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SHEAR STRENGTH OF SELF COMPACTED CONCRETE WITH AND WITHOUT STIRRUPS AT DIFFERENT SHAPES

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ABSTRACT: - Eighteen self-compacted concrete (SCC) beams at different shaped were designed and tested to determine the effect of using SCC on the shear strength under two concentrated loads. The tested beams were divided into three groups according to the shape of the cross section, rectangular sections, T-sections and I-sections. Each group was divided into two series with and without stirrups. All the series beams have the same longitudinal steel ratio, gross section area and clear span to effective depth ratio but have different values of compressive strength (f_c'). It was found that the ultimate shear strength predicated by ACI 318M-08 is conservative relative to the experimental values, the ultimate shear strength of SCC beams with and without stirrups increased when the compressive strength of the SCC increased. When the compressive strength increased from (29.36 to 49.2 MPa) at clear span to effective depth ratio (ln/d) equal to 5.84 the ultimate shear strength of SSC beams without stirrups increase about 31.22%,55.55%and 18.931% for rectangular, T- section and I-section respectively ,while the ultimate shear strength of SCC beams with stirrups increased 17.17%,28.57%and 15.584% for rectangular, T- section, I-section respectively .The ultimate shear strength of SCC rectangular beams with stirrups increased about 85.41%, 68.96% and 65.52% as compared with ultimate shear strength without stirrups at compressive strength 29.36,41.42 and 49.2 MPa respectively, the ultimate shear strength of SCC T-beams with stirrups increased about 133.3%, 97.916% and 92.857% as compared with ultimate shear strength without stirrups at compressive strength values of 29.36,41.42 and 49.2 MPa, respectively . Finally the ultimate shear strength of SCC I-beams with stirrups increased about 44.6%, 38.1% and 40.53% as compared with ultimate shear strength without stirrups at compressive strength values of 29.36,41.42 and 49.2 MPa respectively.
Keywords: shear strength, rectangular section ,I-section, T-section, with and without stirrups, self-compacted concrete

1- INTRODUCTION

Self-Compacting concrete (SCC), is a kind of high performance concrete (HPC) with very effective deformability and segregation resistance. The main advantage of SCC is;a flowing concrete without segregation and bleeding, capable of filling spaces in dense reinforcement or in accessible voids without hindrance or blockage. The composition of SCC should be designed in order not to separation not to excessively bleeding. Concrete strength development is determined not only by the water-to-cement ratio, but also by the content and specification of mix materials. (1)

2- RESEARCH SIGNIFICANCE:

Concrete was being used in the construction industry for centuries. Many modification and developments were made to improve the performance of concrete, especially in term of strength and workability. Engineers found new technology of concrete called self-compacting concrete. The main objective of the work described in this study is to investigate and to get more information and more understanding about the shear strength of self-compacting concrete beams with and without stirrups at different shapes.

3- TEST PROGRAM:

3.1 Description of specimens:

The tested beams were divided into three groups according to the shape of the section rectangular sections, T-sections and I-sections. each beam of the first group has overall length 1140 mm, the cross sectional dimension of 100 mm (width of beams) by 170 mm (total depth). The longitudinal steel reinforcement consist of six bar (diameter of the bar 8 mm, with area of 50.265mm^2) laid in two layers at bottom and two bars (diameter 4 mm, area of 12.566 mm^2) laid in one layer at top. The internal steel stirrups are 4 mm in diameter (12.566 mm^2) spaced 73 mm center to center as shown in Fig.(1). Beams of the second group consist of T- cross sections have overall length 925 mm, the cross sectional dimensions of 220 mm (width of flange) by 200 mm (total depth). The thickness of web is (60) mm and the thickness of flange is (50) mm. The longitudinal deformed steel reinforcement consist of four bars of 8 mm diameter laid in two layers at bottom and four plane bars of 4 mm diameter laid in one layer at top. The internal steel stirrups are 4 mm in diameter centrally spaced 89 mm as shown in Fig. (2. The third group consists of I-sections beam each of 1443mm overall length, The cross section is of 250 mm total depth and 200mm flange width . The longitudinal steel reinforcement consists of four (8 mm diameter bar, of (50.265mm^2 area) laid in one layer at bottom, and four 4 mm diameter bars of (12.566 mm^{2}area) laid in one layer at top. The internal steel stirrups are 4 mm in diameter (12.566 mm^{2}area) at spacing 115 mm on center as shown in Fig.(3).The total description of the beams used in this study is listed in Tables (1)and (2) and the test set-up is shown in Fig. (4)

3.2 Materials:

General description and specification of materials used in the tested beams are listed below; tests are made in the National Center for Construction Laboratories and Research

