Numerical Evaluation of the Effect of the Upper Steel Mesh on the Behaviour of Mono-symmetric Steel-Concrete Composite Section

Ahmed Kamar[1], Mahmoud Lasheen[2], Amr Shaat[3], Amr zaher[4], Ayman Khalil[5]

[1] Department of Building and Construction, Faculty of Engineering, October 6 University, Giza, Egypt. Ahmed.kamar.eng@o6u.edu.eg
[2] Concrete Construction Research Institute, Housing and Building National Research Center, Cairo, Egypt.
[3,4,5] Department of Structural Engineering, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

Abstract – *In this paper, a nonlinear finite element model (FEM) was developed using ABAQUS 6.14 to study the effect of the upper steel mesh on the behaviour of mono-symmetric steel-concrete composite (SCC) beams provided with channel shear connectors. Moreover, the FEM will be used to calculate the effective width of the concrete slab against the existence of upper steel reinforcement mesh and compare the results with the calculation of the effective width in the universal codes (i.e., AISC 360-15, CSA S16-14 and the Eurocode 4; CEN 2004). In this respect, six (SCC) beams were modeled to study the effect of the upper steel mesh on SCC beams' behaviour. The results of this study showed that the increase in the ratio of the upper steel reinforcement mesh is affecting the value of the ultimate load, mid-span deflection value and slip value at the steel-concrete interface. The presence of upper steel reinforcement mesh with a ratio of 0.91% from the area of the concrete slab leads to decreased vertical deflection by 32.5 % at the ultimate load of the beam without upper steel reinforcement mesh for beams. Also, the slip value decreased by 60 % at the ultimate load. Also, the effective width of the concrete slab for beams provided with the channel shear connectors increases with the increase in the ratio of the upper steel reinforcement mesh.*

Keywords: *Finite element, Mono-symmetric, Composite beam, Effective width, Upper steel mesh, Reinforcement ratio, slip value.*

I. Introduction

Composite steel-concrete (SCC) solutions are popular in construction applications. The SCC beams formed by two materials amalgamated together act as a single unit. This structural arrangement results in an efficient, lightweight beam with a high load-carrying capacity, the possibility of obtaining larger beam spans and fast construction. Moreover, using a mono-symmetrical steel section is more cost-effective than a double-symmetrical section in SCC, due to the presence of concrete in the compression part of the SCC beams [1].

In steel–concrete composite beams, the steel embedment inside the concrete slab such as the shear connectors and reinforcement bars play important role in the overall behaviour of the beams. The reinforcement mesh inside the concrete slab can affect the stress and strain redistribution in the transverse direction of the slab, while also decreasing the vertical deflection of the beam [2]. Additionally, the reinforcement mesh can affect assessing the slip of the concrete slab. In addition to the above, most of the codes (i.e., AISC 360-15 [3], CISC S16-14 [4] and the Eurocode 4; CEN 2004 [5]) and specifications neglect the presence of the upper transverse steel in calculating the capacity of the composite beams. However, the presence of the upper transverse steel reduces or prevents the presence of upper cracks in the slab, which affects the calculation of the capacity of the composite beams, the slip value between the slab and steel beam and the calculation of the effective width of the slab. So, the presence of reinforced steel in the concrete slab is studied to find the effect of the upper transverse steel mesh on the effective slab width and behaviour of the concrete slab.

The concrete slab in the steel-concrete composite beams is typically subject to variable compression stresses along its overall width and thickness. The importance of evaluating the effective slab width in the mono-symmetric steel-concrete composite beams comes from finding the exact beam deflection and the actual stress-strain distribution along with the mono-symmetric steel-concrete composite beam depth. The effective slab width concept is used in the flexural analysis of the mono-symmetric steel-concrete composite beams to simply the computation of flange bending stresses. Longitudinal compressive stress distribution along the concrete slab width is non-uniform, with high values above the steel beam, which decreases at the slab boundaries [6]. This phenomenon is called the 'shear lag' The shear lag contributes to a natural, non-uniform distribution of stress over the width of the slab [7–8]. The calculation of the effective width in the universal codes (i.e., AISC 360-15 [3] & CSA S16-14 [4]) depends on the beams span and spacing between steel beams. Besides, the effect of reinforcement mesh is not mentioned. However, most recent research in the field of the composite beams has introduced different new parameters which affect the effective slab width [9-10]. The effective concrete width depends on the loading stage. The effective width at ultimate loads is wider than that at service loads [10]. Therefore, the evaluation of the effect of reinforcement mesh on the effective width value of the concrete slab attached to the mono-symmetric steel section becomes crucial.

