AE 227: Solid Mechanics

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Bird-strike with aircraft

Boeing 737 after a bird hit

Car crash

(a)

(b)

(c)

(d)

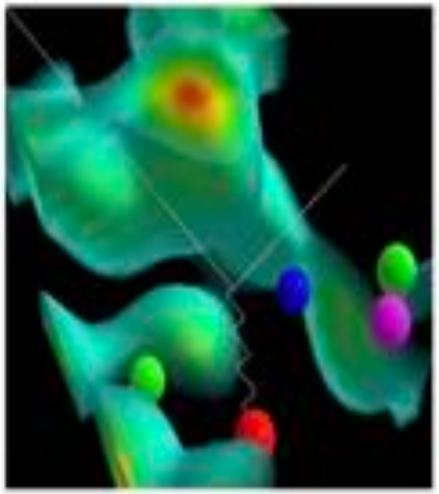
General motivation

1. Mathematical concepts of physical 'things' : *Bodies*
2. A body occupies a set of places or geometry: *Shape*
3. Change of shape with time: *Motion*
4. Description of motion: *Kinematics*
5. Motion occurs by the action of : *Forces*

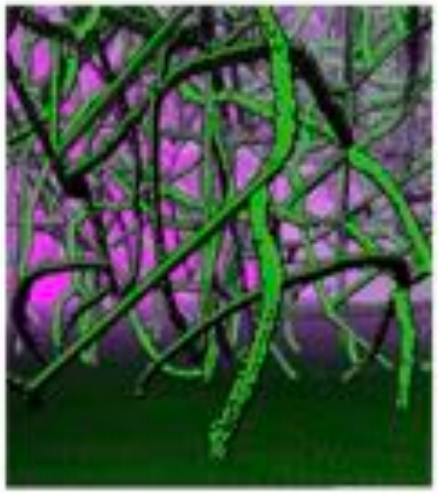
Mechanics provides *mathematical model* of certain aspect of nature

