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High Strength Concrete Deep Beam With Opening

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Abstract - Through this paper investigation of opening shapein high strength fiber reinforced concrete deep beams without stirrups have been studied to report a comparison between specimens with maximum opening different shape (square, circle) at shear span center in term of load-deflection curve, pattern of crack and stress- strain curve, this paper investigate which specimen has better shape than other. This study done by testing nine specimens one of these is control deep beam without opening and steel fiber while the other aretwo group each group has four specimens with different opening shape and steel fiber content (0,0.5,0.75,1)%, the opening were square (0.387dX0.387d) while the circle opening is (0.435d) diameter all opening located at the shear span center and reinforced by (3Ø16mm) at the bottom and (2Ø12mm) at the top and two stirrups to prevent local failure. The results showing that the circle opening shape has good stress distribution around opening and get more strength than square opening. The modeling of specimens in abaqus have good agreement with experimental result.

Keyword - High Strength , Deep Beam , Openin

I. INTRODUCTION

Deep beam has a (In<4h) that mean a depth deeper than overall length and its geometry make the distribution of strain and stress do not a linear distribution. Two meet the requirement of architecture and because the depth increasing
more than ordinary beam limit, the principle stress is change
and the compression path mad due to the transfer of stress to the support, the failure is controlled rather than flexure and after applied the load the section do not remain plane and the distribution of strain and stress through the depth of beam became non linear and the prediction of the shear strength in deep beam don by two dimensional elasticity analysis (strut-tie method and finite element).

Some times in the building the services may be intersect with beam used in building, so that the opening in beam is required to pass the service, this opining make with different size and location, like electrical, ducts and other services, the strength of deep beam is decreases due to the opening , the cracks around opening will appear and the deep beam behavior with opening will different compared with solid deep beam.

II. State Of the Art

Naik and Kute (2013) **[1], studied that the high-strength concrete deep beam strengthen with steel fiber effected by**
The Span-to-depth ratio, in this study the (ANN8) neural network used to assessment shear strength of RC deep beam strengthen with steel fiber by taking (L/D) on shear span in consideration, notice a high of shear strength between obtain data from ANN8 and equations of previous studies

Mohamed (2013)**[2]** , RC Deep beam with steel fiber with different web Opening size, study the behavior of deep beam with different size of opening strengthen with steel fiber, by using ADINA program the sixteen model have been analyze the size of opining and steel fiber different in each models, the result show that the ultimate load in beam increase by using the steel fiber.

YANG S. S. (2015) **[3]** study the effect of size and location of opening on reinforced concrete deep beam in term of deflection and crack pattern by using ANSYS 12.0, By creating seven models consisting of solid beams and three models with different opening size and the last three models with different location of opening.

Results show that the deflection of reinforced concrete deep beam increases by 31.2% when the opening size increase by 60% and for different locations of opening as moving toward the center of the beam about (350 mm) the deflection increased by 31.8%, the best location of opening on reinforced concrete deep beam is far away from the loading.

Sethuraman at el (2017) **[4]** , **Using ABAQUS in Analysis RC High Strength Beams,** This study used ABAQUS program to analysis the result of the beam which recently have been don , and a comparison made between analytical and experimental result, a twelve specimens have been tested under static and cyclic load then ABAQUS program used to analyzed the specimens. Finally the good agreement notice between the ABAQUA program and experimental works.

III. EXPERIMENTAL WORK

The teste have been done in the laboratory of collage of engineering.

- **Cement** Commercially available ordinary Portland cement (OPC), confirming to Iraqi specifications (5:1984)**[5]**, was utilized in the mixes. The chemical and physical characteristics of (OPC) cement are displayed in Table 1.
- **Fine aggregate** available locally available natural sand is applied as fine aggregate conforming to (45:1984) **[6].** The fine modulus of 2.42 sulfate content is 0.1% with a density of fine aggregate of 1600 kg/m 3 . The grading of fine aggregate is demonstrated in Table 2

- **Coarse aggregate** The coarse aggregate utilized was crushed gravel with max sizes (14, 20) mm, sulfate content of 0.08%, with a density of coarse aggregate of 1600 kg/m 3 . It conforms to the requirements of (45:1984) **[6].** The grading of coarse aggregate is demonstrated in Table 3.
- **Steel reinforcement**, For reinforcement of deep beam (ø 12mm) used for top reinforcement , (ø 16mm) for bottom reinforcement for deep beam and (ø 10mm) as stirrup, the steel spread according to strut and tie method. To know the steel properties the test of tensile has been don according to (ASTM A615/A615M-04b) **[7].**

- **Superplasticizer**: Euniflow 612i was utilized in mixes. It was German Production in a light brown Color; the properties of the superplasticizer are demonstrated in table 4 and [8]
- **steel fiber:** In this study the steel fiber has bean add to concrete in different ratio, this steel fiber added according to ASTM A820 **[9]**

Water: - It was distilled water utilized through this work for both mixing and curing.

Table 1. the physical and chemical characteristics of cement.