In this respect, a numerical investigation is carried out to study the effect of the upper steel mesh on the behaviour of mono-symmetric steel-concrete composite (SCC) beams. Also, the numerical results will be used to investigate the effect of using the upper reinforced steel mesh on load capacity. The effect of top reinforcement mesh on the effective slab width of a mono-symmetric steel section will also be discussed in the current study. Moreover, the FEM will be used to calculate the effective width of the concrete slab against the existence of upper steel reinforcement mesh and compare the results with the calculation of the effective width in the universal codes (i.e., AISC 360-15, CSA S16-14 and the Eurocode 4; CEN 2004).

II. Finite element model

Six specimens were modelled using ABAQUS 6.14 [11] as listed in Table 1. The details of beams are shown in Figures 1 and 2. The main variable of the study had been the upper steel reinforcement mesh ratio. This numerical model was conducted on six beams to evaluate the contribution of using the upper reinforced steel mesh on the ultimate load capacity, deflection values, strain values, slip values at the steel-concrete interface. Also, to study the effect of top mesh on the effective slab width of a mono-symmetric steel section and compares the results with the codes limit. As shown in Table 1, the mono-symmetrical steel beams with a total length of 5000 mm were simply supported with a 4800 mm clear span. The span-to-composite section depth ratio (L/d) is calculated for all beams, as shown in Table 1. Also, the ratio between slab width to span (BS/L) and the slenderness ratio (L/rs) is equal to 0.25 and 42.15, respectively, for all beams. The connectors' spacing of all beams is 200 mm. According to Table 1 and Fig. 2, All beams have a concrete slab thickness of 140 mm and concrete slab width of 1200 mm. The lower reinforcement of concrete slabs is a mesh of 8 mm diameter and 200 mm spacing in both longitudinal and transverse directions for all beams. The upper reinforcement of concrete slabs is a variable, as shown in Table 1 with 200 mm spacing in both longitudinal and transverse directions. It should be noted that the ratio between the area of upper steel mesh to the area of the concrete slab is varying from 0.18% to 0.91%.

II.1. Material model

Concrete modeling

The damage simulation for reinforced concrete elements can be done using ABAQUS 6.14, which offers three crack models: smeared crack concrete model, brittle crack concrete model, and concrete damaged plasticity model. In the current research, the concrete damaged plasticity model was utilized to represent the concrete slab. This model can depict the complete inelastic behaviour of concrete, including damage characteristics, in both tension and compression. The model assumes that the two major failure mechanisms in concrete are tensile cracking and compressive crushing. The uniaxial tensile and compressive behaviour is characterized by damaged plasticity. The compressive strength and Young's modulus of the proposed NWC are 28 MPa and 24 GPa, respectively, while the density and Poisson ratio of concretes are considered as 25 kN/m^3 and 0.2. To define the strain-softening behaviour for cracked concrete, tension stiffening is used to model the post-failure behaviour for direct tension across cracks. Studies have shown that a total strain of 0.1 is preferred for reinforced concrete slabs in SCC beams, instead of the previously accepted value of 10 times the tensile cracking strain [12,13,14].

Steel modeling

The Bi-linear model is employed for steel material. The properties of steel sections, shear connectors, and steel reinforcement bars are indicated in Table 2. The elastic properties of steel beams were assumed to be 210 GPa for Young's modulus and 0.3 for Poisson's ratio.

Steel-concrete interaction

To define the interaction between the concrete slab and internal steel reinforcement bars, the truss in solid technique option was utilized in ABAQUS 6.14. This technique models the concrete slab as the host region using continuum solid elements, while the reinforcement bars are modelled as embedded elements using truss elements. The contact surfaces between the concrete slab and channel shear connector, as well as between the lower surface of the concrete slab and the upper surface of the steel beam flange, were modelled using the surface-to-surface contact algorithm. The channel shear connector was designated as the master surface, while the concrete slab was assigned as the slave surface. Similarly, the upper steel flange was designated as the master surface, while the concrete slab was assigned as the slave surface. The contact property was defined by tangential and normal behaviours to account for friction, elastic slip, penetration, and separation. The tangential behaviour used a penalty friction formulation with a coefficient of 0.5, while the normal behaviour used hard pressure over closure. Welded regions, such as the welded lines between the shear connector and steel beam flange, were modelled using tie constraints to prevent separation at the weld positions.

