The Thermal Response of Multi-Storey Concrete Frame Building in the Arabic Area

Ikhlass Sydnaoui, Rosli Bin Noor Mohamed, Mariyana Aida Binti Ab.Kadi

Abstract: In this paper, there will be an analysis study to figure out the impact of the environment thermal loads, shrinkage and creep at multi-storey reinforced concrete frame buildings in the Arabic area. Etabs models will be prepared based on NTDP and TDP of ordinary concrete, considering two columns heights as 3m and 6m, and two supports conditions as fixed and hinged to define the major aspects affect the thermal response of multi-storey concrete frame buildings concentrating at the thermal deformations and the columns reactions, then it will be compared with the thermal response of existing concrete building considering both methodologies of TDP as per CEBFIP99 and NTDP as per ACI Committee to define the optimum methodology to be recommended and followed. The generated Etabs models confirmed that the time dependent properties method is the optimum with a clear conversion between time dependent properties model and the existing parking thermal deformations. Increasing the thermal reaction forces at column supports reduces the correlated thermal deformations due to stiffness increment of the entire building. The first-level displacements of multi-storey buildings are slightly smaller than those of upper levels and single-storey buildings, but the displacements of the second level are slightly larger than those of the other levels. Meanwhile, the displacements of levels above the second storey are close to the displacements of single-storey models. Overall, there are small differences between multi- and single-storey models, finally, the importance of analyzing thermal loads fluctuation at columns reactions for multi storey buildings whereas the reactions of multi storeys cannot be predicted from single storey analysis.

Keywords: Time Dependent, Thermal, Diversion, Strains

I. INTRODUCTION

It is essential for design to understand the behavior of reinforced concrete at early stages of construction and at whole life span of the structure, the concrete properties are not constant values, the mechanical properties vary with time in function of the progress of hydration process. This includes the concrete strength, the modulus of elasticity, shrinkage and creep [1]. Defining the structural behavior of a concrete structure over the course of its estimated lifespan is a fascinating phenomenon. It is important to mention that CEP FIP,1999 code [2] provides complete process for time dependent properties of concrete considering creep effects and coefficients, with variable values of concrete strengths. The CEB FIP code includes figures for total shrinkage over the building lifespan in concrete structures in addition to values of concrete creep coefficient. It will be inserted in ETABS model, time dependent properties input values. The effectiveness of the expansion joints was measured by researchers whereas they got that increasing the number of expansion joints by reducing the spacing between the joints improves its effectiveness [4] which may justify the variances of allowed spacing between joints in different codes. The spacing requirements listed in codes are smaller than those for modern or unique buildings. Moreover, whilst PCA (1982) and Dubai municipalities prescribe a maximum spacing of 60 m, other standards allow much smaller spacings such as ACI 350R Committee with a maximum spacing of 36 m. Increasing such spacing requirements is possible based on the results of finite element models to meet the requirements of modern unique buildings whereas FEM is recommended methodology for similar phenomena analysis and conclusions [6].

This significant response is noticed in constrained slabs while the effect of temperature fluctuation is ignored in non-restrained slabs. It is clear that the loads of temperature are composed of two main parts, these parts will be considered in my analysis too. The 1st part is related to seasonal climate changes and the 2nd part is related to shrinkage impact and equivalent thermal effects [4]. Superposition and interaction of humidity and temperature changes with the creep and the shrinkage of concrete are with similar nature, they impose increment in concrete deformations and creep [5] (Bazant and et al,1997).