Test name	Contents (by weight %)
Specific surface (m^2/kg)	310
Specific gravity	3.15
SiO_2	20.39
CaO	62.20
MgO	2.36
L.O.I	2.41
Fe_2O_3	3.81
SO_3	1.97
Al_2O_3	4.55

Table 2. Fine aggregate grading.

Sieve size (mm)	Percent Passing %
10	100
4.75	93.5
2.36	84
1.18	75.5
0.6	50
0.3	20
0.15	4

Table 3. The grading of coarse aggregate for a different sizes.

Sieve size (mm)	Particle size 20mm	Particle size 14mm
25	100	-
19	95	100
12.5	60	95
9.5	37.5	55
4.75	5	7.5
2.36	2.5	2.5
1.18	0	0

Table 4. Chemical composition of WGP.

Composition	Glass powder(%)
SiO_2	73.6
CaO	8.04
SO_3	0.23
Na_2O	12.6
MgO	2.78
K_2O	0.3
Fe_2O_3	0.7
Cr_2O_3	0.04
TiO_2	0.025
AL_2O_3	1.4

A: Concrete Mix Design

British method (DOE)[10] was used to mix design. The table (5) shows the material quantity.

Table (5): Concrete Mix Design

Type	Cement content (1)	Fine aggre gate (1.33)	Coarse aggrega te (2.167)	Water (0.28)	Superpl -astiizer (2%)	Steel fiber
Weight (kg) per 1m3	502	669	1087	140.6	10	0
SF0.5	500	665	1084	140	10	39.2 8
SF0.75	498.64	663.2	1080.55	139.6 2	9.97	58.9 2
SF1	497.38	661.5 2	1077.82	139.2 7	9.95	78.5 6

B: Specimens Details

Table (6) and fig.(1) shows the details of casted specimen.

C: Concrete Casting

The concrete casting in form after mixing in mixer then poker vibration has been used to compacted concrete after that the surface smoothing by using trowel, for each specimen 1 cylinder and three cubic was casting for test. Photo(1) shows the concrete casting

Photo (1): Specimens Casting and Vibration

D: Concrete Curing

Wet damp burlap sacks used to covered the specimens after concrete casting as show in Photo(2)

Photo (2): Specimens Curing

E: Testing

E-1: Concrete Compressive Strength

The cube of concrete have been casting with (15x15x15)cm dimension **[11]** during casting the specimens , Theis cubes are sign with identification sign then putting in reservoir water for curing , a part of this cubs teste in 7 days and then teste after 28 day from curing, photo (3) show the cubs testing to determine the concrete compressive strength. The result of test record in table (7).

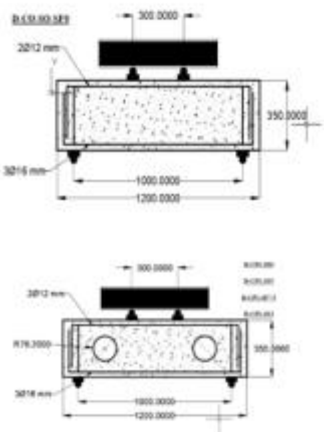

Fig. (1): Specimens Details

Table (6): Specimens Details

No	Beam Description	Symbol	Opening	Steel Fiber	a/d	Total length	Reinforcement
1	Control Beam	D_CO-SO_SF 0	solid	with out	1	1200 mm	2ø12 mm top 3ø16 mm bottom
2	Without steel fiber and-circle opening	D-CP1-SF0	Circle 0.435d diameter	with out	1	1200 mm	2ø12 mm top 3ø16 mm bottom
3	With steel fiber and - circle opening	D-CP1-SF5	Circle 0.435d diameter	0.5%	1	1200 mm	2ø12 mm top 3ø16 mm bottom
4	With steel fiber and - circle opening	D-CP1-SF7.5	Circle 0.435d diameter	0.75 %	1	1200 mm	2ø12 mm top 3ø16 mm bottom
5	With steel fiber and - circle opening	D-CP1-SF1	Circle 0.435d diameter	1%	1	1200 mm	2ø12 mm top 3ø16 mm bottom
6	Without steel fiber and-square opening	D-CP1-SF0	Circle 0.435d diameter	with out	1	1200 mm	2ø12 mm top 3ø16 mm bottom
7	Without steel fiber and - square opening	D-SP-SF0	Square 0.387dX 0.387d	0.5%	1	1200 mm	2ø12 mm top 3ø16 mm bottom
8	With steel fiber and square opening	D-SP-SF7.5	Square 0.387dX 0.387d	0.75%	1	1200 mm	2ø12 mm top 3ø16 mm bottom
9	With steel fiber and square opening	D-SP-SF1	Square 0.387dX 0.387d	1%	1	1200 mm	2ø12 mm top 3ø16 mm bottom

Table (7): Compression Strength 28 Day

No.	Name of Cube	RC Compression Strength (MPa)	Average of Strength (MPa)
1	AG1_SF0	54.7	53.4
2	BG1_SF0	52.7	
3	CG1_SF0	52.9	
4	AG1-SF5	56.1	57.5
5	BG1-SF5	58.2	
6	CG1-SF5	58.3	
7	AG1-SF7.5	59.2	58.9
8	BG1-SF7.5	59.4	
9	CG1-SF7.5	58.3	

