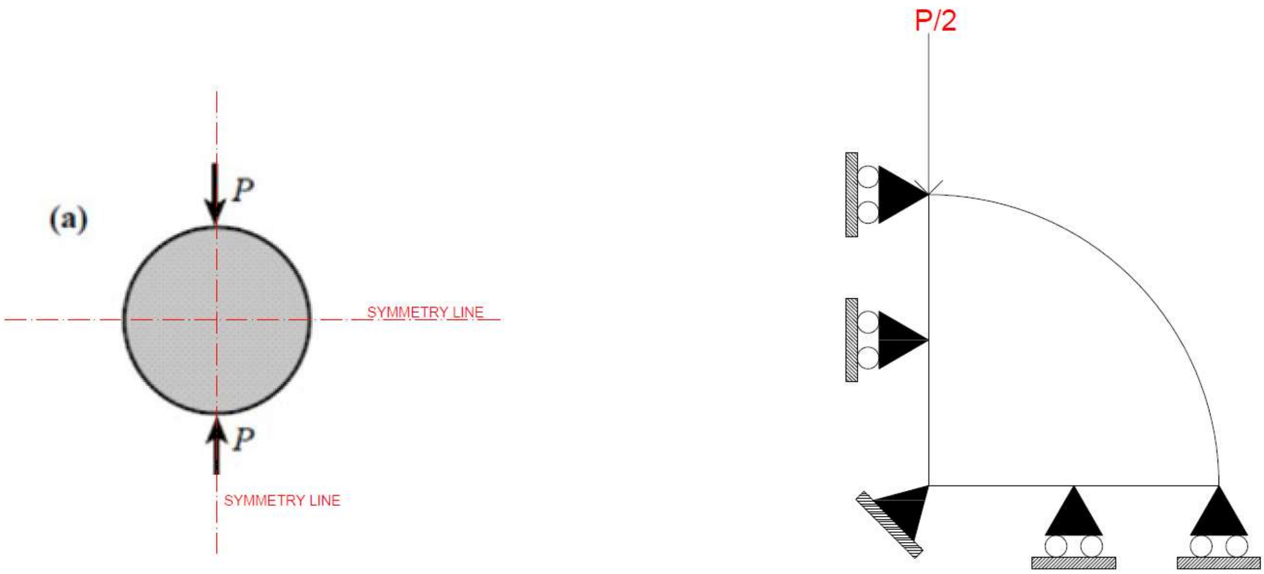
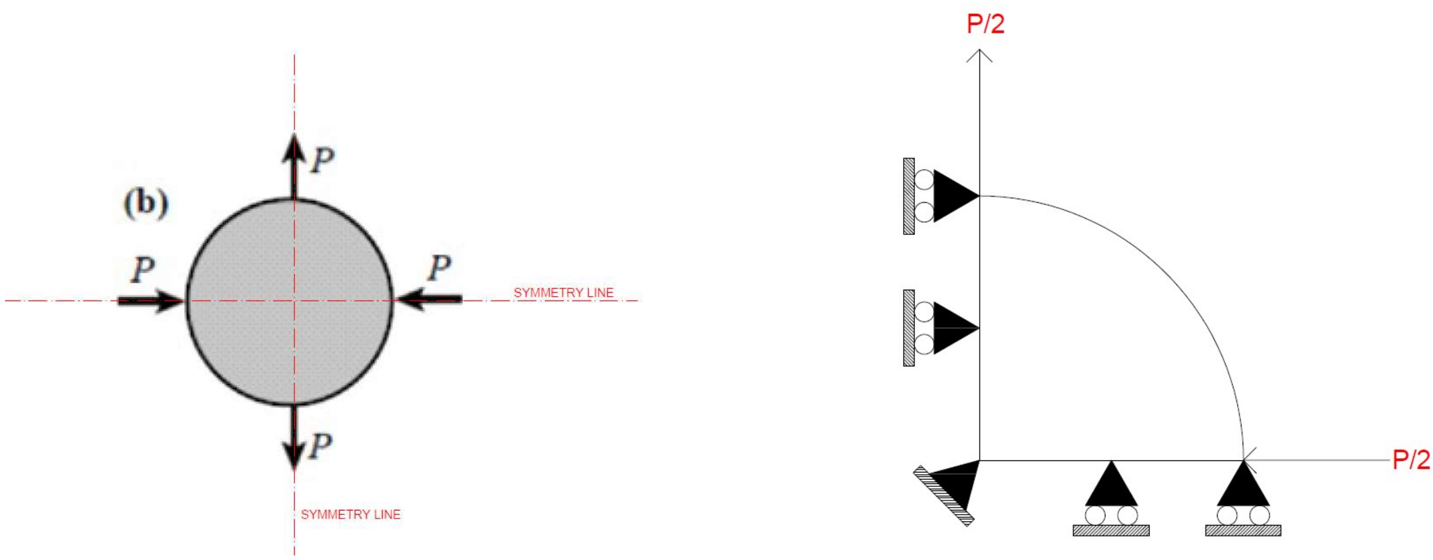
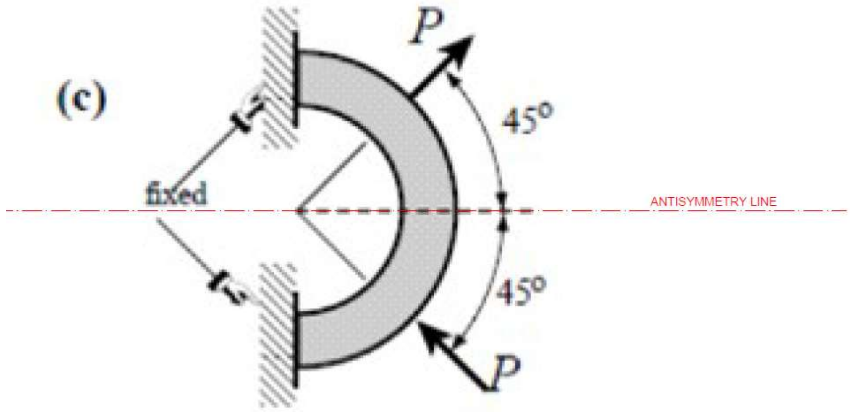
Assignment 2.1