II. METHODOLOGY

A. Used Methods

The annual thermal expansion coefficient value is approximately 1.852 of the correlated seasonal coefficients, and the correlated average value is 9.5×10⁻⁶, as determined by various tests on unrestrained concrete samples with different reinforcement compositions, cement types, and aggregate sizes [7]. Accordingly, this figure will be inserted in FEM model. The cylinder strength of used concrete fc2 is 40 N/mm² with elasticity modulus of 30000 N/mm² as per American concrete institution and used codes in Arabic region. The mass of concrete per unit volume is 2400 kg/m³. The used temperature fluctuation between summer and winter, The design temperature maximum daily variation is: whereas Ts is -17°C=-30°F for drying shrinkage consideration. The design temperature with maximum daily variation is 9-43=-34°C as shown in Fig. (1). while Ts is 17°C, the total variation will be

\[ \Delta T = \frac{2}{3} \left( T_{\text{max}} - T_{\text{min}} \right) + T_s = 22.6 + 17 = 39.2°C. \]

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* Correspondence Author

Ikhlass Sydnaoui¹, Designer Structural Engineer, Faculty of Civil Engineering, University Teknologi Malaysia, Johor Bahru, Malaysia. Email: Ikhlass.sydnaoui@musanada.com

Dr. Rosli Bin Noor Mohamed, Faculty of Civil Engineering, University Teknologi Malaysia, Johor Bahru, Malaysia. Email: rosli@utm.my

Dr. Mariyana Aida Binti Ab. Kadi, Faculty of Civil Engineering, University Teknologi Malaysia, Johor Bahru, Malaysia. Email: mariyanaida@utrm.my

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The thermal displacements (UY) for columns M, N, and O are presented in Tables I and II. The displacements in figure 3 are on the same side of the axis Y. Table I shows the results of three-dimensional multi-story concrete frame buildings with hinged columns, while Table II shows the deformations of three-dimensional multi-story finite element models with fixed columns conditions. The slabs come in two thicknesses: 300mm and 400mm. The heights of column are 3 and 6 meters. At the exterior columns M, N, and O, distinct values of thermal deformations are induced.

Table-I: Thermal displacements UY(M), UY(N), and UY(O) in (mm) for constructions with hinged supports and 300 mm thick floors at all levels

| Length | Height of columns (3m) | Height of columns (6m) | UY(M) | UY(N) | UY(O) |
|--------|------------------------|------------------------|-------|-------|-------|
| 1st    | 10.1                   | 10.1                   | 10.1  | 10.1  | 10.1  |
| 2nd    | 12.3                   | 12.3                   | 12.2  | 12.2  | 12.2  |
| 3rd    | 14.4                   | 14.4                   | 14.5  | 14.5  | 14.5  |
| 4th    | 16.5                   | 16.5                   | 16.5  | 16.5  | 16.5  |
| 5th    | 18.6                   | 18.6                   | 18.6  | 18.6  | 18.6  |

Fluctuations in environmental temperature reported in 1997 (A.D.I.A, 2015) [5]

To recognize the impact of temperature variations on the displacements of multistory structures and correlated reactions, a comprehensive analysis was undertaken based on Etabs program. Consequently, three-dimensional multi-story concrete buildings are generated. The perspective and plan view are shown in Figures (2) and (3). A comparison of external columns displacements and the reactions results is presented for the columns M, N, and O at axis (a). These columns are shown in figure (3) which have the most critical values than internal columns. The reactions and the deformations of columns at axis (a) are similar to reactions and deformations at slab edge at axis (k) too (edge columns will suffer from maximum stresses and deformations under thermal loads).

III. RESULT AND DISCUSSION

A. Displacements at columns M, N and O
The deformations of the 2nd storey are slightly more than the other levels deformations (1st, 3rd and 4th). Deformations of the upper levels above the 2nd storey seem very close to the 1st storey displacements. Third and fourth levels deformations at all columns M, N and O have very close values with respect to the column height. The deformations of column O for all different slabs lengths from 50 to 200m are more than other analyzed columns M and N displacements at 1st storey level. For columns with hinged support, the biggest displacements are not detected at a specific column, whereas all studied displacements are nearly identical at the same level, whereas critical displacements for columns with fixed support are observed at column O at 2nd level as shown in table II. As a result, column displacements in multi-story concrete structures must be calculated using the maximum thermal displacements at the internal peripheral columns rather than the corner column. The columns M, N and O horizontal displacements above 1st slab level are close to Δ,

$$\Delta = \frac{\Delta \cdot a \cdot \Delta t}{2}$$

(2)

The deformations from single storey models and utilizing same observations and equations formulas for deformations of single storey moment frame buildings at multi-storeies buildings. Consequently, we can use same allowed expansion joints spacing for single storey to be implemented in multi-stories buildings, whereas expansion joints spacings between two adjacent segments of the building are limited to the maximum allowed lateral deformations of H/180.

