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Thin plate theory...

Thu, 2007-05-24 14:13 - ramdas chennamsetti

Hi all!

I have a small doubt in the assumptions made in thin plate theory.

We make some of the following assumptions in thin plate theory (Kirchoff's classical plate theory) (KCPT).

[1] The normal stress (out of plane=> sigma(z)) is zero. and

[2] The vertical deflection 'w' is not a function of 'z' => dw/dz = 0

Now there are three stress components sigma(x), sigma(y) and sigma(xy). The other three stress components sigma(z), sigma(xz) and sigma(yz). This is like a plane stress.

But, from the second assumption ez=0 (strain in z-direction) and from the above exz=0 and eyz=0.

Then, this leads to plane strain.

From the constitutive equation for 'ez' => sigma(x)+sigma(y)=0

But, this doesn't happen.....I am looking for explanations ...

Thanks in advance.

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the constitutive equation is not used
Permalink Submitted by Ying Li on Thu, 2007-05-24 14:17.

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In the Kirchoff's classical plate theory , such a constitutive equation is not considered. So, you needn't to use it.

Lee

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R. Chennamsetti, Scientist,

Permalink Submitted by **ramdas chennamsetti** on Thu, 2007-05-24 14:39.

R. Chennamsetti, Scientist, India

Hi Lee,

Thank you. But, constituvie equatations are to be satisfied. In this case they relate the stresses and strains.

- R Chennamsetti

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Kirchhoff's assumptions.

Permalink Submitted by **Erkan Oterkus** on Tue, 2007-05-29 20:41.

This is just my idea and I cannot claim that it is exactly true. After these assumptions, we do not have any dependency on z (out-of plane direction) coordinate. So, we only end up with a problem on an in-plane surface. Therefore, we should only concentrate on x-y components of stress and strain. What this means, we should not take into account the relations related with the z-coordinate. So, we do not need to take into account the constituve relation of εzz and corresponding stress components.

Erkan Oterkus.

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R. Chennamsetti, R&DE(E),

Permalink Submitted by **ramdas chennamsetti** on Wed, 2007-05-30 00:53.

R. Chennamsetti, R&DE(E), INDIA

Hi Erkan,

- **Thanks Emma for the very** 5 days 8 hours ago
- **Thanks Emma for such an insightful discussion** 5 days 9 hours ago

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Thank you. Here relations means 'Constitutive relation?' But, we can't violate the constitutive relation in any direction (I think).

- Ramdas

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We estimated Kirchoff

Permalink Submitted by **TarasVasiliev** on Wed, 2007-05-30 01:05.

We estimated Kirchoff theory by solving spatial problem for small hight **h=H/R** (<0.1).

It can be concluded that all normal stresses and deflection give asimptoticaly right values.

But shear stress σrz must be approximated only by theories wich includes shear.

For example Timoshenko-Reissner theory.

More detailed information about useful boundaries in Kirchoff theory see

http://www.springerlink.com/content/y725477x15885301/?p=3bd506ccac034d2f...

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Kirchhoff's assumptions -2

Permalink Submitted by **Erkan Oterkus** on Wed, 2007-05-30 01:50.

Hi Ramdas,

Thank you for this interesting topic. What I mean with the term relations is in general. Maybe I should even correct my phrase. Under the assumptions that we are making, we should eliminate the terms related with the z-coordinate. As a crude example, like eliminating applied boundary conditions from our global governing equation.So,, we should only have the in-plane related terms in any relation suh as equilibrium equations, constitutive relations,etc. You are right, we should not violate constitutive relation, but here we are making assumptions, so we need to sacrifice something which is OK to ignore under some particular conditions.

Erkan.

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evaluation and structural health monitoring" by Zahra Sharif Khodaei, 24--26 May 2022, Czech Republic, Prague

- **Postdoc/Research Fellow for computational mechanics of all solid state battery at the Department of Mechanical Engineering, National University of Singapore**

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The Conflicting Kirchhoff Assumptions

Permalink Submitted by **Wenbin Yu** on Fri, 2008-09-19 15:10.

The original post made a point. The violation of the 3D constitutive relations is happened because the second assumption is not correct. The first assumption is asymptotically correct for the first approximation of the original 3D model using a 2D model. However, the second assumption, transverse normal remains rigid, is clearly violating the first assumption, plane stress. Because by assuming plane stress, we assume that the plate is free to move in the thickness direction, which means the transverse normal is not rigid. Both assumptions can be valid only if the Poisson's ratio is zero. Recall the well-known and readily observed Poission's effect. The reason the second assumption is used is because it is convient to derive a 2D version kinematics (strain-displacement relations). It is noted that same conflicting assumptions also used to derive beam models dealing with tension and bending: section remain rigid in its own plane and the beam is in uniaxial stress state.

As a final comment, both assumptions are not absolutely needed for one to derive a plate theory. One can use the variational asymptotic method to take advantage of the smallness of theory as the small parameter to reduce the 3D model to a 2D model with the first assumption comes out as a result of the first assumption and the transverse displacement will be a quadratic function of the thickness coordinate. Please refer to the following paper for more details.

Yu, W.: "Mathematical Construction of a Reissner-Mindlin Plate Theory for Composite Laminates," *International Journal of Solids and Structures*, vol.42, no. 26, 2005, pp. 6680-6699. (**pdf**)

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