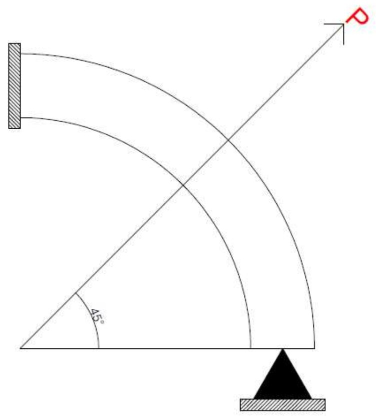
Engineers doing finite element analysis should be on the lookout for conditions of *symmetry* or *antisymmetry*. Judicious use of these conditions allows only a portion of the structure to be analyzed, with a consequent saving in data preparation and computer processing time

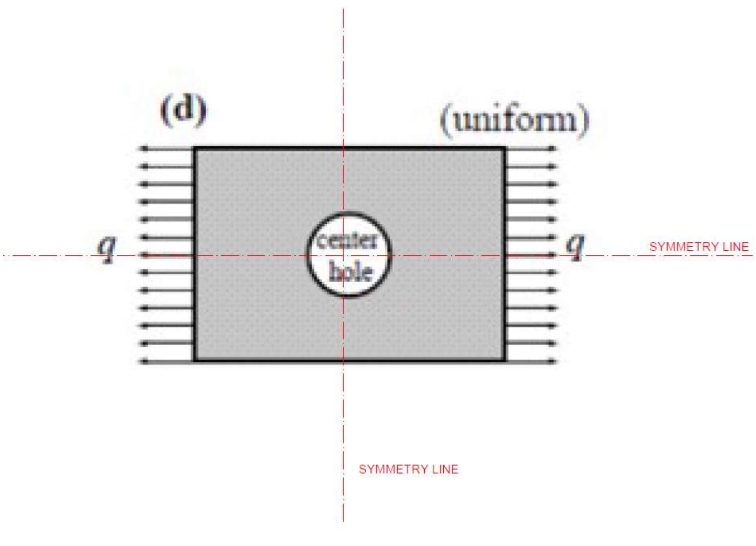
Recognition of symmetry and antisymmetry conditions can be done by either visualization of the displacement field, or by imagining certain rotational ot reflection motions.