Mathematical description of physical laws are known as *field equations*

Continuum theory



Atomic



Molecular

Continuum

Modeling

real structure / real materials

(i) fundamental laws

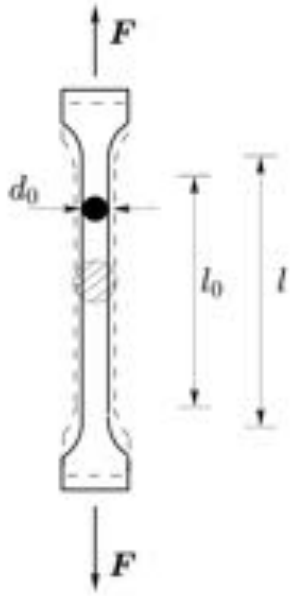
(ii) efficient theories

(iii) constitutive relations

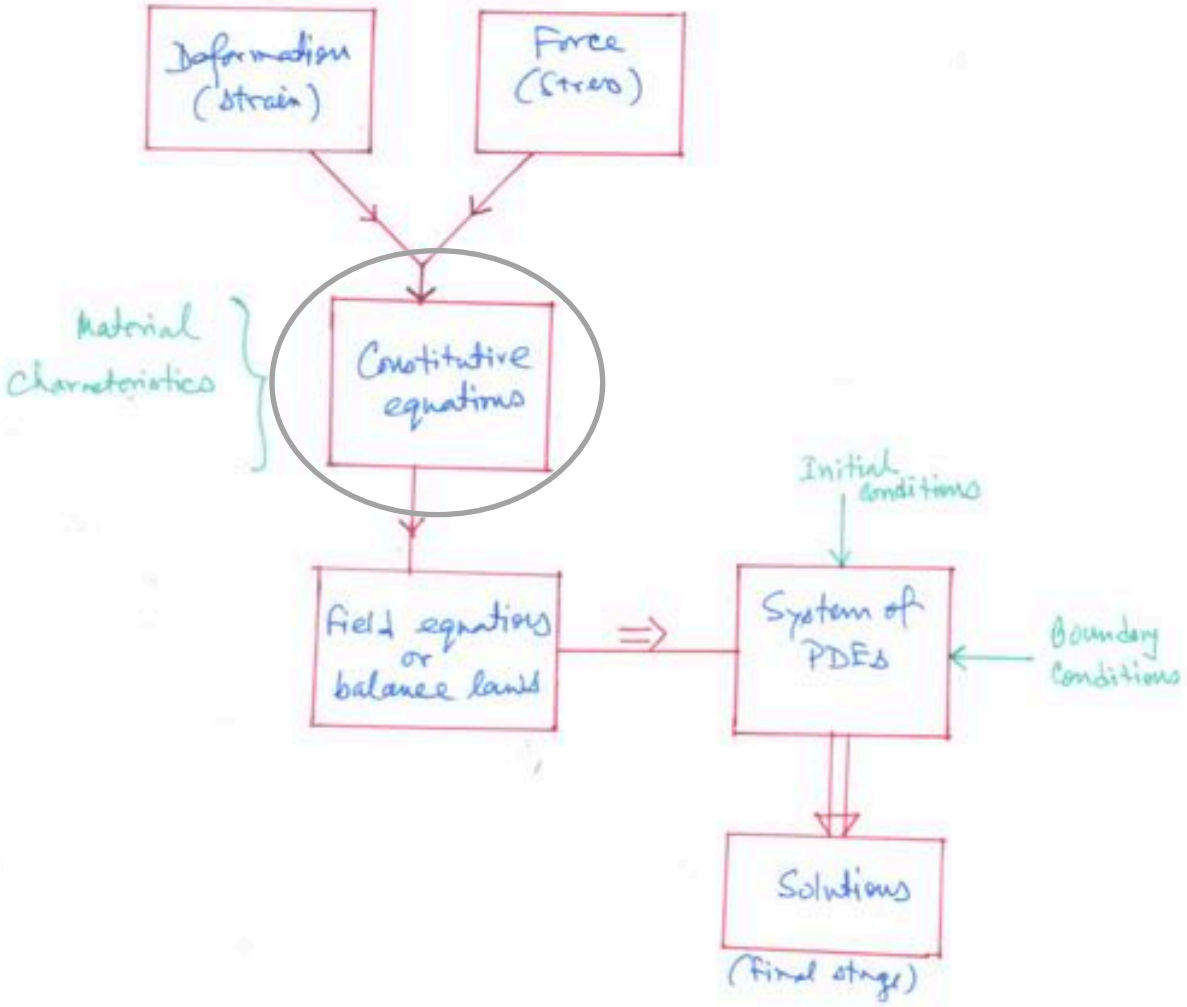
(iv) computational modelling

(v) simulation

verification / validation



Solution strategy



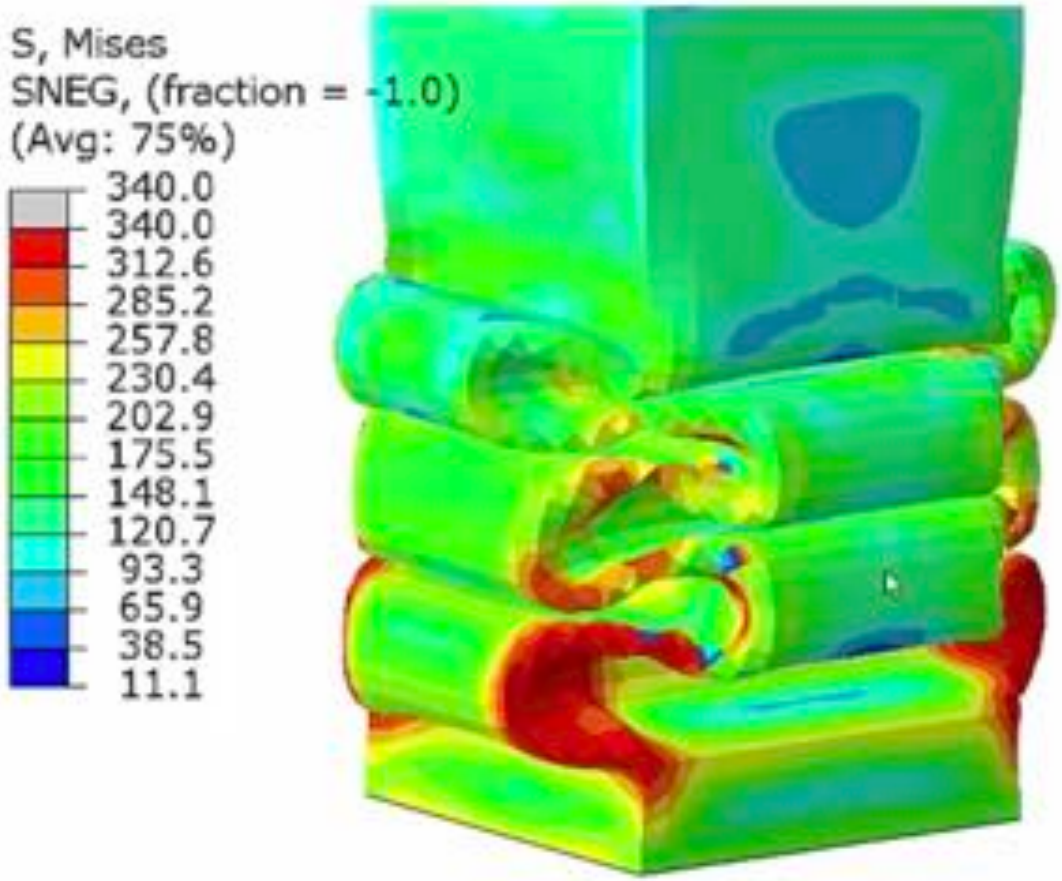
Concept of constitutive modeling

- constitutive models are mathematical simplifications of a complex physical behaviour · there is no 'exact' model