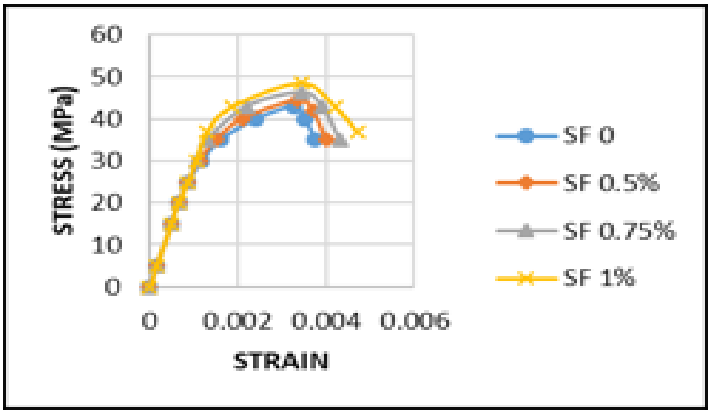

Fig. (2): Stress-Strain curves

Photo (3): Split and Compressive Tensile Strength

E-2: Split Tensile Strength

Photo (3) and table (8) show the test of concrete cylinders according to (C496/C496M) **[12]**

Table (8): Split tensile strength

NO.	Cylinder Name	Split Tensile Strength (MPa)
1	G1_SF0	5.41
2	G1-SF5	5.33
3	G1-SF7.5	6.22
4	G1-SF10	6.92

Photo (4): Cylinder for uniaxial compression test

E-3: Uniaxial Compressive Strength

The concrete modulus of elasticity of concrete with steel fiber has been found from teste three concrete cylinders under compression stress and curve constructed in fig.(2). By using the H-2911 instrument; the test was done in the lab of Basra University, as shown in Photo (4). The test don according (to ASTM C-469) **[13]**

IV. SPECIMENS RESULT

All groups of the specimens tested used a universal machine of 2000 KN, and the test was done in the lab of Basra University. To distribute the one concentrated load (P) from the machine, the beam shaft is used to load distribution into two loads (P/2); the distance between the two loads is (30cm), and the H-section is used to support the specimen to support the specimen a solid tube is welding and a plate of (7cm) thick is fix on the tube at a distance 10cm from each side of edges of the specimen.

The strain is taken before loading is applied(at zero load); after that, the dial gauge reading is put to zero. Photo (5) shows a universal machine.

Photo (5): Cylinder for uniaxial compression test

A: Ultimate Load

For each specimen, the ultimate loads have been recorded as shown in table (9). Fig(3) show the effects of opening on the ultimate load.

Figure (3): Opening Shape against Steel Fiber Effect on Ultimate Load

Table (9): Specimens Ultimate load

NO.	Name of Specimens	Ratio of Steel Fiber	Ultimate Load (KN)	Pu/Pcn %
,1	D-CO-SO-SF0	0	320	40.625
2	D-SP-SF0	0	130	53.125
3	D-SP-SF5	0.5	170	65.625
4	D-SP-SF7.5	0.75	210	76.563
5	D-SP-SF10	1	245	50
6	D-CP1-SF0	0	160	62.5
7	D-CP1-SF5	0.5	200	73.438
8	D-CP1-SF7.5	0.75	235	84.375
9	D-CP1-SF10	1	270	40.625

For table (9), to obtain maximum effect of opening on strength of deep beam, nine beam with different opening location and shape (Square opening and circle) have been tested, the opening center is located at center of shear zone to obtain maximum effect of opening on strength of deep beam, the result of load-deflection curve for the tested specimens show that ultimate load is decreases in square opening deep beam compared with solid deep beam ,that has ultimate load (320 kN), that (Pu/Pcn) (40.625%) in case of no steel fibers and this ratio increased with (0.5%) steel fiber and square opening into (53.125%), with steel fiber (0.75%) the ultimate load become (65.625%) in case of square opening and with steel fiber (1%) the ultimate load become (76.563%) in case of square opening.

It is clear from the above results (for both shapes of opening) that increasing the amount of steel fibers in the beam will increase its strength, this due to the bridging effect of fibers on cracks in the beam.

Also results from table (9) convinced that the beams with a circular openings have higher strength compared to the beams with square openings for all ratios of steel fibers, the comparison of the beams strength according to opening shape is shown in figure (4) and figure (5), which is clearly showed that the beam with circular opening is more efficient than the beam with square opening, therefore the circular shape of opening is selected to be used for the second group to study the effect of the opening size on the strength of beam.

B: Load-Deflection Curve

After the specimen place inside the machine, load apply to specimen as step and recorded the deflection of specimen in each load step even appear the first crack , the recorded load on this stage represent the first crack load and the beam behavior became plastic behavior.