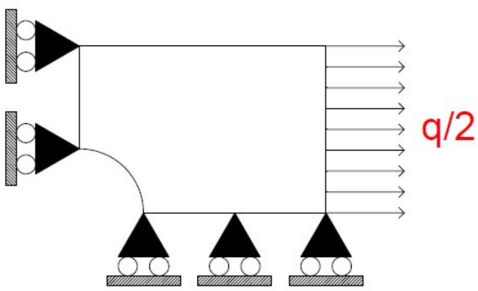


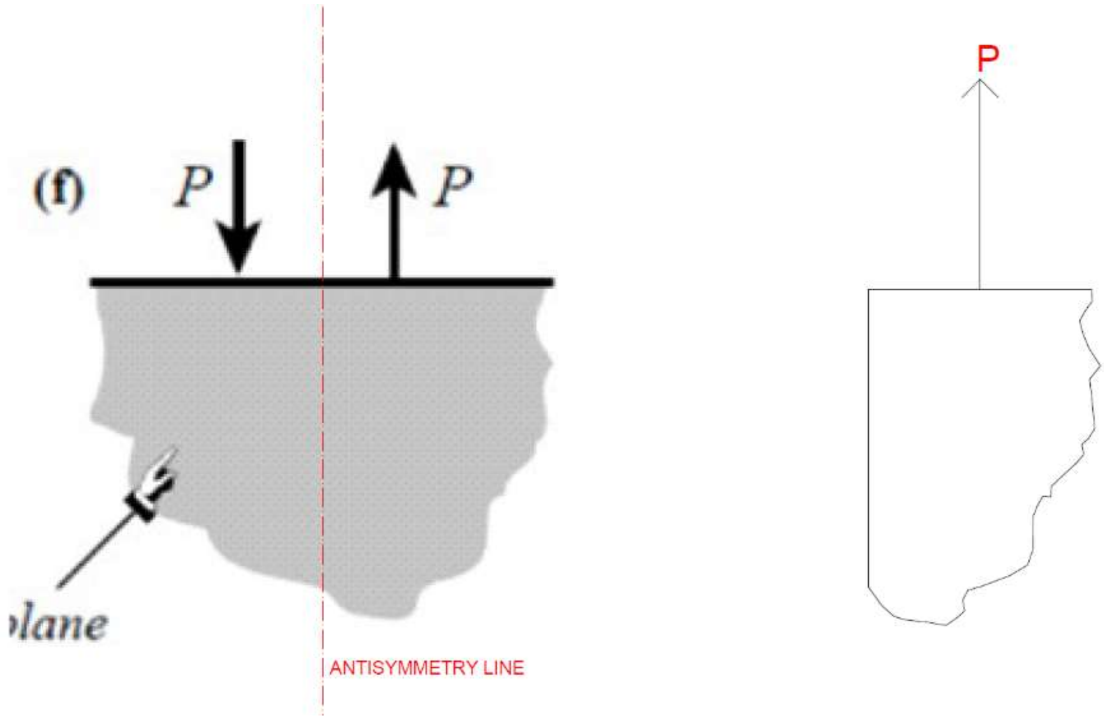


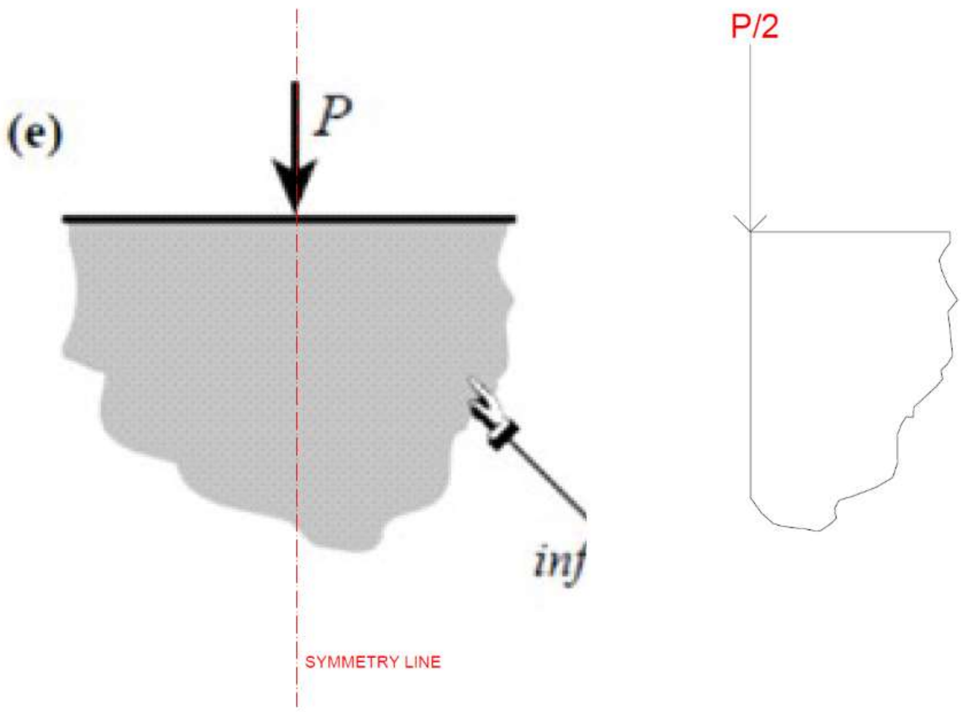

(c)
P
45°
fixed
ANTISYMMETRY LINE
45°
P


P
45°

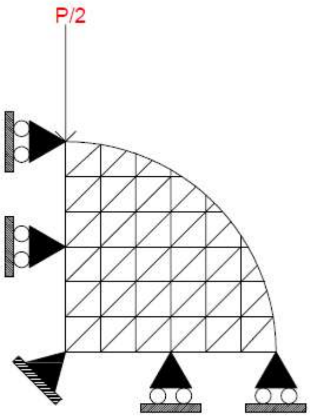

(d)
(uniform)
q
center
hole
q
SYMMETRY LINE
SYMMETRY LINE

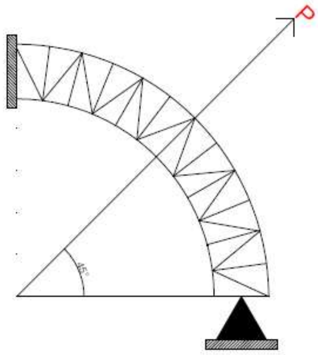

q/2

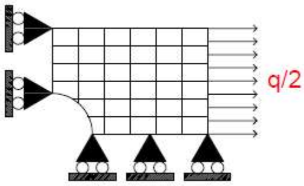

(f)
P
P
lane
ANTISYMMETRY LINE
P

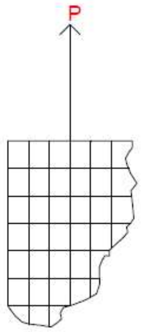

(e)
P
inf
SYMMETRY LINE
P/2

Mesh Layout









Assignment 2.2

Verification	**Validation**
Making sure it works	Making sure it does what it's supposed to do.
