The plate and shell models have been used widely in micro- and nano-sized systems and devices such as sensors, actuators, micro-switches and ultra thin films. It is noted that the classical (local) theory (CT) is not taken into account the size effect on the mechanical behaviors when the structural size is in micro or nano-scale. Because of these applications, it has been shown that the size effect plays major role on the mechanical behaviors of nanostructures which is essential to be considered. On the other hands, the various size-dependent continuum theories such as couple stress elasticity ( Toupin, 1962; Mindlin and Tiersten, 1962). nonlocal elasticity (Eringen, 1972). strain gradient elasticity (SGT) (Aifantis, 1999), surface elasticity (Gurtin et al., 1998) and micropolar elasticity (Eringen, 1967) are considered in the literatures. An overview of the work done in this field is described as follows:

Using nonlocal elasticity theory, Mousavi et al (2010) and Ghorbanpour Arani et al. (2011) investigated the size effect on the buckling characteristics of the double-walled carbon nanotubes and laminated composite rectangular plates, repectively. Kim and Reddy (2013) presented analytical solution of the third order shear deformation plate theory with considering the functionally graded material based on modified coupled stress theory (MCST) and the Navier's type solution. They showed that the effects of the microstructural such as the length scale parameter makes the plate stiffer. Thi and Choi (2013) studied analytical solution of the two variable plate theory for the analysis of bending, buckling and vibration of rectangular plate. They observed that the critical buckling load and deflection from this theory have a good agreement with the obtained results by the first and third order shear deformation theories. Wang et al. (2011) investigated microplate Kirchhoff based on strain gradient elasticity theory. They studied that the static and vibrations analysis of micro rectangular plates and found that the stiffness, critical buckling load and natural frequency micro plate very dependent on size effect. Reddy and Berry (2012) developed the classical and first-order shear deformation plate theories for bending of circular plates that its material properties is changed in the thickness direction according to power law and using the modified couple stress theory and nonlinear strain von Kármán and Hamilton's principle. Ramezani (2012) illustrated the first order shear deformation micro-plate model based on strain gradient elasticity theory and the governing equations of motion and boundary conditions are determined using the variational method. He showed that when the plate thickness is comparable to the material length scale parameter, the critical buckling load increase while the natural frequency of the plate reduced. It also proved that the effect of shear deformation is sensible at the small scale. Thai and Kim (2013) analyzed the bending and free vibration of functionally graded Reddy plate theory. They found that when the thickness of plate is small, the effect of small scale is important, but with increasing the thickness will be negligible. Thai and Choi (2013) developed the bending, buckling and vibration functionally graded Kirchhoff and Mindlin plate using the modified coupled stress theory and Hamilton's principle. By numerical results, they found that considering the small-scale effects leads to a reduction in the value of bending and increased the critical buckling load and natural frequency. Mozafari and Ayob (2012) derived the equations of motion using the first and third order shear deformation theory and the power law distribution of material properties through the thickness of plate. Then they presented the buckling analysis of functionally graded plates under in-plane
compression. They obtained closed form solution for the critical buckling load plates and found for the functionally graded plate increasing power law index decreases the critical buckling load, and also it increases with increasing along the aspect ratio rectangular plate. Using the non-local elasticity theory, Mohammadimehr et al. (2011) presented the Timoshenko beam model to study the elastic buckling of double-walled carbon nanotubes embedded in an elastic medium under axial compression. They observed that the critical buckling load can be overestimated by the local beam model if the small-scale effect is overlooked for long nanotubes. Rahmati and Mohammadimehr (2014) studied the electro-thermo-mechanical vibration analysis of non-uniform and non-homogeneous boron nitride nanorod embedded in an elastic medium. They obtained the steady state heat transfer equation without external heat source for non-homogeneous rod is developed and temperature distribution. They investigated the effects of attached mass, lower and higher vibrational mode, elastic medium, piezoelectric coefficient, dielectric coefficient, cross section coefficient, non-homogeneity parameter and small-scale parameter on the natural frequency. Using the continuum mechanics model and the minimum total energy method, Ghorbanpour Arani et al (2011) studied the dynamic stability of single- and double-walled carbon nanotubes under dynamic axial loading. They obtained the critical dynamic axial load of the single- and double-walled carbon nanotubes using the Rayleigh-Ritz method. Also they considered the effect of the small length scale using the Eringen Model. They showed that the critical dynamic axial load is increased by inserting an inner carbon nanotube into an isolated carbon nanotube embedded in an elastic medium.