- it is appropriate to model a material in a number of ways · depending on the purpose and the required precision of the model predictions

Choice of certain model

- Is the model relevant for describing the physical phenomena at hand?
- Does the model produce sufficiently accurate predictions for the given purpose?
- Is it possible to devise and implement a robust numerical algorithm to obtain a truly operational model?

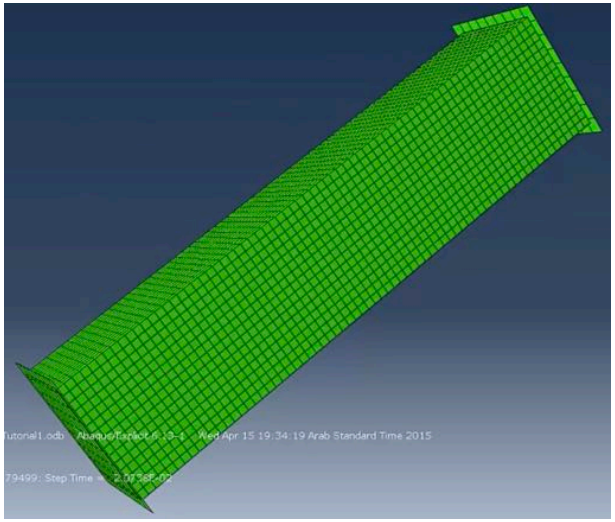
Square tube crash



Real (experiment)