Between opening and support at opening bottom side the cracks formation and then cracks developed and appears new cracks and after that the load drop and the beam is failure.

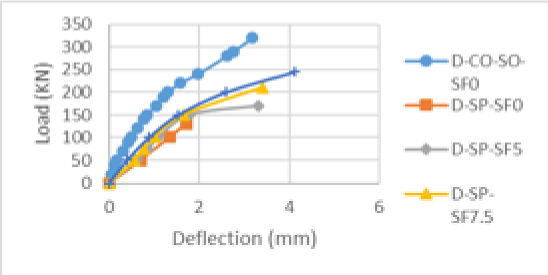

Figure (4): Load -Deflection Curves with Maximum Square Opening

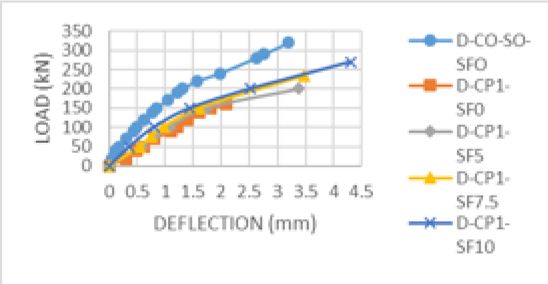

Figure (5): Load -.Deflection Curves with Maximum Circle Opening

Figure (4) show that all curves of square opening have approximately the same behavior at the elastic range but the behavior changed after cracking, the specimen with steel fiber content 1% has a curve steeper than other specimens which have square opening, the stage of hardening is biggest (steel fiber effect), but this specimen is not stiffer than the solid beam because existing the openings which has more effect than the steel fibers, Similar results obtained in figure (5) where the beam with maximum circular opening and steel fibers of 1% is stiffer than the other but less stiff than the control beam.

Comparing the curve of the beam (D-SP-SF10) with the curve of the beam (D-CP1-SF10) show that the later beam is stiffer than the former due to effect of opening shape on the distribution of stress around opening.

As a general conclusion, the circular opening has less effect on the beam than square opening

C: Crack Width

The first crack is formed after load applied, the width of crack is taken when the loading stop by Reader of Micro Crack, recording first crack load and width of crack then by pen highlight the first crack propagation to study propagation of crack, with new cracks the same procedures followed, for all specimens the same procedures is follow, table (10) show the first crack for all specimens. Table (10) show the first cracking load.

Table (10): First crack of Specimens

NO.	Specimens Name	First Cracking Load (KN)	Ultimate load (KN)	Pfc/Pu %
1	D_CO_SO_SF0	171	322	52.13
2	D-SP-SF0	75	130	57.69
3	D-SP-SF5	100	170	58.82
4	D-SP-SF7.5	128	210	60.95
5	D-SP-SF10	150	245	61.22
6	D-CP1-SF0	95	160	59.38
7	D-CP1-SF5	120	200	60
8	D-CP1-SF7.5	145	235	61.7
9	D-CP1-SF10	170	270	62.96

The first crack is shallow and narrow and has small length and direction parallel to direction of compression path as shown in photo (6).

When load increased some of cracks are complete its formation, micro cracks formed beside the first crack, in different loading stage cracks development and propagate toward the load applied and supports. In compression path when the load reach to level which stress intensity become more than the maximum tensile stress failure occur by diagonal crack, to reach to stable state a redistribution every load stage occur at crack tip this represented the reasons for formation cracks.

Photo (6) : Crack pattern of specimens

First crack is formation at often specimens at lower corners of opening in case of square opening or tangentially of circumference opening in some case of circle opening below neutral axis at shear span because the opening is cut off the compression path so that the stress has concentration at this region higher than the other region.

Beams with square openings the first crack formed when the applied load reached (58%-62%) of the ultimate load while Beams with circular openings the first crack formed when the applied load reached (59%-63%) of the ultimate load.

At specimen without steel fiber the first cracking load is smaller than the other cracking load in specimens that have steel fiber because the main role of steel fiber in enhance the shear resist and post-peak behavior.

For Normal Concrete (NC), aggregate interlock provide a large proportion of load. When interlock of aggregate reduced because some reason such as widening of cracks on one side of the cantilever mechanism causes further crack propagation and unbalance, leading to sudden failure due to diagonal tension failure.

In (HSC) crack propagation leading to failure of diagonal tension, which sudden failure. In HSC due to crack propagation through the aggregate the crack surface is smooth and aggregate interlock force are minimize and failure follow ignoring the interlock of aggregate.

Crack width for the specimens have higher steel fiber ratio is smaller than the other specimens with less steel fiber ratio because the efficiency of steel fiber to eliminate crack width, it work like bridge to transmit the stress cross it and decrease the crack width.

As compare between control deep beam and specimen (D-SP-SF0), the deep beam with opening has first cracking load (57.69%) from the ultimate load while control deep beam has first cracking load (53.13%) from ultimate load, the same thing with specimens with circle openings the first crack creation about (59%-63%) from ultimate load, in addition the crack width of specimen with opening is wider than control deep beam, all that because the opening that interrupt the compression path and induce the concentrated stress in some region and because of lack in concrete strength due to opening all that cause the first crack formation in (D-SP-SF0) and specimens with circle opening without steel fiber faster than control deep beam because of it have less ultimate load and hardening stage as compare to control specimen and crack width in these specimens wider than control deep beam.