II.2. Element type and mesh

The element meshing, constitutive material models, and boundary conditions all have an impact on how accurate the findings are. Therefore, in the suggested FE mode, these parts are precisely investigated. In this study, the concrete and steel parts of the model were represented by eight-node brick elements with reduced integration (C3D8R). A maximum mesh size of 20 mm was selected for these elements. The reduced integration approach avoided the need for higher-order solid elements, while still maintaining the reliability of the measured responses. This element type also addressed hourglass issues that frequently arise with continuum linear solid elements. A regular structured hexahedral mesh was employed. The reinforcement bars were modelled using three-dimensional truss elements (T3D2) in linear order, with a maximum mesh size of 20 mm. This element type was used for all reinforcement types.

II.3. Boundary conditions and load arrangements

Due to the symmetry in the geometry, loading, and boundary conditions, a quarter of the specimen was simulated, as illustrated in Fig.3. The model employed axes 1, 2, and 3 to represent the X, Y, and Z coordinate axes, respectively. The symmetry planes are depicted in Figure 1. External loads were modelled as a proportional pressure applied to the top surface of the concrete slab over a contact width of 100 mm x 200 mm at the load point location.

III. Results

The results of the current study will be discussed in this section for all beams models. This section illustrates the effect of using different ratio of the upper steel reinforcement mesh on the behaviour of the SCC beams. A summary of study results, including the ultimate load, mid-span deflection value at yield and ultimate, slip value at the steel-concrete interface at yield and ultimate and the effective concrete slab width, are presented in Table 3. Also, the results are presented in terms of the load-deflection, load-steel strain, load-concrete strain and load-slip value for all beams as shown in Fig.5.

III.1. Effect of the upper steel reinforcement mesh on the ultimate load

The results demonstrate a notable increase in the failure load of the beams as the ratio of upper steel reinforcement mesh increased. Fig.6.a illustrates this trend. For instance, beam B2 with upper steel reinforcement mesh at a ratio of 0.18% from the area of the concrete slab exhibited a 7.9% higher failure load than beam B1 without upper steel reinforcement mesh. The failure load of beam B2 was 622.58 kN. Similarly, beam B3 with upper steel reinforcement mesh at a ratio of 0.28% demonstrated an 8.4% higher failure load than beam B1, with a failure load of 625.4 kN. Further, beam B4, B5, and B6 with upper steel reinforcement mesh ratios of 0.4%, 0.72%, and 0.91% respectively showed failure load increases of 9%, 10.1%, and 10.4% compared to beam B1 without upper steel reinforcement mesh. The failure loads for these beams were 628.8 kN, 635.1 kN, and 636.9 kN, respectively.

III.2. Effect of the upper steel reinforcement mesh on mid-span deflection value.

The inclusion of upper steel reinforcement mesh reduced deflection due to a reduction of cracks along the total span. Fig.6.b illustrates the effect of upper steel reinforcement mesh with a ratio of 0.18%, 0.28%, 0.4%, 0.72%, and 0.91% from the area of the concrete slab on beam B2, B3, B4, B5, and B6.

At the ultimate load of beam B1 without upper steel reinforcement mesh, beam B2 with upper steel reinforcement mesh exhibited an 18.5% reduction in vertical deflection, measuring 46.61 mm compared to 57.24 mm.

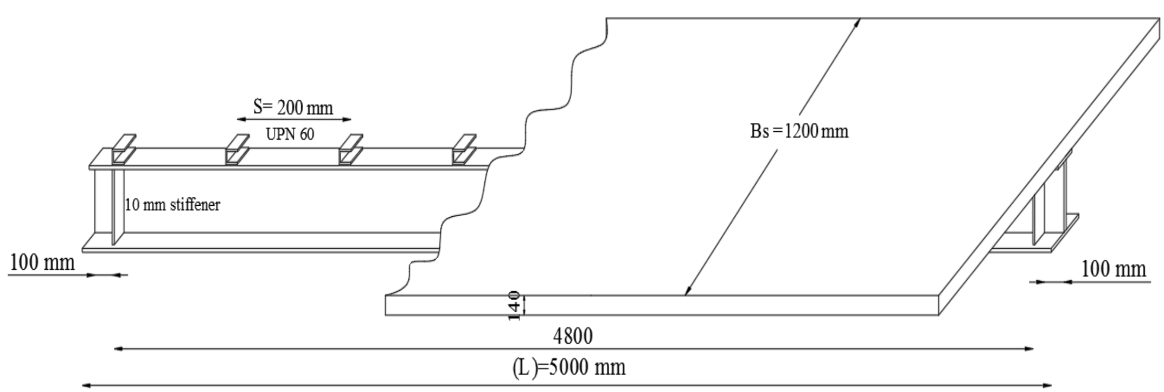


Fig. 1. Details of Test Specimens

TABLE I

DETAILS OF TEST SPECIMENS.