Simulation

Square tube crash



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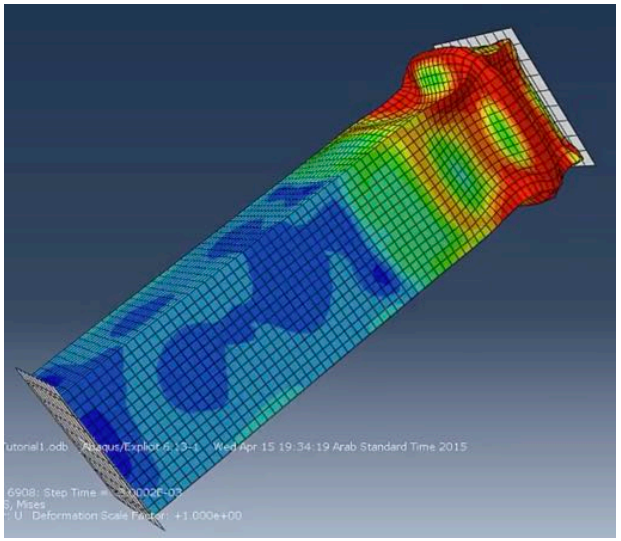

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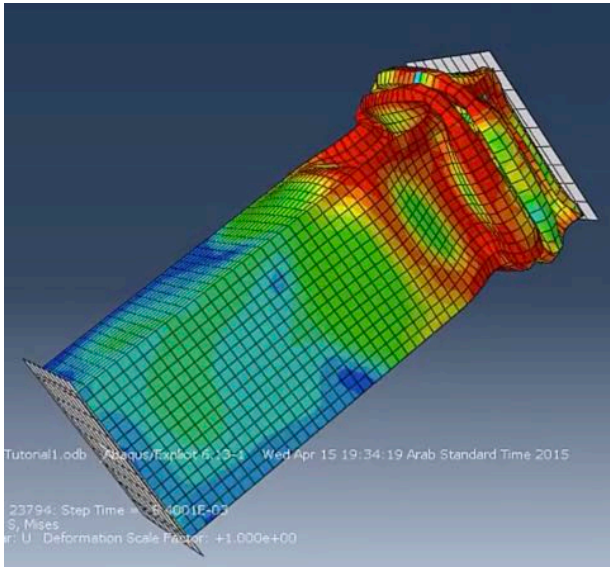
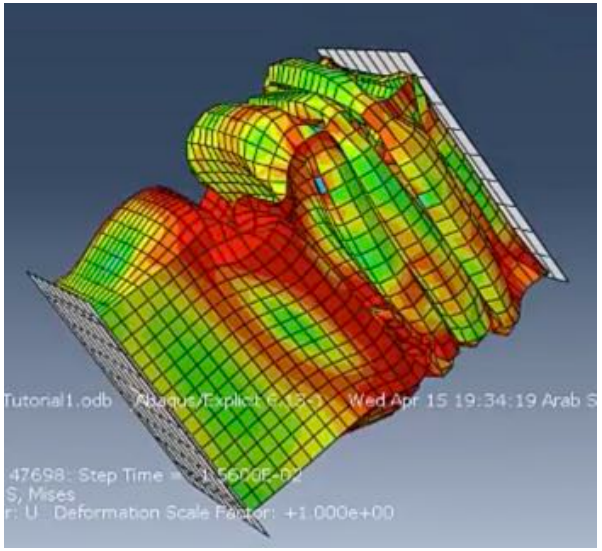


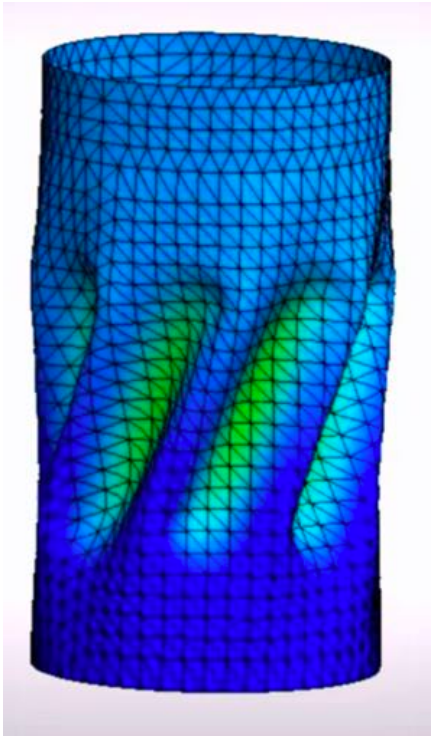
(c)