- Cement: Ordinary Portland cement type I produced at northern cement factory (Tasluja-Bazian) is used throughout this investigation which conforms to the Iraqi specification No. 5/1984[2], Tables (2) and (3) show the chemical and physical properties of the used cement.
- Fine Aggregate: Al-Ukhaider natural sand was used. Which complies with the Iraqi Standard Specification No.45/1984,[3]zone(2).The specific gravity, sulfate contents (SO_3) and absorption of the used sand were 2.66,0.4% and 1.7% respectively.
- Coarse Aggregate: Crushed gravels of 10mm maximum size from Al-Nibaee area was used in this study. This complies with the Iraqi Standard Specification No.45/1984,[3]The specific gravity, sulfate contents(SO_3) and absorption of the used gravel were 2.65,0.07% and 0.57% respectively.
- Water: Ordinary potable water was used throughout this work for both mixing and curing of concrete.
- Steel Reinforcement: Deformed longitudinal steel bars with 8mm and 4mm nominal diameters were used in this study. Reinforcing bars were tested to determine the yield stress of 8mm and 4mm which were found to be 400 and 350 MPa respectively.
- Limestone Powder: Fine limestone powder (locally named as Al-Gubra) of northern origin with fineness (3100 cm^2/ gm) was used as a filler for concrete production for many years. It was found to increase workability and early strength, as well as to reduce the required compaction energy. The increased strength is found particularly when the powder is finer than the Portland cement (4). The cement in SCC mixes is generally partially replaced by fillers like lime stone powder in order to improve certain properties such as;

- avoiding excessive heat generation,
- enhancing fluidity and cohesiveness,
- enhancing segregation resistance,
- Increasing the amount of powder (cement +filler), to become more economical than using cement alone.
- Superplasticizer [(5)]: To produce SCC, a superplasticizer known as (High Water Reducing Agent) based on polycarboxylic ether is used; it has the trade mark of Glenium 51, which is free from chlorides and complies with ASTM C494, types A and F. It is compatible with all Portland cements that meet recognized international standards. Table (4) shows the typical properties of Glenium 51.

3.3 Mix Design for Self-Compacted Concrete

Mix proportioning is more critical for SCC than for NSC (normal strength concrete) and HSC (high strength concrete). Many trials are carried out on mixes incorporating superplasticizer by increasing the dosage of the admixture gradually, adjusting the w/c ratio to ensure the self-compact ability [(6)]. Table (5) indicates the mix proportion of SCC mixes. For each concrete mix, three standard cube specimens (150×150×150) mm are taken, they were tested at 28 days of age, the test result of fresh concrete properties are shown in Table (6) these results are within the acceptable criteria for SCC given by ACI committee-363 [(7)] and indicate excellent deformability without blocking.

4. TEST PROCEDURE OF TESTED BEAMS:

All the beam specimens were white washed in order to aid the observation of the crack development during the testing. They were tested under gradually increasing load up to failure under two point symmetric top loading by the universal-Testing machine (MFL systems) in the structural laboratory of the college of the engineering , Al-Mustansiriya university as shown in Fig.(5).The tested beam specimens were simply supported at ends over an effective span. A dial gauge of (0.01 mm) accuracy with (30 mm) capacity was fixed at the middle of the bottom of the beam to measure the mid span deflection, the test set-up is shown in Fig. (4).Loading procedure was started by the application of single point load from the testing machine to the upper midpoint of the loading bridge. The single load was then divided equally between the two point loads that were transferred to the concrete beam through two (Φ 30 mm) steel bars loaded at the end of the bridge. Beam specimens were placed at the testing machine and adjusted so that the centerline, supports, point loads and dial gauge were fixed at the correct and proper locations. Loading was applied in small increments of (4 kN).At each load stage the deflection readings at the mid span was recorded. The loading increments were applied until failure.

5 SHEAR STRENGTH OF BEAM IN CODE PROVISIONS:

ACI 318M-08 estimates the nominal shear capacity (V_n) of beam as follows [(9)]:

$$V_n = V_c + V_s \quad \text{..................... (1)}$$

$$V_c = \frac{\sqrt{f_c'}}{6} b_w \ d \quad \text{.................... (2)}$$

$$V_c = (\sqrt{f_c'} + 120\ell w V_u d/M_u) b_w d/7 \quad \text{........................ (3)}$$

$$V_s = Av \ f_y \ d / S \quad \text{........................ (4)}$$

Where:-

V_c and V_s are shear transfer capacity of concrete and shear reinforcement respectively; Mu and Vud are factored moment and shear force; ℓ_w = As/b_wd is the longitudinal bottom reinforcement ratio; As is the longitudinal bottom reinforcement area; b_w is the width of the web; d is the effective depth; A_v is the vertical shear reinforcement area, S is the spacing between the vertical stirrups reinforcement; f_c' is the compressive strength of concrete and f_y the yield strength of shear reinforcement. The clear span to effective depth ratio (ln/d)is the main variable in this research , Eq.(3) will be used since the shear stress at cracking depends on the bending moment and shear force at critical section ratio (Vud/Mu)and the longitudinal steel ratio (ℓ_w) that lead to reduce the shear crack and improved the ultimate strength.