Beam ID	Total Length (mm)	Slab width, Bs(mm)	slab thickness , ts(mm)	Connector shape	h w (mm)	t w (mm)	t f (mm)	b L (mm)	b u (mm)	L/rs	L/d	Upper transverse steel
B1												Without
B2												With 5Ø8/m
B3	5000	1200	140	UPN 60	260	8	12	200	100	42.2	11.32	With 5Ø10/m
B4												With 5Ø12/m
B5												With 5Ø16/m
B6												With 5Ø18/m

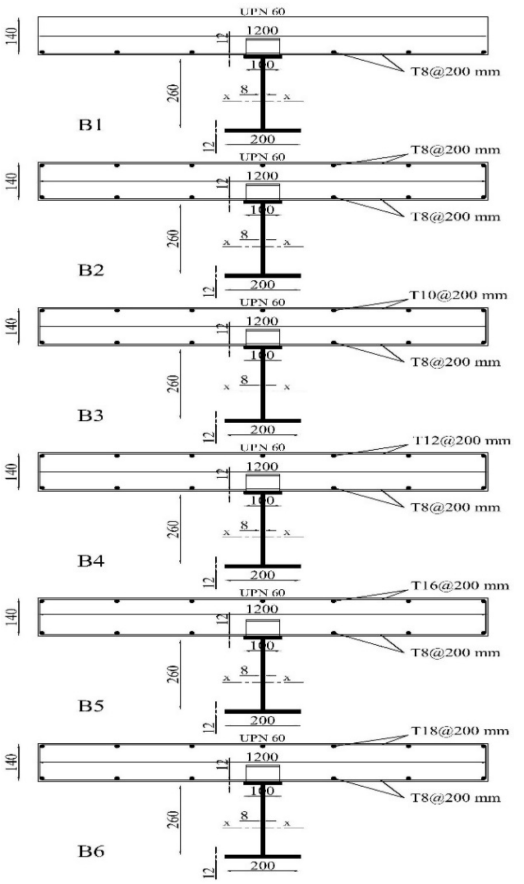


Fig.2. Dimensions of Test Specimens.

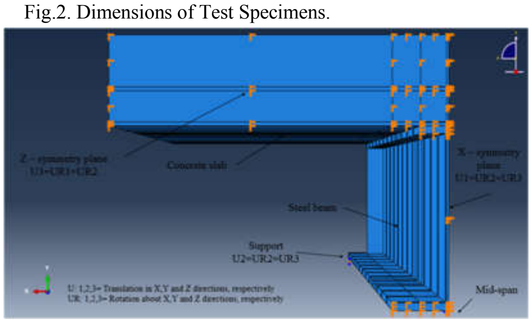


Fig.3. Boundary Conditions for One Quarter of SCC Beam.

Similarly, beam B3 with 0.28% reinforcement demonstrated a 19% reduction in vertical deflection, measuring 46.36 mm. Beam B4, B5, and B6 with 0.4%, 0.72%, and 0.91% reinforcement ratios respectively, showed vertical deflection reductions of 23.5%, 27.45%, and 32.5% at the ultimate load of beam B1 without upper steel reinforcement mesh. The recorded deflection values for B4, B5, and B6 were 43.79 mm, 41.53 mm, and 38.63 mm, respectively.

TABLE II

MECHANICAL PROPERTIES OF STEEL PLATES AND STEEL REINFORCEMENT.

Steel Section	Average Yield Stress, fy (MPa)	Average Ultimate Stress, fu (MPa)	Average Young's Modulus, E (GPa)	Average Elongation/ Shortening at ultimate %
Plate 8 mm	290	470	210	28.3
Plate 12 mm	360	550	210	21
Diameter 8 mm	350	435	200	13.6
Diameter 10,12,16,18 mm	490	570	200	14.1

III.3. Effect of the upper steel reinforcement mesh on slip value.