(d)

Torsion of a can

(a)



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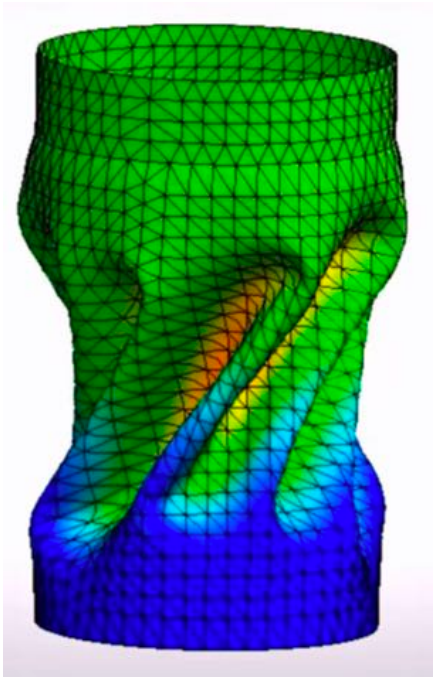
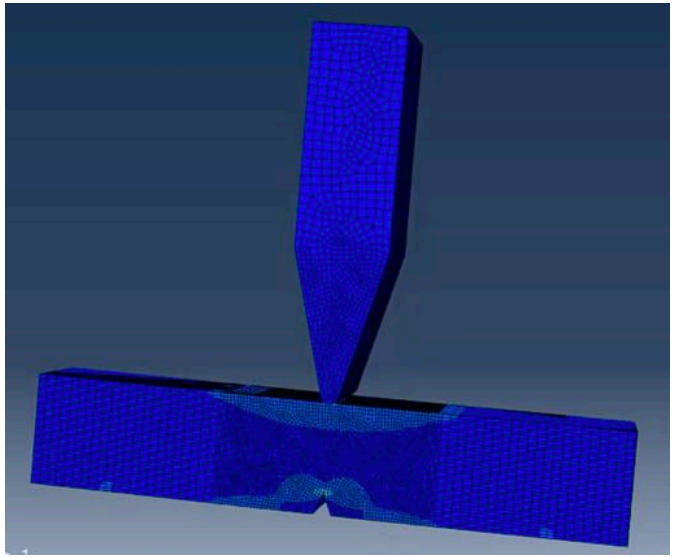


(c)

Torsional buckling for a twist load

Charpy impact test



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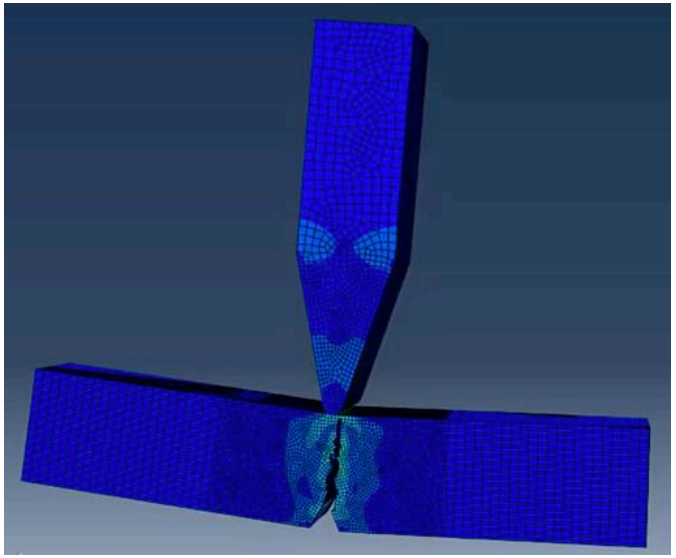