B. Reaction forces at columns M, N and O

Tables III and IV present the thermal reaction forces (FY) at columns M, N and O for fixed and hinged column supports respectively. These reactions are on the same side of the axis Y.

Table: III: Reactions FY(M), FY(N) & FY(O) in (KN) for constructions with fixed supports and 300 mm thick floors

| Slab length (m) | Height of columns (3 m) | Fixed column supports | FY | FY | FY | Ratio FY(M) | Ratio FY(N) | Ratio FY(O) |
|-----------------|------------------------|-----------------------|----|----|----|------------|------------|------------|
| 50              | 9.9                    | 10                    | 7.5 | 7.5 | 7.5 | 97%        | 97%        | 93%        |
| 60              | 11.9                   | 10                    | 7.5 | 7.5 | 7.5 | 97%        | 97%        | 93%        |
| 80              | 15.8                   | 10                    | 7.5 | 7.5 | 7.5 | 97%        | 97%        | 93%        |
| 100             | 19.8                   | 10                    | 7.5 | 7.5 | 7.5 | 97%        | 97%        | 93%        |
| 120             | 23.8                   | 10                    | 7.5 | 7.5 | 7.5 | 97%        | 97%        | 93%        |
| 140             | 27.8                   | 10                    | 7.5 | 7.5 | 7.5 | 97%        | 97%        | 93%        |
| 160             | 31.7                   | 10                    | 7.5 | 7.5 | 7.5 | 97%        | 97%        | 93%        |
| 180             | 35.6                   | 10                    | 7.5 | 7.5 | 7.5 | 97%        | 97%        | 93%        |
| 200             | 39.5                   | 10                    | 7.5 | 7.5 | 7.5 | 97%        | 97%        | 93%        |
| 200             | 10.2                   | 10                    | 7.5 | 7.5 | 7.5 | 97%        | 97%        | 93%        |
| 60              | 12.3                   | 12                    | 7.5 | 7.5 | 7.5 | 97%        | 97%        | 93%        |
| 80              | 16.3                   | 12                    | 7.5 | 7.5 | 7.5 | 97%        | 97%        | 93%        |
| 100             | 20.3                   | 12                    | 7.5 | 7.5 | 7.5 | 97%        | 97%        | 93%        |
| 120             | 24.3                   | 12                    | 7.5 | 7.5 | 7.5 | 97%        | 97%        | 93%        |
| 140             | 28.5                   | 12                    | 7.5 | 7.5 | 7.5 | 97%        | 97%        | 93%        |
| 160             | 32.7                   | 12                    | 7.5 | 7.5 | 7.5 | 97%        | 97%        | 93%        |
| 180             | 36.6                   | 12                    | 7.5 | 7.5 | 7.5 | 97%        | 97%        | 93%        |
| 200             | 40.4                   | 12                    | 7.5 | 7.5 | 7.5 | 97%        | 97%        | 93%        |
| 50              | 8.3                    | 8.6                   | 9.58 | 9.64 | 9.66 | 96%        | 96%        | 93%        |
| 60              | 9.6                    | 9.9                   | 11.39 | 11.49 | 11.52 | 96%        | 96%        | 93%        |
| 80              | 11.9                   | 12.8                  | 14.89 | 15.1 | 15.1 | 96%        | 96%        | 93%        |
| 100             | 13.99                  | 14.8                  | 18.24 | 18.5 | 18.55 | 96%        | 96%        | 93%        |
| 120             | 15.9                    | 16                    | 21.5 | 21.8 | 21.87 | 96%        | 96%        | 93%        |
| 140             | 18.2                   | 16                    | 24.54 | 24.89 | 24.95 | 96%        | 96%        | 93%        |
| 160             | 20.6                   | 16.67                 | 27.3 | 27.7 | 27.8 | 96%        | 96%        | 93%        |
| 200             | 23.6                   | 16.67                 | 30.6 | 32.7 | 32.8 | 96%        | 96%        | 93%        |