The inclusion of upper steel reinforcement mesh in the concrete slab reduced the slip value between the concrete slab and steel section by limiting the occurrence of cracks in the concrete slab, as shown in Fig.6.c. Beam B2, with upper steel reinforcement mesh at a ratio of 0.18% from the area of the concrete slab, demonstrated a 51.2% reduction in slip value at the ultimate load of beam B1 without upper steel reinforcement mesh. The slip values recorded for beam B2 with upper steel reinforcement mesh and beam B1 without upper steel reinforcement mesh were 0.4 mm and 0.81 mm, respectively. Similarly, beam B3, B4, B5, and B6 with upper steel reinforcement mesh ratios of 0.28%, 0.4%, 0.72%, and 0.91% respectively showed slip value reductions of 56.2%, 57.5%, 59.4%, and 60% at the ultimate load of beam B1 without upper steel reinforcement mesh. The recorded slip values for beam

TABLE III
SUMMARY OF BEAMS RESULTS

Beam ID	Failure Load (kN)	Deflection at yield (mm.)	Deflection at ultimate (mm.)	Slip Value at yield (mm.)	Slip Value at Ultimate (mm.)	Effective width (Be) (mm.)
B1	576.82	13.7	57.24	0.165	0.81	1070.5
B2	622.58	13.88	72.69	0.166	0.81	1097.4
B3	625.41	13.76	69.03	0.165	0.79	1109.5
B4	628.82	13.66	66.67	0.165	0.8	1126
B5	635.1	13.33	63.46	0.165	0.88	1152.8
B6	636.92	13.25	61.68	0.164	0.88	1167.6

TABLE IV
EFFECTIVE SLAB WIDTH AT THE ELASTIC STAGE ACCORDING TO FEM, CODES LIMITS, ANSI/AISC 360-15, CAN/CSA S16-14 AND EUROCODE 4; CEN 2004.

Beam ID	B1	B2	B3	B4	B5	B6
Be F.E. (mm)	1070.5	1097.4	1109.5	1126	1152.8	1167.6
Be code. (mm)	1200	1200	1200	1200	1200	1200
% F.E. / Code	89.2	91.5	92.5	93.8	96.1	97.3
Be AISC (mm)	1042.7	1090	1093.6	1097.9	1105.8	1107.9
% F.E. / AISC	102.7	100.6	101.4	102.6	104.25	105.3
Be CSA (mm)	1191.2	1200	1200	1200	1200	1200
% F.E. / CSA	89.9	91.5	92.5	93.8	96.1	97.3
Be Eurocode (mm)	1078.7	1142.8	1146.8	1151.4	1160.1	1162.3
% F.E. / Eurocode	99.2	96.03	96.7	97.8	99.3	100.4

B3, B4, B5, and B6 were 0.36 mm, 0.345 mm, 0.33 mm, and 0.32 mm, respectively.

III.4. Calculation of the effective width of the concrete slab

The effective concrete slab width is calculated based on the numerical model for the six specimens. The effective concrete slab width is calculated at the elastic stage. The results of calculating the effective concrete slab width from the numerical model will be compared with the calculation of the effective width in the universal codes (i.e., AISC 360-15, CSA S16-14 and the Eurocode 4; CEN 2004). The effective concrete slab width is calculated based on the total compressive force in the slab. The total compressive force in the concrete slab (C slab) is calculated using Eq. (1).

$$C_{slab} = \sum_{i=1}^{n} \sigma_i . A_i \qquad (1)$$

where "n" is the number of slab elements, "i" is the element number, "σ" is the longitudinal stress at each element, and "Ai" is the cross-sectional area of the element "i", as shown in Fig. 4.

The effective concrete slab width can be computed using Eq. (2).

$$B_e = \frac{C_{slab}}{average\ stress\ x\ slab\ thickness} = \frac{C_{slab}}{\frac{\sum \sigma_i}{n} x\ t} \qquad (2)$$

where Be is the total effective slab width for beam and "t" is the total slab thickness, as shown in Fig. 4.

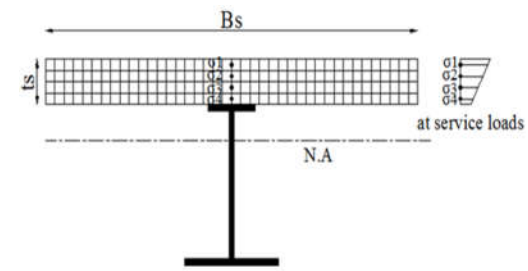


Fig.4. Stress Distribution along Slab Thickness.

The effective concrete slab width for each SCC beam is determined according to Eq. (2) at the elastic stage, as shown in Table 3. Also, the effective concrete slab width for each SCC beam is calculated according to the universal codes (i.e., AISC 360-15, CSA S16-14 and the Eurocode 4; CEN 2004), as shown in Table 4.