According to the authors review the various articles so far the bending and buckling analysis of functionally graded nano-plate using strain gradient elasticity theory is not performed. In this research, the effects of aspect ratio, material length scale parameter and power law index on deflection and critical buckling load of functionally graded Mindlin nano-plate are investigated.

STRAIN GRADIENT ELASTICITY THEORY

According to strain gradient elasticity theory, the strain energy density stored in a linear elastic material which is considered as follows:

\[ U = \frac{1}{2} \int \left( \sigma_{ij} \varepsilon_{ij} + p_i \gamma_i + \tau^{(1)}_{ijk} \eta_{ijk} + m^s_{ij} \chi^s_{ij} \right) dV = 0 \quad (i, j, k = x, y, z) \quad (1) \]

where the \( \varepsilon_{ij} \), \( \gamma_i \), \( \eta_{ijk}^{(1)} \), and \( \chi^s_{ij} \) are the symmetric strain tensor, dilatation gradient tensor, deviatoric stretch gradient tensor, and rotation gradient symmetric tensor, respectively that is defined as:

\[
\varepsilon_{ij} = \frac{1}{2}(u_{i,j} - u_{j,i})
\]

\[
\gamma_i = \varepsilon_{mm,i}
\]

\[
\eta^{(1)}_{ijk} = \frac{1}{3}(\delta_{jk} \varepsilon_{mm,i} + 2\varepsilon_{mk,m} + \delta_{km} \varepsilon_{mm,j} + 2\varepsilon_{mi,m})
\]

\[
\eta^{(1)}_{ijk} = \frac{1}{3}(\varepsilon_{mm,i} + 2\varepsilon_{mk,m} + \delta_{km} \varepsilon_{mm,j} + 2\varepsilon_{mi,m})
\]

\[
\chi^s_{ij} = \frac{1}{4}(e_{inn}u_{n,mj} + e_{jmn}u_{n,m})
\]

Second order stress tensor \( \sigma_{ij} \) and the higher order stresses \( p_i \), \( \tau^{(1)}_{ijk} \) and \( m^s_{ij} \) can be written as follows:

\[
\sigma_{ij} = \lambda \delta_{ij} \varepsilon_{mm} + 2\mu \varepsilon_{ij}
\]

\[
p_i = 2\mu l^2_0 \gamma_i
\]

\[
\tau^{(1)}_{ijk} = 2\mu l^2_0 \eta^{(1)}_{ijk}
\]

\[
 m^s_{ij} = 2\mu l^2_1 \chi^s_{ij}
\]

In the above equations \( (l_0, l_1, l_2) \) denote the material length scale parameters, \( \lambda \) and \( \mu \) are lame coefficients that is written as the following from:

\[ l_0, l_1, l_2 \]
\[
\lambda = \frac{\nu E}{1 - \nu^2}, \quad \mu = \frac{E}{2(1 + \nu)}
\]  

(4)

That here \( E \) and \( \nu \) are Young's modulus and Poisson's ratio, respectively.

**The governing equations of Mindlin nano-plate**

The Mindlin plate theory displacement field in \( x \), \( y \), and \( z \) directions are defined as follows:

\[
\begin{align*}
    u_1(x, y, z, t) &= z \psi_x(x, y, t) \\
    u_2(x, y, z, t) &= z \psi_y(x, y, t) \\
    u_3(x, y, z, t) &= w(x, y, t)
\end{align*}
\]  

(5)

where \( w \) is the transverse displacement of the nano-plate, \( \psi_x \) and \( \psi_y \) are the angular displacement in \( x \) and \( y \) directions, respectively.