Tables III and IV show that the lateral reaction forces have different values at analysed columns (M), (N) and (O) throughout all models. The reactions at Columns (N) and (O) almost have small variances especially in hinged models. The reaction of column (M) appears to be smaller than the response at the other analysed columns (N) and (O). The response ratio of column (M) to columns N and O ranges from 88% to 97% for hinged and fixed column conditions respectively. This provide a logic prediction of the effect of these loads on the dimensions of correlated columns and foundations. overall, hence the imposed thermal reaction forces at column O AT center of slab edge exceed those induced at columns M and N under fiikey conditions, the reactions from column O will be analysed precisely in this paper.
Fig. 4. Thermal reactions (FY) for all models with a slab thickness of 400 mm at external column.

Fig. 5. Thermal reactions (FY) for all models with a slab thickness of 300 mm at external column.

It is clear that concrete frames result with fixed supports conditions and three meters of storey height impose the largest and the most critical values of reactions. Regarding the impact of the building height at the lateral reaction result of multi-stories concrete frame building, table V shows that horizontal reactions related to fixed columns conditions with 3m height are 5 to 5.85 times larger than reactions of models with column heights of 6 m and fixity conditions. This ratio increased to around 11 for hinged conditions models. Finite element models showed that this ratio will increase with the slab length reduction. It is reduced from 11.5 to 10.30 for models with 50m slab length.

Table- V: Ratios of 3m column height reactions to 6m columns height for multi-storeies concrete buildings

| SlabLength (m) | Fixed conditions | Hinged conditions |
|----------------|------------------|------------------|
|                | FYO (3m) / FYO (6m) | FYO (3m) / FYO (6m) |
|                | Column Height (6m) | Column Height (6m) | Ratio % | Column Height (3m) | Column Height (3m) | Ratio % |
| 50             | 323               | 1891             | 5.8     | 76                  | 877              | 11.5   |
| 60             | 384               | 2165             | 5.6     | 91                  | 1026             | 11.2   |
| 80             | 499               | 2620             | 5.2     | 119                 | 1290             | 10.8   |
| 100            | 606               | 2975             | 4.9     | 146.8               | 1514             | 10.3   |

Regarding the impact of columns condition support at lateral reaction result of multi-stories concrete frame building, table VI shows that thermal reaction forces related to fixed column supports with 6m height are 4 times greater than those of hinged supports with same columns height. This ratio reduced to around 2 for models with 3m columns height. Finite element models showed that this ratio will increase slightly with the slab length reduction. It is increased from 3.8 for slab length 200m to 4.25 for models with 50m slab length and column height 6m, this increment is observed too for 3m columns height models whereas it increased from 1.96 for slab with length 100m to 2.15 for the slab with 50m length.

Table- VI: Ratios of fixed columns reactions to hinged columns for multi-storeies concrete buildings

| SlabLength (m) | Fixed conditions | Hinged conditions |
|----------------|------------------|------------------|
|                | FYO (3m) / FYO (6m) | FYO (3m) / FYO (6m) |
|                | Column Height (6m) | Column Height (6m) | Ratio % | Column Height (3m) | Column Height (3m) | Ratio % |
| 50             | 323               | 1891             | 5.8     | 76                  | 877              | 11.5   |
| 60             | 384               | 2165             | 5.6     | 91                  | 1026             | 11.2   |
| 80             | 499               | 2620             | 5.2     | 119                 | 1290             | 10.8   |
| 100            | 606               | 2975             | 4.9     | 146.8               | 1514             | 10.3   |

According to the preceding tables, increasing the thermal reaction forces at column supports reduces the correlated thermal displacements due to stiffness increment of the entire building. These results confirm the importance of analyzing thermal loads fluctuation at columns reactions for multi storeies buildings whereas the reactions of multi storeies cannot be predicted from single storey analysis and the columns and foundations are subjected to high horizontal reactions which has major impact at correlated size and integrity.