The effective slab width obtained from the numerical model was compared to the effective width calculated in universal codes. The results for ANSI/AISC 360-15 showed that the average difference between the FEM and the code's results ranged from 3%, with a maximum and minimum difference of 5% and 1%, respectively, as shown in Table 4. Conversely, for CSA S16-14, the average difference was 6.5%, with a maximum and minimum difference of 10% and 3%, respectively. For Eurocode 4; CEN 2004, the average difference between the FEM and the code's results was 2%, with a maximum and minimum difference of 4% and 0.5%, respectively, as illustrated in Table 4.

III.5. Effect of the upper steel reinforcement mesh on the effective concrete slab width.

This section investigates the impact of different upper steel reinforcement mesh ratios on the effective slab width. The results indicate that the effect of upper steel reinforcement mesh on the effective width of the concrete slab is slight for beams.

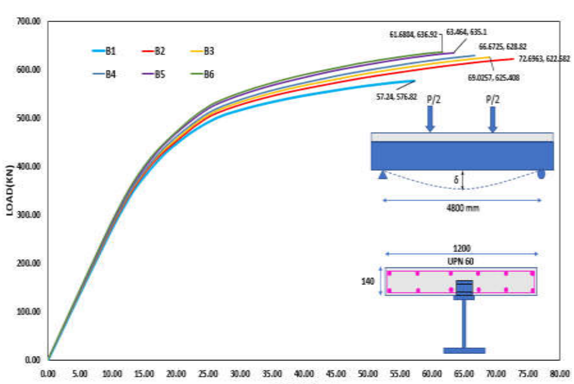
Fig.6.d demonstrates that beam B2 with upper steel reinforcement mesh at a ratio of 0.18% from the area of the concrete slab had a 2.5% increase in effective slab width value at the service load of beam B1 without upper steel reinforcement mesh. The effective slab width values for beam B2 with upper steel reinforcement mesh and

beam B1 without upper steel reinforcement mesh were 1097.4 mm and 1070.5 mm, respectively. Similarly, beam B3, B4, B5, and B6 with upper steel reinforcement mesh ratios of 0.28%, 0.4%, 0.72%, and 0.91%, respectively, showed increases in effective slab width values of 3.64%, 5.2%, 7.7%, and 9.1% at the service load of beam B1 without upper steel reinforcement mesh. The effective slab width values for these beams were 1109.5 mm, 1126 mm, 1152.8 mm, and 1167.6 mm, respectively.

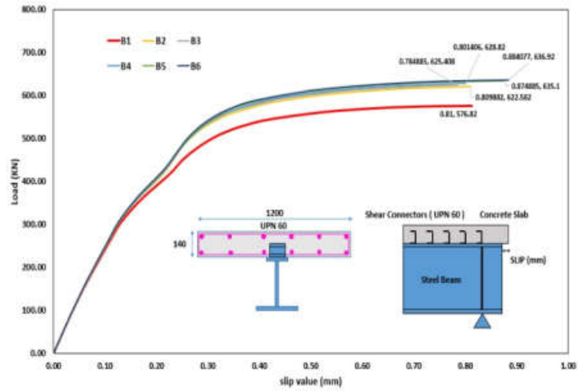
IV. Conclusions

This study had shown that using the upper reinforced steel mesh with different ratio effects on the load capacity and the value of the effective slab width in the mono-symmetric steel section. The following conclusions are drawn:

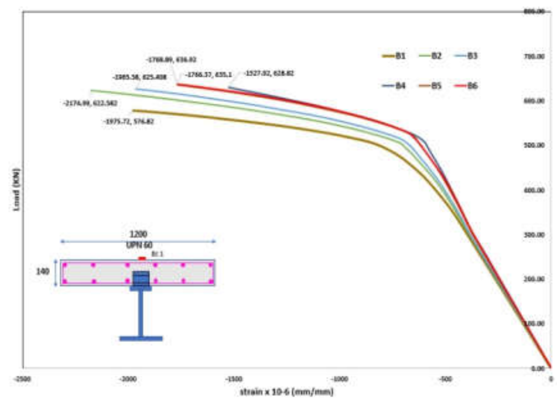
1. The results of the FEM showed that the increase in the ratio of the upper steel reinforcement mesh affects the value of the ultimate load, mid-span deflection value and the slip value at the steel-concrete interface.
2. For beam with upper steel reinforcement mesh at the concrete slab, the ultimate load capacity increasing by 7.9% than the beams without upper steel reinforcement mesh.
3. For beam with upper steel reinforcement mesh at the concrete slab, the deflection is decreasing by 18.5% than the beams without upper reinforced steel mesh, because the cracks are decreasing along the total span.
4. The presence of upper steel reinforcement mesh reduces the slip value between the concrete slab and the steel. The presence of upper steel reinforcement mesh with a ratio of 0.91% from the area of the concrete slab leads to decrease the slip value by 60 % at the ultimate load of the beam without upper steel reinforcement mesh.
5. For beam with upper steel reinforcement mesh at the concrete slab, the upper transverse steel in the concrete slab leads to preventing longitudinal cracks in the concrete slab and thus a decrease in the slip value of the concrete slab by 47% at the yield stage comparing with the beams without upper steel reinforcement mesh.
6. The presence of upper steel reinforcement mesh with a ratio of 0.91% from the area of the concrete slab leads to decreased vertical deflection by 32.5 % at the ultimate load of the beam without upper steel reinforcement mesh.