Substituting Eq. (5) into Eq. (2a), the relationship of the strain - displacement are obtained as follows:

\[
\begin{align*}
    \varepsilon_x &= z \psi_{x,x} \\
    \varepsilon_y &= z \psi_{y,y} \\
    \varepsilon_{xy} &= \frac{z}{2} (\psi_{x,y} + \psi_{y,x}) \\
    \varepsilon_{xz} &= \frac{1}{2} (\psi_{x,z} + w_{x,x}) \\
    \varepsilon_{yz} &= \frac{z}{2} (\psi_{x,y} + w_{y,y})
\end{align*}
\]  

(6)

Substituting Eqs. (5) and (6) into Eq. (2) yields:

\[
\begin{align*}
    \eta_{xxx}^{(1)} &= \frac{z}{5} (2\psi_{x,xx} - 2\psi_{y,xy} - \psi_{x,yy}) \\
    \eta_{yyy}^{(1)} &= \frac{z}{5} (2\psi_{y,yy} - 2\psi_{x,xy} - \psi_{y,xx}) \\
    \eta_{zzz}^{(1)} &= \frac{1}{5} (2\psi_{x,zz} + 2\psi_{y,zz} + w_{x,x} + w_{y,y}) \\
    \eta_{xxy}^{(1)} &= \eta_{yx}^{(1)} = \eta_{zy}^{(1)} = \eta_{yxz}^{(1)} = \eta_{yxy}^{(1)} = \eta_{yzz}^{(1)} = \frac{1}{3} (\psi_{x,y} + \psi_{y,x} + w_{x,y}) \\
    \eta_{xxy}^{(1)} &= \eta_{yx}^{(1)} = \eta_{yxy}^{(1)} = \frac{z}{15} (8\psi_{x,xy} + 4\psi_{y,xx} - 3\psi_{y,yy}) \\
    \eta_{xzz}^{(1)} &= \eta_{yzz}^{(1)} = \eta_{zxy}^{(1)} = \frac{1}{15} (8\psi_{x,zz} + 4w_{x,xx} - 2\psi_{y,yy} - w_{y,yy}) \\
    \eta_{xxy}^{(1)} &= \eta_{yx}^{(1)} = \eta_{yxy}^{(1)} = \frac{z}{15} (4\psi_{x,yy} + 8\psi_{y,xy} - 3\psi_{x,xx}) \\
    \eta_{xxy}^{(1)} &= \eta_{yx}^{(1)} = \eta_{yxy}^{(1)} = \frac{1}{15} (8\psi_{x,y} + 4w_{y,yy} - 2\psi_{x,xx} - w_{x,xx}) \\
    \eta_{xxy}^{(1)} &= \eta_{yx}^{(1)} = \eta_{yxy}^{(1)} = \frac{z}{15} (3\psi_{x,xx} + \psi_{x,yy} + 2\psi_{y,xy})
\end{align*}
\]  

(7)
\[
\eta_{xxy}^{(1)} = \eta_{yyx}^{(1)} = \eta_{yxx}^{(1)} = -\frac{z}{15} (\psi_{y,xx} + 3\psi_{y,yy} + 2\psi_{x,xy}) \\
\chi_{xx} = \frac{1}{2} (w_{,xy} - \psi_{y,x}) \\
\chi_{yy} = \frac{1}{2} (\psi_{x,y} - w_{,xy}) \\
\chi_{zz} = \frac{1}{2} (\psi_{y,x} - \psi_{x,y}) \\
\chi_{xy} = \frac{1}{4} (w_{,yy} - \psi_{y,y} + \psi_{x,x} - w_{,xx}) \\
\chi_{xy} = \frac{1}{4} (w_{,yy} + \psi_{x,xy}) \\
\chi_{xy} = \frac{1}{4} (w_{,yy} + \psi_{x,xy}) \\
\gamma_x = z (\psi_{x,xx} + \psi_{y,xy}) \\
\gamma_y = z (\psi_{x,xy} + \psi_{y,yy}) \\
\gamma_z = \psi_{x,x} + \psi_{y,y} \\
\]

Also following relations for higher-order stresses can be defined as:

\[
M_{ij}^h = \int_{z}^{} \sigma_{ij}^h dz \quad i, j = x, y \quad \& \quad h = 0, 1, 2 \\
M_{ij}^h = k_{ij} \int_{z}^{} \sigma_{ij}^h dz \quad i = x, y; j = z \quad \& \quad h = 0, 1, 2 \\
P_{ij}^h = \int_{z}^{} p_{ij}^h dz \quad i, j = x, y, z \quad \& \quad h = 0, 1, 2 \\
Y_{ij}^h = \int_{z}^{} m_{ij}^h dz \quad i, j = x, y, z \quad \& \quad h = 0, 1, 2 \\
N_{ijk}^h = \int_{z}^{} \tau_{ijk}^{(1)} dz \quad i, j, k = x, y, z \quad \& \quad h = 0, 1, 2 \\
\]

where \( k_{ij} \) is the shear correction factor.