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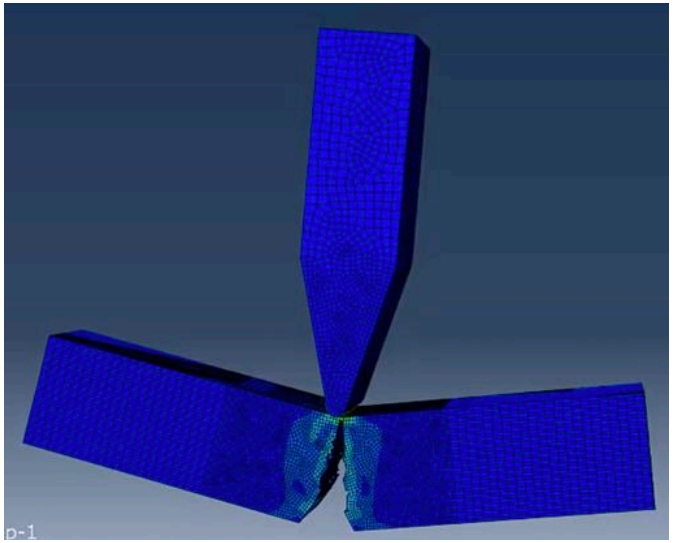

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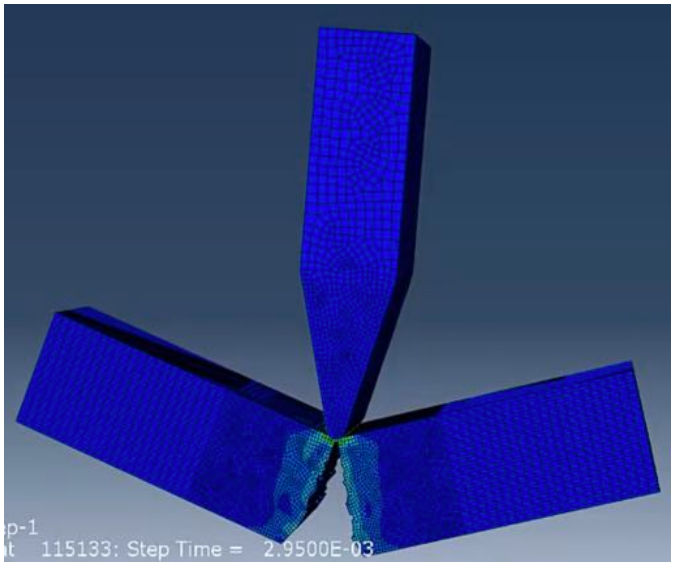
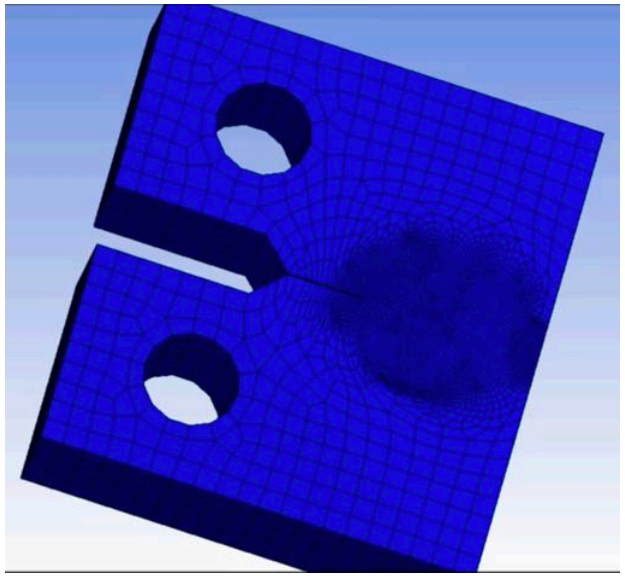
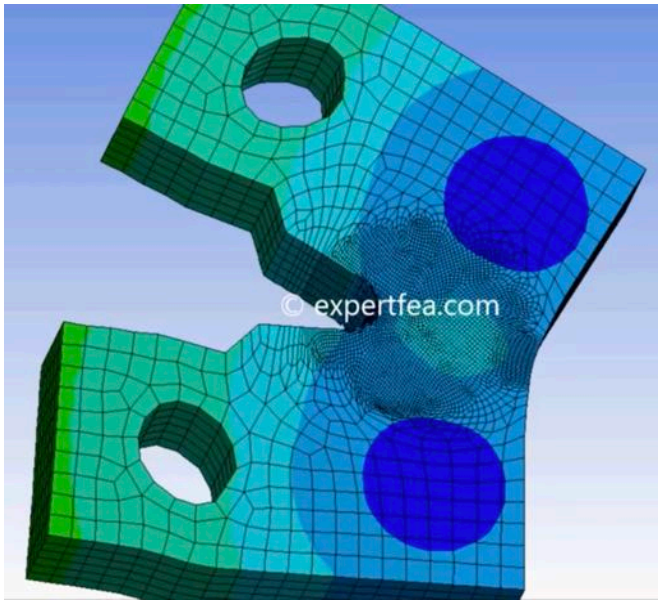