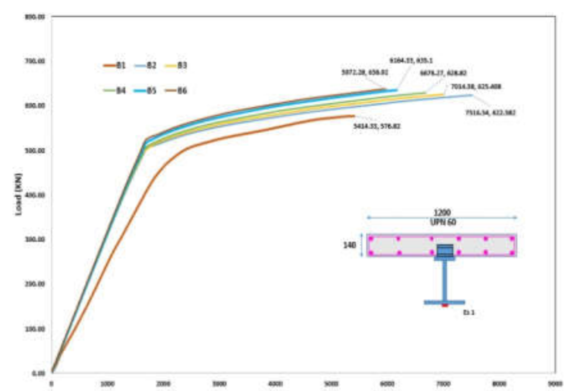
a. Load versus mid-span deflection for beams B1 to B6.



b. Load versus slip of concrete slab for beams B1 to B6.

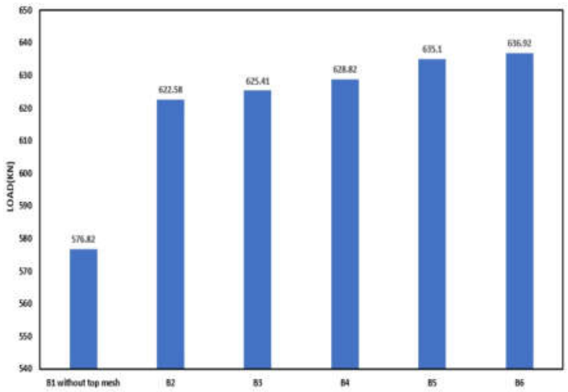


c. Load versus mid-span upper strain of concrete slab for beams B1 to B6.

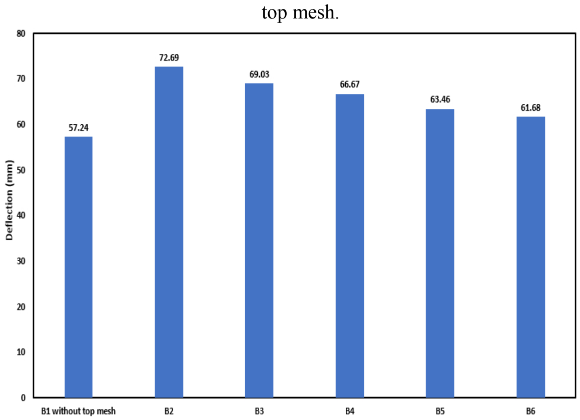


d. Load versus mid-span strain at steel lower flange for beams B1 to B6.

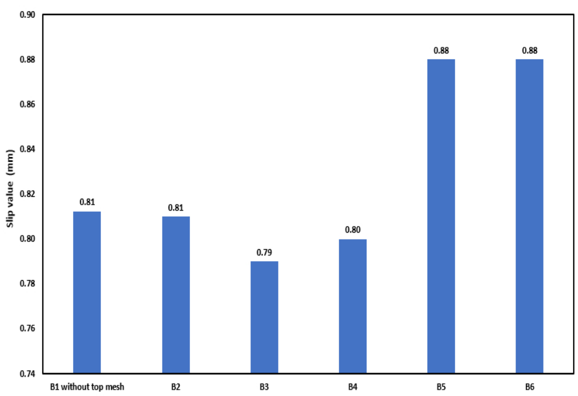
Fig.5. Numerical Results for all Beams.



