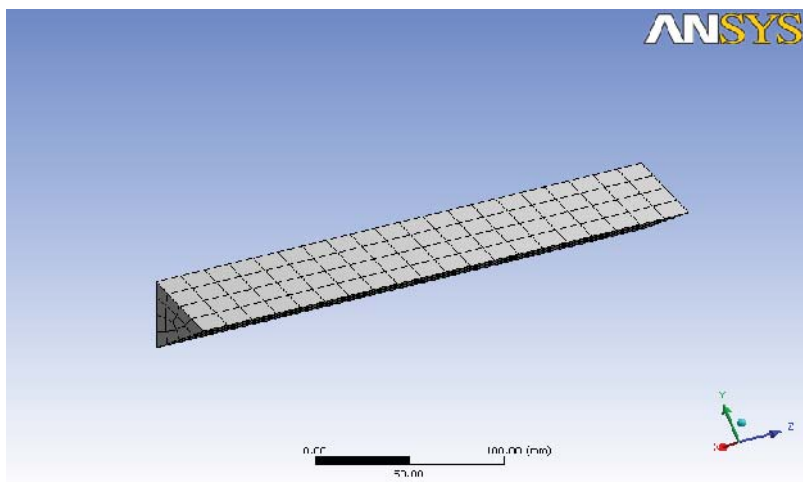

Fig. (5) the total deformation of the beam box

Fig.(6) the geometric parameters of a shaft under torque

Fig. (7) cross-section of a the bar
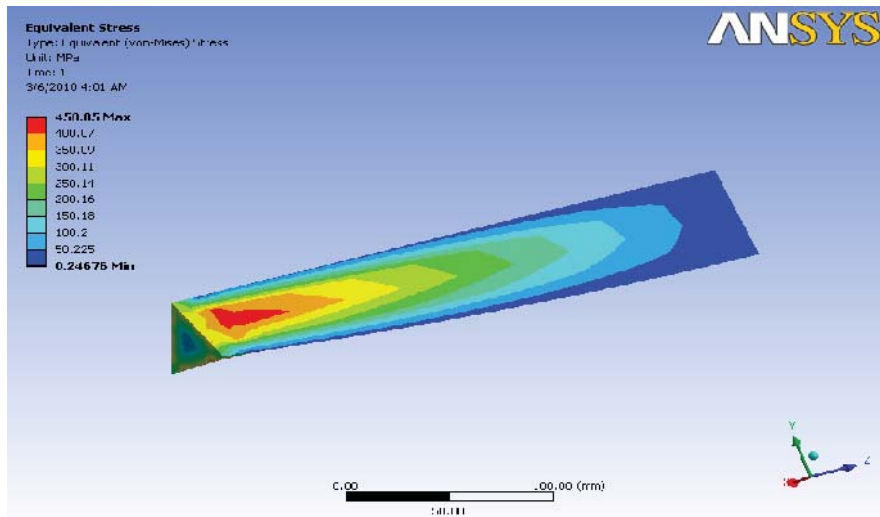

Fig. (8) mesh of the bar
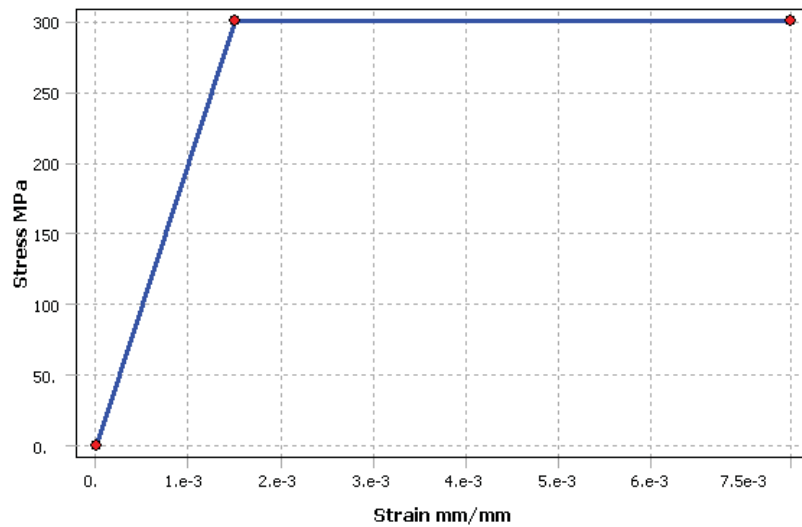
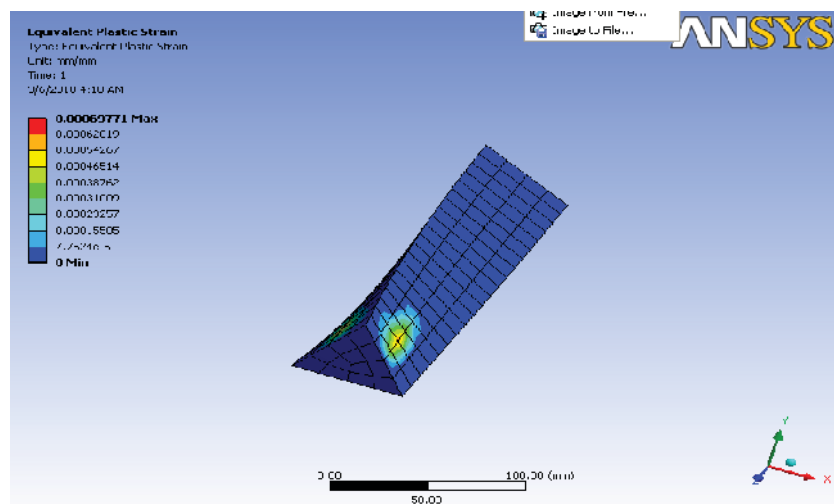**Fig.(9)** Von-Mises stresses along the bar

Fig. (10) the elastoplastic stress-strain curve

Fig. (11) the plastic stain of the bar