The specimens without steel fiber failed with crushing voice because of the shear strength is fully depend on aggregate interlock so that the noise is due to crush aggregate, while specimens with steel fiber have not or less noise when failure because the shear strength is depend on aggregate interlock and steel fiber so that the specimen start behave with ductility and absorb the strain energy.

Sometime specimens with circle opening without steel fiber have first cracking load with higher rate from ultimate load, this indicate the most behavior of deep beam is elastic rather than plastic when crack start formation as show in Figures (6) and (7).

Formation of some cracks are completed when increasing the load , formation the other cracks beside the first crack inside the path of compression and in each loading stage the crack wide are different and propagate towered point load and support . The crack shown in photo (6).

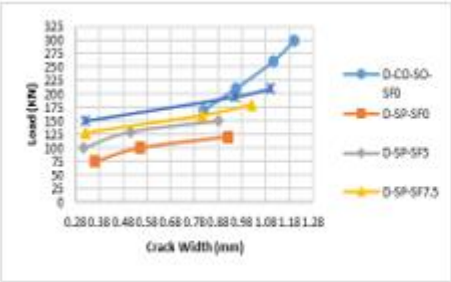

Figure (6): Crack Width of Deep Beam with Square Opening

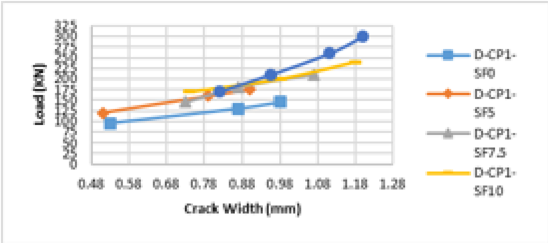

Figure (7): Crack Width of Deep Beams with Circular Opening

V. ABAQUS

Abaqus 6.13 have been used to simulating and meshing the specimens from experimental result, the result from analysis are (plastic strain, deflection , stress distribution and cracks propagation). To make a verification a comparison done between the deflections at failure in case of numerical and experimental.

To creating every modeling in Abaqus must following the sequence like , define property of material, create part, boundary condition, step, interaction, meshing and run job.

A: Concrete Properties
B: Steel Properties

Table (11): Property of Concrete

	Property	Value
General	Density	2.5 g/mm3
	Modulus of Elasticity	according to ASTM C-469
	Poisson's -ratio	0.21
Concrete Damage Plasticity		
Plasticity	Dilation Angle	31
	Eccentricity	0.11
	Fb0/Fc0	1.17
	K	0.655
	Viscosity Parameter	0
Compressive Behavior		
Depend on test of uniaxial compression		
Tension Behavior		
Depend on uniaxial tension test		

Table (12): Properties of Steel

	Property	Value
General		
	Density	7.856 g/mm3
Mechanical	Modulus Of Elasticity	200000 N/mm2
	Poisson's ratio	0.3
Plastic	Yield Stress Vs Plastic Strain	Depend on Tensile test for Reinforcement

C: Elements

Table (13): Elements

No.	Part Name	Element Type	Type Description	Element Size
1	Concrete	C3D20R	Continuum brick element 3d with 20 nodes reduced integration (quadratic)	50
2	Plate	C3D8R	Continuum brick element 3d with 8 nodes reduced integration (linear)	25
3	Stirrup	T3D2	Truss element 3d with 2 node	50
4	Bar12	T3D2	Truss element 3d with 2 node	50
5	Bar16	T3D2	Truss element 3d with 2 node	50

D: Results

Each specimen modeled in Abaqus individually, each specimen has it geometry, boundary conditions and material properties.

The results, represent by; Plastic strain , Deflection contour, cracks pattern and distributions of stress as shown in figures (8) to (16) and table (10).

Fig.(17) shown the comparison has been made between analytical and experimental load-deflection curve

