Step 2: Selection of displacement models and interpolation models.

- The interpolation equations are used to approximate the results obtained at the nodes over the entire element.

- Before getting the results, we assume how results vary over the entire domain based on the assumed variation, a proper displacement equation is selected.

- The assumed interpolation equations may be polynomials or trigonometric functions.

- Polynomials are most commonly used interpolation equations.

Step 3: Derivation of element stiffness matrix.

- Different methods like virtual work method, potential energy method, etc., will be used to determine stiffness matrix.

- A real-time structure having multi DOF will have many stiffness terms associated with these DOF. All these are written in matrix form and such a matrix is called a stiffness matrix.

- Stiffness matrix \([K]\) is a matrix that relates the force vector to the displacement vector.

Mathematically, \([K]\{u\} = \{f\}\)

Where, \([K]\) = Stiffness matrix

\(\{u\}\) = Displacement vectors

\(\{f\}\) = Force vector
12. Aspect Ratio

- Important parameter that affects the accuracy of the analysis.
- It is the ratio of longest dimension to the smallest dimension.
- Defines the shape of the element.
- Element with aspect ratio equal to unity yields better results.

\[ \frac{L}{l} \approx 1 \]

13. Location of Nodes

- If there are no discontinuities in the body, then the body can be divided into equal number of subdivisions & hence spacing of the nodes can be uniform as in fig.
- If the body has discontinuities, then nodes have to be introduced
  - a) Discontinuities in Geometry
  - b) Discontinuities in Load
  - c) Material properties
  - d) Structure.
15. Banded Matrix or Half Band width

Stiffness matrix in FEA is a banded matrix. It is symmetric.
In a banded matrix, all non-zero elements are present in a band.
Outside this band, all elements are zero.

Consider a \([n \times n]\) symmetric banded matrix \((N = \frac{n(n+1)}{2}\) Nodes,)

\[
\begin{bmatrix}
1 & 2 & 3 & 4 & 5 \\
1 & 4 & 6 & -2 & 0 \\
2 & 6 & 3 & 1 & 9 \\
3 & 2 & 1 & 6 & 8 & -2 \\
4 & -2 & 1 & 6 & 8 & 4 \\
5 & 0 & 0 & -2 & 3 & 1
\end{bmatrix}
\]

In the above matrix, \(h_{m,n}\) is called a half-band pattern.
Since only non-zero elements are to be stored, the order of the matrix
will be \((n \times nbw)\).
Advantages of Banded Matrix

• Only half of the matrix can be stored
• Reduces storage space
• Reduces computational time

Node Numbering Scheme

Bandwidth of a stiffness matrix depends on node numbering scheme. If bandwidth reduces, storage space reduces and hence the computational time also reduces. This can be achieved by using proper node numbering scheme. There are basically two types of node numbering scheme:

a) Node numbering scheme along the dimensions
b) Random or Continuous node numbering scheme.