D. Analytical Discussion of Experimental Study Results and Finite Elements Models

A comparison study between Etabs finite elements models for existing parking building and the registered tests results of Aboumoussa and Iskandar [2] experimental study for the thermal response of same existing building within period of five years will be presented. 3D Etabs models will be generated based on NTDP and TDP of ordinary concrete. The results of Etabs finite elements models will be compared with actual thermal response of this building which was presented in Aboumoussa and Iskandar study to get a conclusion about recommended method for predicting thermal responses of concrete frame buildings. Four sensors are fixed in the experimental study, two sensors are at roof level while the others at level C (the third slab level) adjacent to the expansion joint edge. These sensors register the thermal displacement of the expansion joint at the north and the south parts of this building. Four Etabs models are generated based on NTDP and TDP of ordinary concrete and reflecting the maximum variation of temperature for each sensor at north side of the building and at the south side too. Figure 6 clarifies displacement at level ©—south part of the building in Etabs non-time dependent properties (N.T.D.P) models.
figures 7 and 8 present thermal displacements at roof level for sensor fixed at south part of the building for 4.5 years and 70 years respectively. While Figures 9 and 10 display thermal displacements at level C for sensor fixed at south part of the building for 4.5 years and 70 years respectively. Fig. 6. Horizontal displacement at level ©-south part of the building in Etabs N.T.D.P.

Table VII shows all ranges of displacements at the tests locations including all different methods. Firstly, the finite element models with non-time-dependent properties of concrete, then the time-dependent properties models with two different periods 4.5 and 70 years and finally the empirical test results by Aboumoussa and Iskandar. The displacements at north side seem very small, the allowed limit is h/180=2750/180=15.27mm, all values within 4.5 years period are lesser than 6mm. The north side displacements are not critical in all methods due to existence of huge retaining wall at north side, this wall reduced thermal displacements, small value of displacements don’t have impact at expansion joint location, so north side is not the critical one.

The range of displacements at south side of the building are close to the allowed limit h/180=2750/180=15.27mm. This side deformations are the critical with direct impact at expansion joint location. The used methods presented different values of displacements. It is clear that the displacement of time-dependent ETABS model with 4.5 years period is very close to test results with 1mm approximately difference, while non-time-dependent properties model’s results are lesser than tested results within 4.5 Years, so N.T.D. P. don’t represent the deformations of all span life of the building since it is even lesser than imposed displacement within 4.5 years. The predicted deformations within 70 years are about 17.5mm, they exceeded the allowed limit 15.27mm. It is clear that the expansion joint location is not within code requirements CEB-FIP for 70 years period, it can be categorized as a reason for observed cracks within this building during its service life.

Table- VII: The range of displacements in (mm) at tested sensors and finite elements models considering T.D.P and N.T.D.P

| Sensor side and level | N.T.D.P models | T.D.P. models | Test-sensors results Aboumoussa and Iskandar 2012 |
|-----------------------|----------------|---------------|-----------------------------------------------|
|                       | 4.5 years      | 70 years      | UYM(mm) | UYM(mm) | UYO(mm) | Δ˳(mm) |
| Roof -south           | 11.989         | 13.226        | 17.524  | 14.85   |
| level C-south         | 12.06          | 12.787        | 17.191  | 13.89   |
| Roof -north           | 5.5            | 5             | 14      | 0.08    |
| level C-north         | 6              | 6             | 13      | 0.08    |

Fig. 6. Horizontal displacement at level ©-south part of the building in Etabs N.T.D.P.

Fig. 7. displacement at roof level-south part of the building in Etabs T.D.P models for period 4.5 years.

Fig. 8. displacement at roof level-south part of the building in Etabs T.D.P models for period 70 years.

Fig. 9. displacement at level C-south part of the building in Etabs T.D.P models for period 4.5 years.