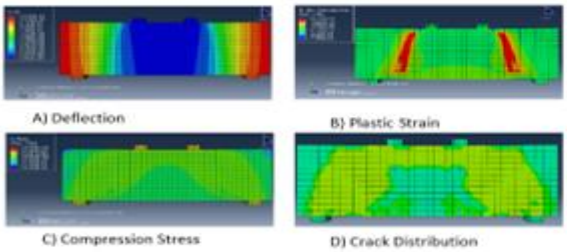

Figure (8) Data of Specimen D-CO-SO-SF0 Data

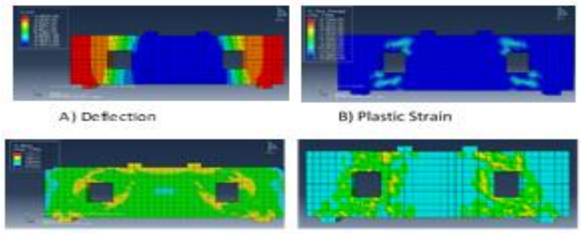

Figure (9) Data of Specimen D-SP-SF0 Data

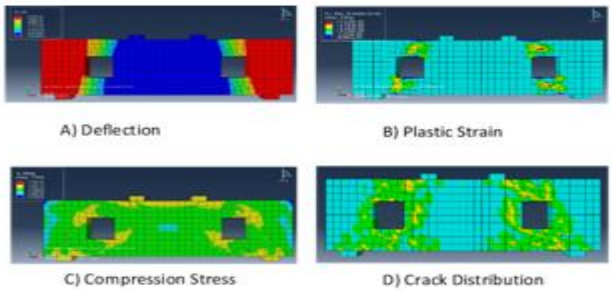

Figure (10) Data of Specimen D-SP-SF5 Data

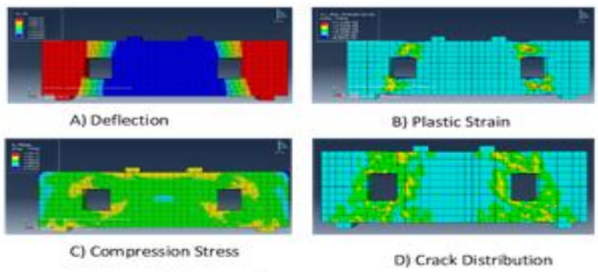

Figure (11) Data of Specimen D-SP-SF7.5 Data

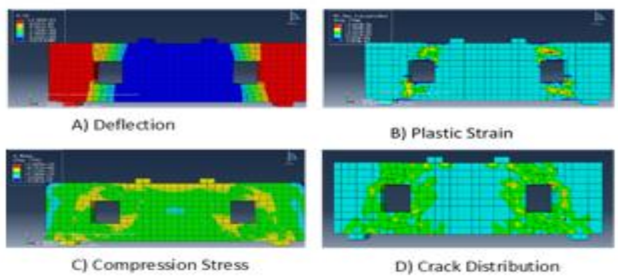

Figure (12) Data of Specimen D-SP-SF10 Data

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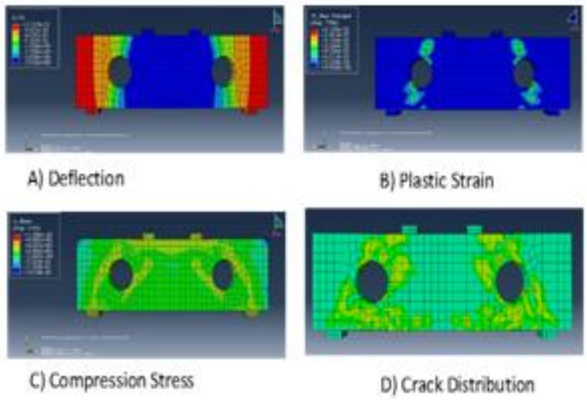