Work done due to the external force is obtained from the following equation:

\[
V = -\frac{1}{2} \int_A \left[ (N_x) \left( \frac{\partial w}{\partial x} \right)^2 + (N_y) \left( \frac{\partial w}{\partial y} \right)^2 + q(x, y) w \right] dA \\
\]

Plate is considered as a functionally graded so that the elastic modulus in the thickness direction using the continuous changes that can be expressed in the following form:

\[
E(z) = E_m + (E_c - E_m) \left( \frac{1}{2} + \frac{z}{h} \right)^n \\
\]

where \( n \) is power law index. Also \( m \) and \( c \) subscripts are metal and ceramic materials, respectively.

The total potential energy is defined as follows:

\[
\Pi = T - (U + V) \\
\]

where \( U \), \( V \), and \( T \) are the strain energy, work done due to the external force, and kinetic energy, respectively. In this study, the static analysis is investigated, then the kinetic energy is equal to zero.
Using the minimum potential energy principle, we have:

\[ \int_0^t \delta \Pi dt = 0 \]
\[ \delta \Pi = \delta U + \delta V = 0 \] (14) (15)

Substituting Eqs. (1) and (11) into Eq. (15) and separating the coefficients \( \delta w \), \( \delta \psi_x \) and \( \delta \psi_y \), the governing equations of motion are obtained as follows:

\[ \delta w : k_s A \frac{1 - \nu}{2} (\psi_{x,x} + \psi_{y,y} + \nabla^2 w) + \frac{A_n}{8} \left[ \nabla^2 (\psi_{x,x} + \psi_{y,y}) - \nabla^4 w \right] \]
\[ - \frac{4A_m}{15} \left[ \nabla^4 w + 2 \nabla^2 (\psi_{x,x} + \psi_{y,y}) \right] - N_s \frac{\partial^2 w}{\partial x^2} - N_y \frac{\partial^2 w}{\partial y^2} + q(x, y) = 0 \] (16a)

\[ \delta \psi_x : D \left( \psi_{x,xx} + \frac{1 - \nu}{2} \psi_{x,xy} + \frac{1 + \nu}{2} \psi_{y,xy} \right) - k_s A \frac{1 - \nu}{2} (\psi_{x,x} + w_{,x}) \]
\[ - D_1 \left[ \nabla^2 (\psi_{x,xx} + \psi_{y,xy}) \right] + A_l (\psi_{x,xx} + \psi_{y,xy}) + \frac{A_n}{4} \left[ 2 \nabla^2 \psi_x - \frac{3}{2} (\psi_{x,xx} + \psi_{y,xy}) \right] \]
\[ + \frac{\partial}{\partial x} (\psi_{x,xx} + \psi_{y,xy}) - \frac{1}{2} \nabla^2 w_{,x} \] + \frac{D_n}{8} \left[ \nabla^2 (\psi_{y,xy} - \psi_{x,xy}) \right] + \frac{2A_m}{15} \left[ 5 \nabla^2 \psi_x \right] + 3 \frac{\partial}{\partial x} (\psi_{x,xx} + \psi_{y,xy}) + 4 \nabla^2 w_{,x} = 0 \] (16b)

\[ \delta \psi_y : \left( \psi_{y,yy} + \frac{1 - \nu}{2} \psi_{y,x} + \frac{1 + \nu}{2} \psi_{x,x} \right) - k_s A \frac{1 - \nu}{2} (\psi_{y,y} + w_{,y}) \]
\[ - D_1 \left[ \nabla^2 (\psi_{y,yy} + \psi_{x,x}) \right] + A_l (\psi_{y,yy} + \psi_{x,x}) + \frac{A_n}{8} \left[ \nabla^2 \psi_y \right] \]
\[ - 3 (\psi_{y,xx} - \psi_{x,xy}) - \nabla^2 w_{,y} \] + \frac{D_n}{8} \left[ \nabla^2 (\psi_{x,xy} - \psi_{y,xx}) \right] + \frac{2A_m}{15} \left[ 5 \nabla^2 \psi_y + 3 (\psi_{x,xx} + \psi_{y,xy}) + 4 \nabla^2 w_{,y} \right] \]
\[ - \frac{2D_m}{15} \left[ 2 \nabla^2 \psi_y + \nabla^2 \psi_{y,yy} + \nabla^2 \psi_{x,xy} \right] = 0 \] (16c)

where

\[ (A, B, D) = \int_{-h/2}^{h/2} E(z) \left( \frac{z}{h} \right) \left( 1 - \nu \right) dz \]
\[ \left\{ \begin{array}{c}
(A_I, B_I, D_I) \\
(A_m, B_m, D_m) \\
(A_n, B_n, D_n)
\end{array} \right\} = \left[ \begin{array}{c}
l_0^2 \\
l_1^2 \\
l_2^2
\end{array} \right] \left( 1 - \nu \right) (A, B, D) \] (17)