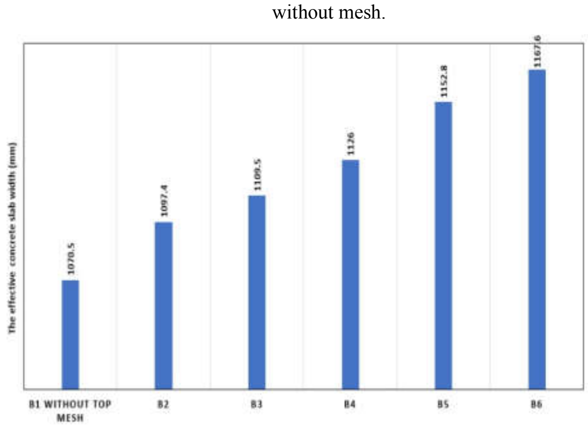
a. Comparison of the failure load for the specimens with and without top mesh.



b. Comparison of the deflection for the specimens with and without top mesh.



c. Comparison of the slip value for the specimens with and without mesh.



d. Comparison of the effective concrete slab width for the specimens with and without top mesh.

Fig.6. Effect of the Upper Steel Reinforcement Mesh on Specimens.

References

[1] Kamar, Ahmed, Mahmoud Lasheen, Amr Shaat, Amr zaher, and Ayman Khalil. "Behaviour of Mono-symmetric Steel-concrete Composite Section provided with Angle and Channel Shear connectors" International Journal of Research in Engineering & Management 4(1), 2020, pp. 36-51.

[2] Kamar, Ahmed, Mahmoud Lasheen, Amr Shaat, Amr zaher, and Ayman Khalil. " Factors affecting slip and stress distribution of concrete slabs in composite beams" Engineering Structures, Volume 245, 2021.

[3] American Institute of Steel Construction, ANSI/AISC-360-15.Specification for Structural Steel Buildings, Chicago, Illinois.

[4] Canadian Standards Association, CAN/CSA-S16-14, Limit states design of steel structures, Mississauga, Ontario.

[5] Eurocode, Design of Composite Steel and Concrete Structures. Part 1. 1: General Rules and Rules for Buildings, 2004.

[6] M. Chiewanichakorn, A. Aref, S. Chen, I. Ahn, Effective flange width definition for steel– concrete composite bridge Girder, J. Struct. Eng., ASCE 130 (12) (2004) 2016–2031.

[7] G. Sedlacek, S.A. Bild, Simplified method for the determination of the effective width due to shear lag effects, J. Constr. Steel Res. 24 (1993) 15582.

[8] L. Dezi, F. Gara, G. Leoni, A.M. Tarantino, Time-dependent analysis of shear-lag effect in composite beams, J. Eng. Mech. 127 (1) (2001) 71–79.

[9] C. Amadio, C. Fedrigo, M. Fragiacomo, L. Macorini, Experimental evaluation of effective width in steel–concrete composite beams, J. Constr. Steel Res. 60 (2) (2004) 199–220.

[10] Mahmoud Lasheen, Amr Shaat and Ayman Khalil (2016) “Behavior of lightweight concrete slabs acting compositely with steel I-sections.” J.conbuildmat , 124 (2016) 967-981.

[11] ABAQUS, Theory Manual Version 6.14, Dassault Systemes, 2014.

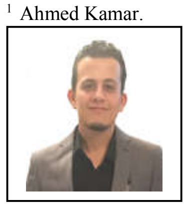
[12] K. Baskar, N.E. Shanmugam, Thevendran, Finite element analysis of steel-concrete composite plate girder J. Struct. Eng. ASCE 128 (9) (2002) 1158–1168.

[13] Q.Q. Liang, B. Uy, M.A. Bradford, H.R. Ronagh, Ultimate strength of continuous composite beams in combined bending and shear, J. Constr. Steel Res. 60 (8) (2004) 1109–1128.

[14] Q.Q. Liang, B. Uy, M.A. Bradford, H.R. Ronagh, Strength analysis of steel–concrete composite beams in combined bending and shear, J. Struct. Eng. ASCE 131 (10) (2005) 1160–1593

Authors’ information

[1] Ahmed Kamar.



Ahmed Kamar was born in Tanta – Gharbia. He completed his Bachelor of Engineering- Building and Construction Department- October 6th University, Egypt, in 2007. Subsequently, he pursued a Master of Science in Civil Engineering (Structures) from Ain Shams University, Egypt, graduating in 2015. Subsequently, he pursued a Doctor of Philosophy in Civil Engineering (Structures) from Ain Shams University, Egypt, graduating in 2021.

He has experience in academia work, serving as a Demonstrator, Teaching Assistant, Assistance Professor, in the Faculty of Engineering at October 6th university. He has a diverse range of research interests, focusing on Composite Design and Structural analysis.