(d)

Fracture and crack



(a)



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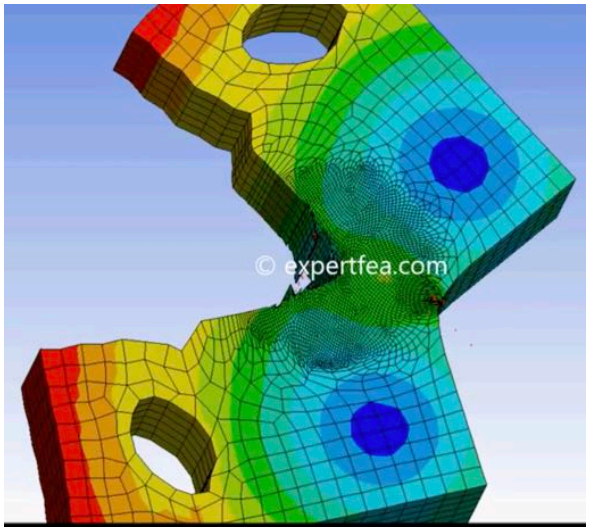

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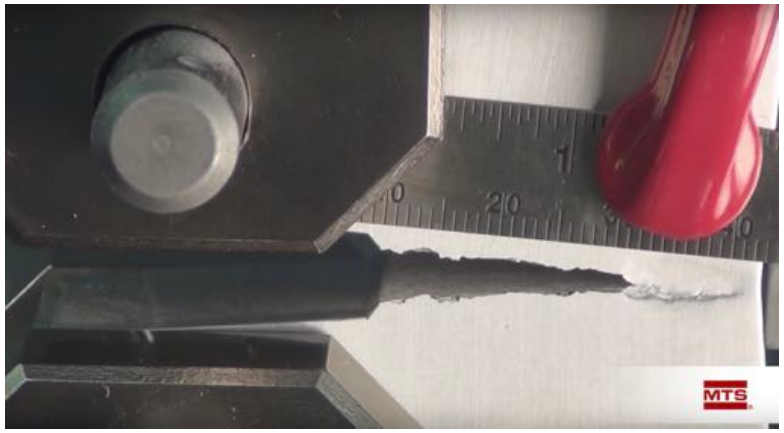
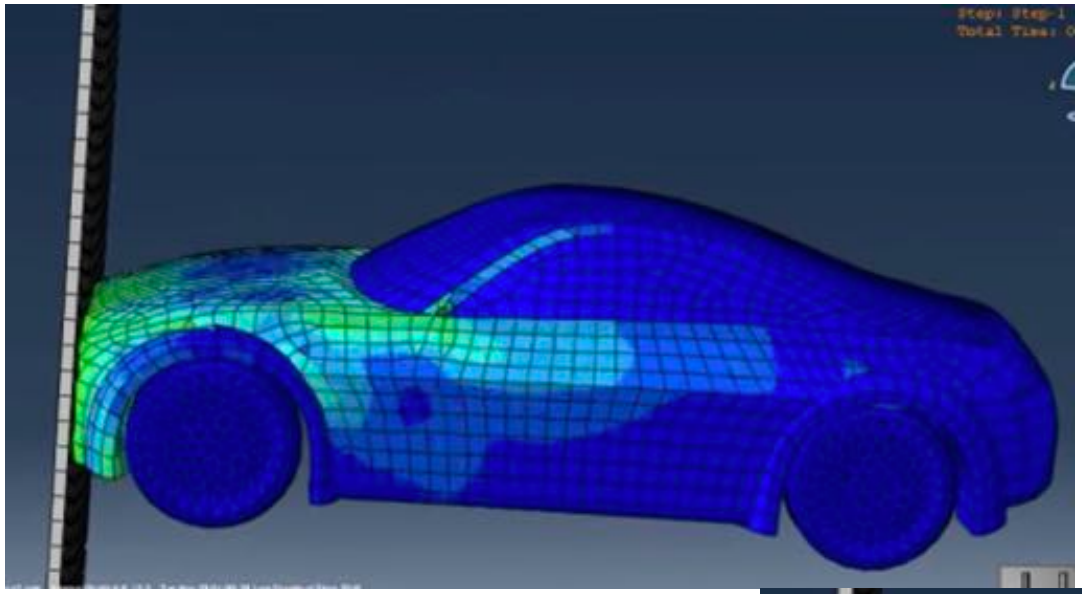
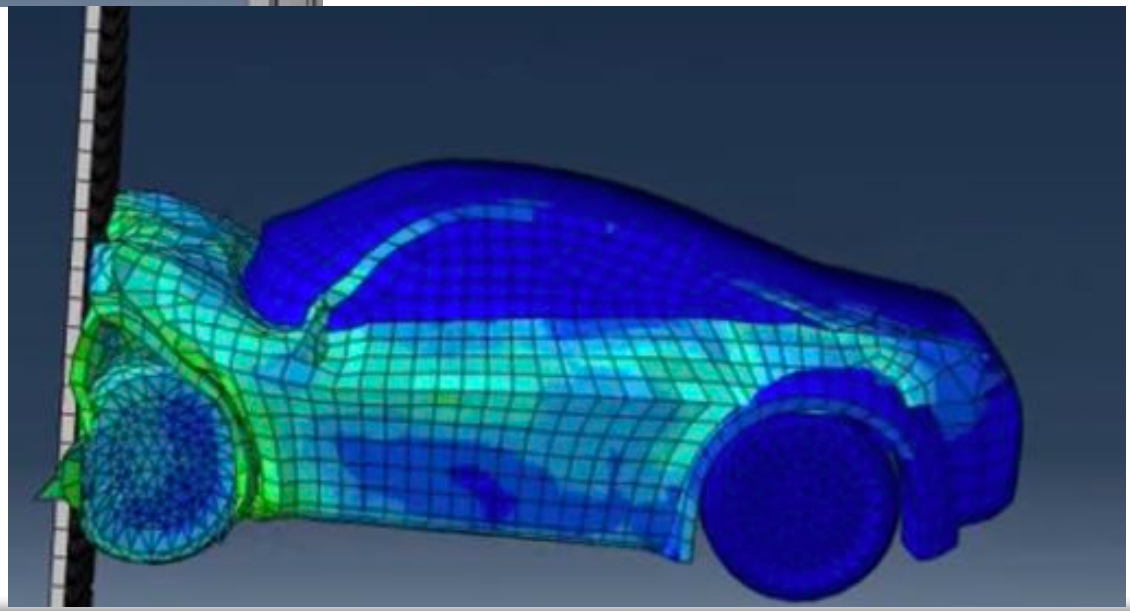


(d)

Car crash simulation





Head injury simulation