Figure (13) Data of Specimen D-CP1-SF0 Data

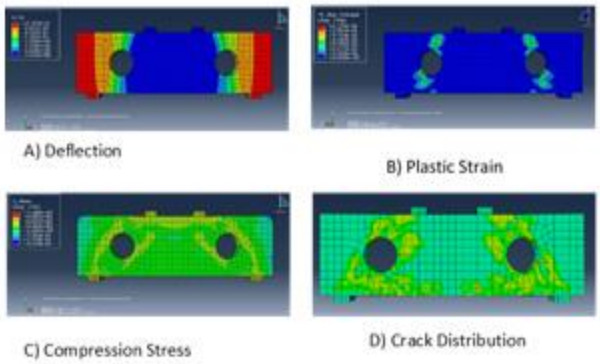


Figure (14) Data of Specimen D-CP1-SF5 Data

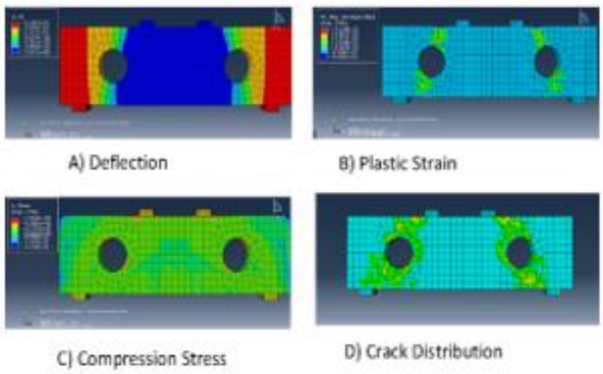


Figure (15) Data of Specimen D-CP1-SF7.5 Data

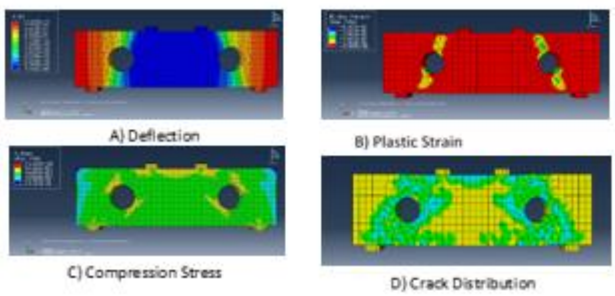
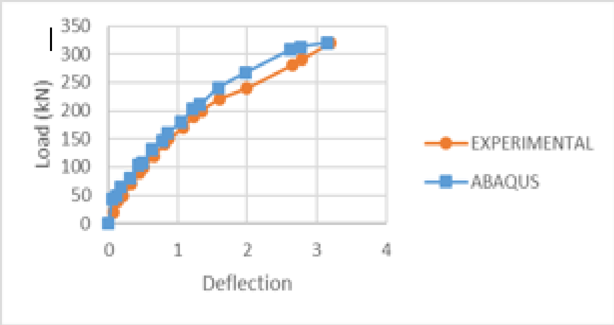
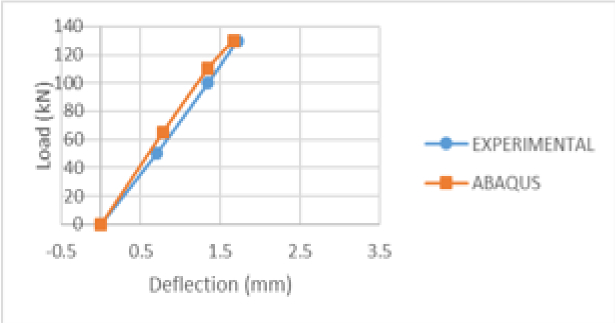


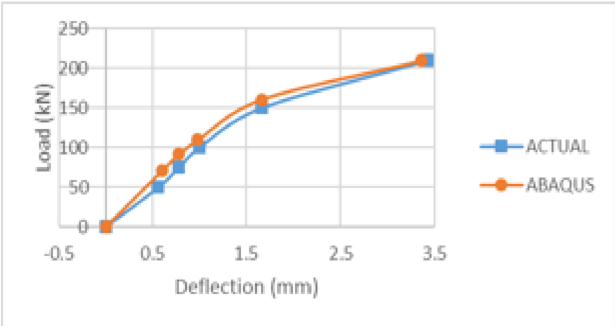
Figure (16) Data of Specimen D-CP1-SF10 Data


350
300
250
200
150
100
50
0
Load (kN)
0
1
2
3
4
Deflection
EXPERIMENTAL
ABAQUS

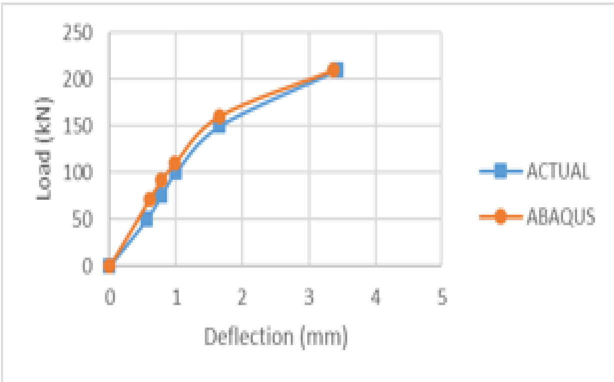
(A)


140
120
100
80
60
40
20
0
Load (kN)
-0.5
0.5
1.5
2.5
3.5
Deflection (mm)
EXPERIMENTAL
ABAQUS

(B)

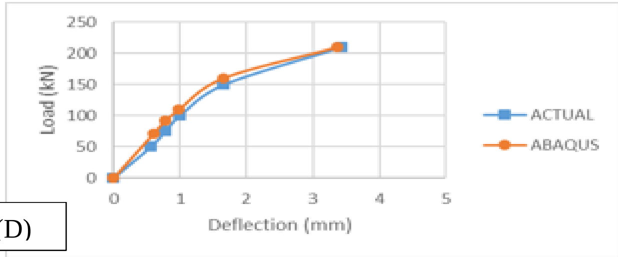

250
200
150
100
50
0
Load (kN)
-0.5
0.5
1.5
2.5
3.5
Deflection (mm)
ACTUAL
ABAQUS

(C)

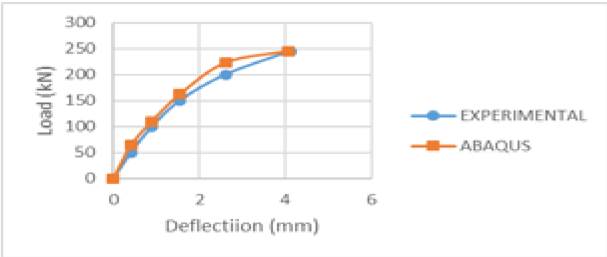

250
200
150
100
50
0
Load (kN)
0
1
2
3
4
5
Deflection (mm)
ACTUAL
ABAQUS

(D)