**Analytical Solution Of The Functionally Graded Mindlin Nano-Plate**

To investigate the bending and buckling functionally graded rectangular nano-plate under distributed transverse load \( q \) and lateral forces \( N_x = \gamma_x N_c \); \( N_y = \gamma_y N_c \); \( N_{xy} = 0 \) with simply supported boundary conditions for four sides. The Navier's type solution to satisfy the governing equations of motion and boundary conditions is considered as follows:
\[ w(x, y, t) = \sum_{m_1=1}^{\infty} \sum_{m_2=1}^{\infty} W_{m_1m_2} \sin \alpha x \sin \beta y \]

\[ \psi_x(x, y, t) = \sum_{m_1=1}^{\infty} \sum_{m_2=1}^{\infty} X_{m_1m_2} \cos \alpha x \sin \beta y \]  
\[ \psi_y(x, y, t) = \sum_{m_1=1}^{\infty} \sum_{m_2=1}^{\infty} Y_{m_1m_2} \sin \alpha x \cos \beta y \]

where \( \alpha = \frac{m_1 \pi}{a} \), \( \beta = \frac{m_2 \pi}{b} \) and \( \{ W_{m_1m_2}, X_{m_1m_2}, Y_{m_1m_2} \} \) are coefficients. Using Fourier series, distributed transverse load \( q \) is defined as:

\[ q(x, y) = \sum_{m_1=1}^{\infty} \sum_{m_2=1}^{\infty} Q_{m_1m_2} \sin \alpha x \sin \beta y \]  

\[ Q_{m_1m_2} = \frac{4}{ab} \int_0^a \int_0^b q(x, y) \sin \alpha x \sin \beta y \, dx \, dy \]  

where \( Q_{m_1m_2} \) would be equal to \( q_0 \) for a sinusoidal load \( q_0 \).

Substituting Eqs. (18) and (19) into Eq. (16) obtained the Mindlin plate analytical solution as follow:

\[
\begin{bmatrix}
  s_{11} & s_{12} & s_{13} \\
  s_{12} & s_{22} & s_{23} \\
  s_{13} & s_{23} & s_{33}
\end{bmatrix}
\begin{bmatrix}
  W_{m_1m_2} \\
  X_{m_1m_2} \\
  Y_{m_1m_2}
\end{bmatrix}
= \begin{cases}
  Q_{m_1m_2} \quad \text{if } m_1 \neq m_2 \\
  0 \quad \text{if } m_1 = m_2
\end{cases}
\]

where

\[
\begin{aligned}
s_{11} &= k_x A \frac{1-\nu}{2} (\alpha^2 + \beta^2) + \frac{A_n}{8} (\alpha^2 + \beta^2)^2 + \frac{4A_m}{15} (\alpha^2 + \beta^2)^2 \\
&\quad + N_{cr} (\gamma_1 \alpha^2 + \gamma_2 \beta^2) \\
s_{12} &= k_x A \frac{1-\nu}{2} \alpha - \frac{A_n}{8} \alpha (\alpha^2 + \beta^2) + \frac{8A_m}{15} \alpha (\alpha^2 + \beta^2) \\
s_{13} &= k_x A \frac{1-\nu}{2} \beta - \frac{A_n}{8} \beta (\alpha^2 + \beta^2) + \frac{8A_m}{15} \beta (\alpha^2 + \beta^2) \\
s_{22} &= k_x A \frac{1-\nu}{2} + D (\alpha^2 + \frac{1-\nu}{2} \beta^2) + D_x \alpha^2 (\alpha^2 + \beta^2) + A_x \alpha^2 + A_n \frac{4 (\beta^2 + \alpha^2)}{8} \\
&\quad + \frac{D_n}{8} \beta^2 (\alpha^2 + \beta^2) + \frac{2A_m}{15} (5 \beta^2 + 8 \alpha^2) + \frac{2D_m}{15} (3 \alpha^4 + 5 \alpha^2 \beta^2 + 2 \beta^4) \\
s_{23} &= D \frac{1+\nu}{2} \alpha \beta + D_x \alpha \beta (\alpha^2 + \beta^2) + A_x \alpha \beta - \frac{3}{8} A_n \alpha \beta - \frac{D_n}{8} \alpha \beta (\alpha^2 + \beta^2) \\
&\quad + \frac{2}{15} A_m \alpha \beta + \frac{2D_m}{15} \alpha \beta (\alpha^2 + \beta^2)
\end{aligned}
\]
NUMERICAL RESULTS AND DISCUSSION