Getting the math right.	Getting the physics right.
Providing an accurate FE analysis.	Checking the FEA against test.

From these definitions, verification is very much to do with the typical checking process we should be going through when developing an FEA model. The validation process comes down to checking the FEA model against available test data.

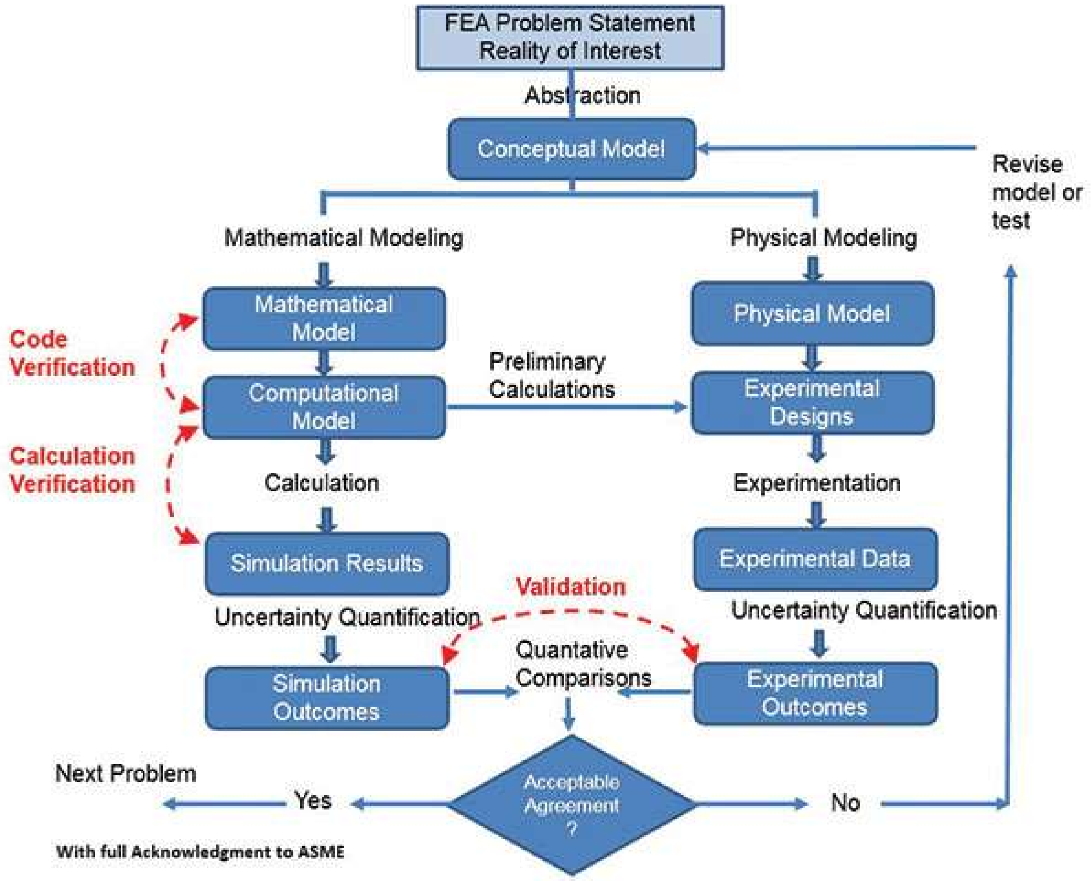
The ASME, American Society of Mechanical Engineers, verification definition is: "The process of determining that a computational model accurately represents the underlying mathematical model and its solution"