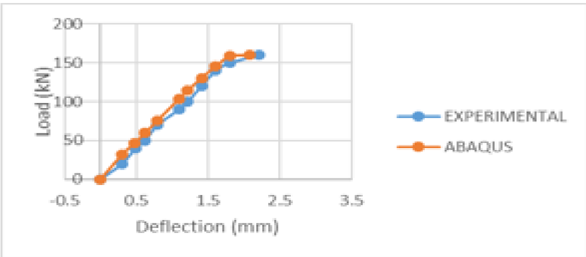
(D)



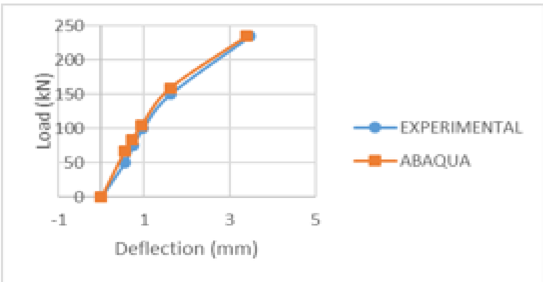
(D)



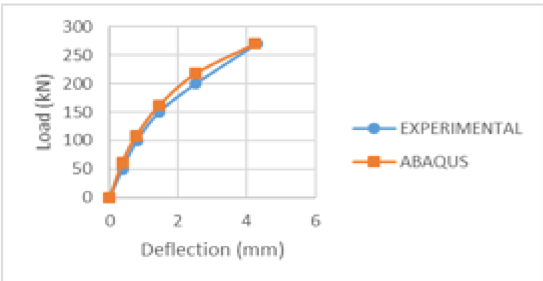
(E)



(F)



(H)



(I)

Figure (17) Load Deflection Curves for Experimental and Abaqus for
A) D-CO-SO-SF0 **B)** D-SP-SF0 **C)** D-SP-SF5 **D)** D-SP-SF7.5
E) D-SP-SF10 **F)** D-CP1-SF0 **G)** D-CP1-SF5 **H)** D-CP1-SF7.5 **I)** D-CP1-SF10

Table (10): Comparison between Numerical and Experimental and Displacement at

NO.	Deep Beam	Experimental Displacement (U2) mm	Numerical Displacement (U2) mm	U2Num/U2Exp. %
1	D-CO-SO-SF0	3.2	3.15	98.44
2	D-SP-SF0	1.72	1.67	97.09
3	D-SP-SF5	3.34	3.28	98.2
4	D-SP-SF7.5	3.42	3.36	98.25
5	D-SP-SF10	4.12	4.06	98.54
6	D-CP1-SF0	2.21	2.08	94.12
7	D-CP1-SF5	3.38	3.3	97.63
8	D-CP1-SF7.5	3.48	3.39	97.41
9	D-CP1-SF10	4.3	4.24	98.6

From the comparison between numerical and experimental results, the followings are concluded

1. A good agreement between numerical and experimental result that obtained from Abaqus program, with 98% an average percentage. So to predict the ultimate load can depend on Abaqus. .

2.From the point of applied load to support the path of compression created, from numerical result the path created from strut in reality.

3. good agreement with experimental results regarding of the propagation and distributions of cracks which are found in path of compression.

4. The load-Deflection curves of numerical result stiffer then experimental result and have good agreement.

5. The model in Abaqus has a stress less than the concrete compressive strength .

VI. CONCLUSION

In view of shear strength of high strength concrete deep beams with openings strengthen with fiber reinforced the following conclusions are drawn:

1. Using maximum openings size at the shear span center of deep beams with shear span ratio (a/d=1), the experimental results proved that the circular opening has better stress distribution than the square opening.

2. The strength of deep beam with opening influenced by shape of opening, square openings decrease the strength to (40.625%) of the control while the equivalent circle opening produce decreased the strength to (50%) of the control, These ratios increases with increasing steel fiber content, The deep beams with shear span ratio (a/d=1) without steel fiber and with different circle opening size are influenced by opening size, the maximum circle opening diameter cause decreasing the ultimate load to (50%) while the smallest circle opening size (0.286d diameter) cause decreasing the ultimate load to (68.75%).

3. For deep beam with high ratio of steel fiber, ductility of deep beam increased and behave as plastic material so that deflection and ultimate load increased.

4. First crack formation in deep beam with square opening when load reach (53%-61%) from ultimate load while deep beam with circle opening at (57%-64%) from ultimate load.

5. First cracking load at specimens without steel fiber are smaller than that with higher steel fiber, the ability of steel fiber to enhance post peak behavior.

6. Crack width for specimens without steel fiber are wider than the specimens with high steel fiber.

7. The specimens without steel fiber failed with crushing noise higher than specimens with steel fiber.

8. In spite of difference of factors that influence of strength of deep beam, but all deep beam failure by compression failure (diagonal-splitting failure). A good agreement between experimental an numerical result that obtained from Abaqus program, with 98% an average percentage. So to predict the ultimate load can depend on Abaqus.

9. The load-Deflection curves of numerical result stiffer then experimental result and have good agreement. At specimen with maximum opening size, the displacement at ultimate load has good agreement with experimental data than other specimen.

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