To validate the results of this research, because so far no article has been presented about to analyze the bending and buckling analysis of functionally graded Mindlin nano-plate with simply support boundary conditions using strain gradient elasticity theory. The results of this analysis for micro-plate are compared with the obtained results by Thai and Choi [15] that have a good agreement between them. The mechanical properties are considered as follows:

\[ \nu = 0.38 \quad h = 17.6 \times 10^{-6} \text{ m} \quad \gamma_1 = \gamma_2 = -1 \quad n = 0 \quad q_0 = 1 \]

\[ E_c = 1.44 \text{ GPa} \quad E_m = 14.4 \text{ GPa} \quad k_s = 5/6 \quad l_0 = l_1 = 0 \]

Then, bending and buckling analysis of functionally graded nano-plate with below characteristics for nano-plate have been considered in this research as follows (Hashemi et al., 2012).
Dimensionless deflection and critical buckling load are given by:

\[
\begin{align*}
\bar{w} &= \frac{100E_m h^3}{q_0a^4} w\left(\frac{a}{2}, \frac{b}{2}\right) \\
\bar{N} &= \frac{Na^2}{E_m h^3}
\end{align*}
\]

Figs. 1 and 2 show the influence of power law index on dimensionless deflection and critical buckling load of Mindlin nano-plate for classical, modified coupled stress, and strain gradient elasticity theories. It can be seen for all three theories, the dimensionless critical buckling load decreases with increasing the power law index and vice versa for the dimensionless deflection of functionally graded rectangular plates. Also the obtained critical buckling load from the classical theory is lower than that of from the other theories (MSCT and SGT), while these results are reversed for the dimensionless deflection of nano-plate.

The effect of the length scale parameter on the dimensionless deflection and critical buckling load for different power law index investigated in Figs. 3 and 4. The results indicate that increasing the length scale parameter, the deflection of functionally graded nano-plate decreases and vice versa for the critical buckling load in MCPT and SGT theories, while it doesn't have any effect on the results of the classical theory. For a larger power law index, the slope of the deflection nano-plate curve decreases with an increase in the length scale parameter and reverses for the dimensionless critical buckling load. This means that the functionally graded nano-plate become stiffer with increasing the power law index, then it has the inverse and direct effects on the deflection and critical buckling load of nano-plate, respectively.
CONCLUSION

In the present study, the bending and buckling analysis of functionally graded Mindlin nano-plate with simply supported boundary conditions using strain gradient theory are investigated. Using Hamilton's principle and energy method, the governing equations of equilibrium are obtained. The Navier's type solution is used to solve these equations. The results of this research can be listed as follows:

- It is observed that the effects of the nanostructural such as the length scale parameter make the nano-plate stiffer.
• The obtained critical buckling load from the other theories (MSCT and SGT) is higher than that of from the classical theory, and vice versa for the dimensionless deflection of nano-plate.

• The dimensionless critical buckling load decreases with increasing the power law index, and it is reversed for the dimensionless deflection of functionally graded rectangular plates.

• The deflection of functionally graded nano-plate decreases with an increase in the length scale parameter, and vice versa for the critical buckling load in MCPT and SGT theories, while it doesn't have any effect on the results of the classical theory.

• It can be also seen that the dimensionless deflection of nano-plate decreases with increasing the aspect ratio and the vice versa for the dimensionless critical buckling load.

ACKNOWLEDGEMENTS

The authors would like to thank the Iranian Nanotechnology Development Committee for their financial support and the University of Kashan for supporting this work by Grant No. 255941/4.

REFERENCES