Fig. 10. displacement at level C-south part of the building in Etabs T.D.P models for period 70 years.
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IV. CONCLUSION

The fluctuation of temperature loads cause various lateral displacements on the external columns at slab edge on the first slab level. The transition is obvious in the registered displacements, but it is not the same. This variance increases in fixed models than hinged models. The thermal reaction forces at column (M) is smaller than those at columns (N) and (O). The size of foundations and columns for models with fixed conditions can be identical under thermal loads while the difference in the elements design is observed in structures with hinged supports. The thermal displacements rise with length of the floor slab and the height of the storey. The displacements of the 1st level of multi-storeies are almost identical with single storey models. The deformations at the 2nd storey are slightly more than the other levels deformations (1st, 3rd and 4th). Deformations of the upper levels above the 2nd storey seem very close to the 1st storey displacements. It leads to same allowed values for spacing between expansion joints for both single and multi-stories concrete frame buildings. For multi-storeies buildings, the thermal reaction forces induced at column (M) by thermal variation are smaller than those at columns (N) and (O). The ratio of thermal reaction of Column M reaction to columns N and O ranges from 94% to 97% for the hinged and the fixed columns respectively. This ratio is higher than was concluded for single story models which ranged from %50% to %58% in single hinged concrete models and 81%-89% for fixed single storey models. Over all, multi storeys model’s ratios are more than single story models which refers to increment in corner column reaction in multi-storey building under thermal loads effects. The ratios of multi storeys models to single storeys is not proportional to storeies number, for fixed models, this ratio varied from 150% to 180% for both heights while hinged model’s reactions ratios of multi-storeys to single storey are around 10 times for models with 3m column height and reduced to around 4 times for models with 6m columns height. Thermal reaction forces related to fixed column supports with 6m height are 4 times greater than those of hinged supports with same columns height. This ratio reduced to around 2 for models with 3m columns height.

Finite element models showed that this ratio will increase slightly with the slab length reduction. It is increased from 3.8 for slab length 200m to 4.25 for models with 50m slab length and column height 6m, this increment is observed too for 3m columns height models whereas it increased from 1.96 for slab with length 100m to 2.15 for the slab with 50m length. These results confirm the importance of analysing thermal loads fluctuation at columns reactions for multi storeies buildings whereas the reactions of multi storeies cannot be predicted from single storey analysis and the foundations are subjected to high horizontal reactions which has major impact at foundation size. A comparison study between Etabs finite elements models for existing parking buildings and the tests results of Aboumoussa and Iskandar (2012) of experiment study for thermal response of same existing building within period of 4.5 years are generated, the range of displacements at south side of the building are close to the allowed limit h/180=2750/180=15.27mm. This side deformations are the critical with direct impact at expansion joint location. The used methods presented different values of displacements. It is clear that the displacement of time-dependent ETABS model with 4.5 years period is very close to test results with 1mm approximately difference, while non-time-dependent properties models results are lesser than tested results within 4.5 Years, so N.T.D. P. don’t represent the deformations of allspan life of the building since it is even lesser than imposed displacement within 4.5 years. The predicted deformations within 70 years are about 17.5mm, they exceeded the allowed limit 15.27mm. It is clear that the expansion joint location is not within code requirements CEB-FIP for 70 years period, it can be categorized as a reason for observed cracks within this building during its service life.

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REFERENCES

1. Delsaute, J. Torrenti, J. and Staquet, S. Modelling basic creep of concrete since setting time. Cement and concrete composites, 2017. 83: 239-250.
2. Comite Euro-INTERNATIONAL DU BETON. CEB-FIP MODEL CODE 1990, 1999: 1-461.
3. Aboumoussa, W., and Iskandar, M. Thermal movement in concrete: case study of multi- storey underground car park. Materials in civil engineering, 2012. 109- M07: 63-70.
4. Hamza, O., S. Attard, D. and Gatt, R. (2015). and Anejode, O. (2016). ‘Effectiveness of expansion joints provision for temperature and load in steel structures’, International Journal of Research in Engineering AND Applied Sciences, 6, pp 209-223.
5. DAILY TEMPERATURE. https://weatherspark.com/history.
6. Badrah, M., and Jadid, N. (2013). ‘Investigation of developed thermal forces in long concrete frame structures’, benthamscience.net. Open Civil Engineering Journal, 3(7), pp 210-217.
7. Havel , A. Anthony,S.and Archilla, R. (2015). ‘Coefficient of Thermal Expansion of Concrete Mixes in Hawaii: Determination and Implications for Concrete Pavement’, Design. Journal of Materials in Civil Engineering, 27, pp 56-78.