This does not imply that verification is just a mechanistic set of checks on the FEA model. The checklist and checking process is a vital part of any traditional analysis plan, but we must do more than that. Verification definition gives an indicator of the wider task: "The process of determining that a model implementation accurately represents the developer's conceptual description of the model and the solution to the model."

So our early assumptions about the FEA model and its relevance to the actual physical structure, loads and boundary conditions are part of the verification process. Getting the physics right was attributed to validation in the table. However predicting the physics is an important part of verification in practice.

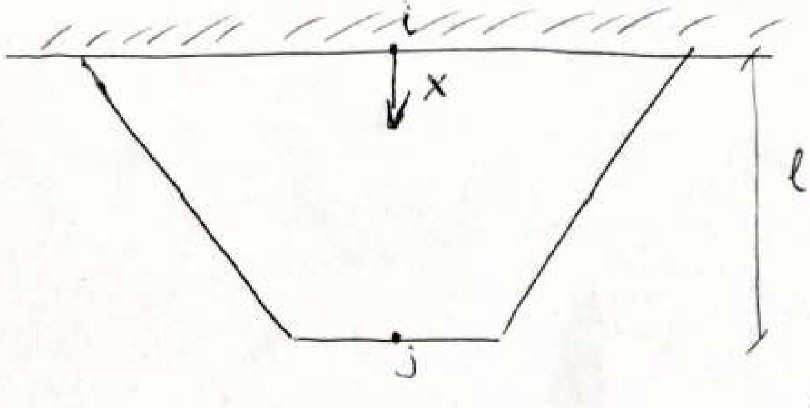
In contrast, ASME, allocate the confirmation of the physics to a validation role: "Validation: The process of determining the degree to which a model is an accurate representation of the real world from the perspective of the intended uses of the model." The intention of the validation is to define this as an evaluation of the FEA model results against test evidence, but it should not be taken to mean we ignore any prior test evidence and experience.

Viewing the ASME process chart is a much better way of trying to understand the relationship between Verification, Validation, FEA and testing. A simplification of that chart is shown in the Figure.



The early planning and assessment of the applicability of both the FEA model simulation methods and the test program to the real world structure and environment is done formally. It is also an integrated process between analysis and test disciplines.

Assignment 2.3.



$q(x) = \rho A w^2 x$

$A = A_i(1-\xi) + A_j \xi$

$\xi = \frac{x - x_i}{l} \rightarrow x = \xi l + x_i$

$d\xi = \frac{dx}{l}$

$$f^e = \int_{x_i}^{x_j} q(x) \begin{pmatrix} 1-\xi \\ \xi \end{pmatrix} dx = \int_0^1 q(x) \begin{pmatrix} 1-\xi \\ \xi \end{pmatrix} l \, d\xi =$$

$$= \rho w^2 l \int_0^1 \left[A_i(1-\xi) + A_j \xi\right](\xi l + x_i)\, d\xi =$$

$$\underset{x_i=0}{=} \rho w^2 l \int_0^1 \left[A_i \cdot l(\xi - \xi^2) + A_j \cdot l \xi^2\right] d\xi =$$

$$= \rho w^2 l \left[A_i l \left[\frac{\xi^2}{2} - \frac{\xi^3}{3}\right]_0^1 + A_j l \left[\frac{\xi^3}{3}\right]_0^1\right] =$$

$$= \rho w^2 l \left(\frac{A_i l}{6} + \frac{A_j l}{3}\right) = \rho w^2 l^2 \left(\frac{A_i}{6} + \frac{A_j}{3}\right)$$

For a prismatic bar $\rightarrow A = A_j = A_i \rightarrow$ $\boxed{f^e = \frac{\rho w^2 l^2 \cdot A}{2}}$