AUTHORS PROFILE

Master’s Degree in structural – building Engineering, (Structure Section), Alhosn University2015, GPA 3.97/4 Preparing for Master’s Degree in Civil Engineering, (Structure Section), Damascus University High diploma (2 years with 10 structural subjects and thesis) in structural design engineering, Damascus University, 82% (2001) Bachelor’s Degree in structural/ civil Engineering, (structure Section), Damascus University, (1999) 20 years’ experience as structural designer engineer and then senior structural reviewer and designer 5 years as lecturer in Damascus university for civil engineering college A competent result-driven senior structural engineering professional with 20 years of experience, including 15 years international experience in the UAE in the Middle East, mainly in areas of managing, reviewing & structural designing engineering for many projects constructed as per recognized American codes, British standards and local authority’s requirements. A good team player, with ability to lead the team to deliver results and successfully meet strict deadlines. Possess quick decision-making abilities and leadership qualities, with ability to work efficiently in demanding work environments to meet deadlines.
Dr. Rosli Bin Noor Mohamed | Right alert
(DS52)
Second Vice-Chair of the School Chair Faculty of Engineering
School of Civil Engineering.
Department of Structure & Materials Faculty of Civil Engineering University of Technology Malaysia Skudai, email rosli@utm.my

Academic coordinator at post graduate (course work) with continuous following up with post graduate students.

Senior Lecturer, Universiti Teknologi Malaysia With different onferences and publications such as:

Shear strength of short recess precast dapped end beams made of steel fibre self-compacting concrete
RN Mohamed, KS Elliott
33rd Conference on Our World in Concrete & Structures, Singapore
Concrete
The effects of inclined shear reinforcement in reinforced concrete beam, NF Zamri, RN Mohamed, NHA Khalid, KY Chiat Malaysian Journal of Civil Engineering 30 (1)
Bond stress in grouted spiral connectors
ABA Rahman, M Mahdinezhad, IS Ibrahim, RN Mohamed Jurnal Teknologi 77 (16)
Shear capacity of composite slab reinforced with steel fibre concrete topping
IS Ibrahim, MBC Bakar, NN Sarbini, RN Mohamed Malaysian Journal of Civil Engineering 23 (1)
Properties of Lightweight Concrete Using Palm Oil Clinker in Prestressed Concrete Beam
W Omar, RN Mohamed Universiti Teknologi Malaysia.

Dr. Mariyana Aida Ab Kadir is a Senior Lecturer at the Structure and Materials Department, Faculty of Civil Engineering, Universiti Teknologi Malaysia (UTM). She is the Research Fellow at the Institute of Noise and Vibration (INV) and Engineering Seismology and Earthquake Engineering Research (eSEER). After completing her secondary education at Mara Junior Science Collage, she pursue her B.Eng in Civil Engineering at UTM with First Class Honours and Chancellor’s Award in 2005. She was awarded with Erasmus Mundus Scholarship for M.Sc in Earthquake Engineering and Seismology Engineering at two universities; University of Pavia, Italy and Université Joseph Fourier, Grenoble France before completing a PhD at University of Edinburgh, Scotland United Kingdom in Structural Seismic and Fire Engineering. Dr. Mariyana research interest focuses on the vulnerability of structures expose to risk of hazards for earthquake and fire, soil-structure interaction, input ground motion for structural design, new structural system for earthquake and fire, and durability of concrete materials. She particularly focuses on the earthquake and fire performance of concrete structure.