6. RESULTS:

6.1 Load-Carrying Capacity of the Tested Beams.

The relationship between the applied load and the deflection for the tested beams is shown in Fig. (6) to Fig.(11). At every stage of loading, the deflection at mid-span is obtained by using dial gage, it can be noticed that:

- During the early stage of loading no interface slip was recorded and this continue until the applied loading was equal to first crack loading approximately, Beyond that loading each beam behaved in a certain manner.
- The ultimate shear strength obtained from testing of SCC beam specimens were compared with that obtained by using the ACI code provisions and given in Table (8). By the inspection of this table it can be noted that the ultimate shear strength predicated from ACI 318M-08 is conservative in comparison with experimental values because the SCC will improves durability, and increases bond strength [10].
- The ultimate shear strength of SCC beams specimens without stirrups increased when the compressive strength of the SCC increased as shown Fig. (12). When the compressive strength increased from (29.36 to 49.2 MPa) at clear span to effective ratio (ln/d) to value 5.84. The ultimate shear strength increased by about 31.22%,55.55%and 18.931% for rectangular, T- section, I-section, respectively given in table (9)
- The ultimate shear strength of SCC beam specimens with stirrups increased when the compressive strength of the SCC increased as shown in Fig. (13). When the compressive strength increased from (29.36 to 49.2 MPa) at clear span to effective depth ratio (ln/d) of value 5.84 ,the ultimate shear strength increased about 17.17%,28.57%and 15.584% for rectangular, T- section, I-section respectively as given in table (10) .
- The ultimate shear strength of SCC beam specimens with stirrups is greater than these without stirrups as shown in Figs.(14),(15) and.(16).The ultimate shear strength of SCC rectangular beams with stirrups increased about 85.41%, 68.96% and 65.52% as compared with ultimate shear strength without stirrups at compressive strength 29.36,41.42 and 49.2 MPa respectively. The ultimate shear strength of SCC T-beams with stirrups increased about 133.3%, 97.916% and 92.857% as compared with ultimate shear strength without stirrups at compressive strength values 29.36, 41.42 and 49.2 MPa respectively, while the ultimate shear strength of SCC I-beams with stirrups increased about 44.6%, 38.1% and 40.53% as compared with ultimate shear strength without stirrups at compressive strength values 29.36, 41.42 and 49.2 MPa, respectively as given in Table (11).

6.2 Failure

As is expected, all the tested beams failed in shear as shown in Fig. (17) and Fig.(18),where the diagonal cracks formed independently. The beam specimens remained stable after such cracking. Further increase in shear force caused the diagonal crack to penetrate into the compression zone at the loading point, until eventually crushing failure of concrete occurred there [11].

7 CONCLUSIONS:

Based on the tested results of this experimental investigation for evaluation of shear strength of SCC beams, the following conclusions are drawn:

- The ultimate shear strength predicated from ACI 318M-08 is conservative prediction than the experimental values for the SCC beams.
- The ultimate shear strength of SCC beams without stirrups increased when the compressive strength of the SCC increased. When the compressive strength increased from (29.36 to 49.2 MPa) at clear span to effective ratio (ln/d) 5.84 The ultimate shear strength increase about 31.22%,55.55%and 18.931% for rectangular, T- section , I-section respectively .
- The ultimate shear strength of SCC beams with stirrups increased when the compressive strength of the SCC increased. when the compressive strength increased from (29.36 to 49.2 MPa) at clear span to effective ratio (ln/d) 5.84 The ultimate shear strength increase about 17.17%,28.57%and 15.584% for rectangular, T- section and I-section respectively .
- The ultimate shear strength of SCC rectangular beams with stirrups increased about 85.41%, 68.96% and 65.52% as compared with ultimate shear strength without stirrups at compressive strength 29.36, 41.42 and 49.2 MPa, respectively.
- The ultimate shear strength of SCC T-beams with stirrups increased about 133.3%, 97.916% and 92.857% as compared with ultimate shear strength without stirrups at compressive strength 29.36, 41.42 and 49.2 MPa, respectively.
- The ultimate shear strength of SCC I-beams with stirrups increased about 44.6%, 38.1% and 40.53% as compared with ultimate shear strength without stirrups at compressive strength 29.36, 41.42 and 49.2 MPa, respectively.

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Table (1): Total Description of the Tested Beams without Stirrups

Shapes	Beam designation	Comp. strength (f_c') MPa	Clear span (ln) mm	Effective depth (d) mm	Clear span to effective depth ratio (ln/d)
Rectangular	A10	29.39	1040	178	5.84
Rectangular	B10	41.4	1040	178	5.84
Rectangular	C10	49.2	1040	178	5.84
T- Sections	A20	29.39	852	146	5.84
T-Sections	B20	41.4	852	146	5.84
T- Sections	C20	49.2	852	146	5.84
I- Sections	A30	29.39	1343	230	5.84
I- Sections	B30	41.4	1343	230	5.84
I- Sections	C30	49.2	1343	230	5.84

Table (2): Total Description of the Tested Beams with Stirrups

Shapes	Beam designation	Comp. strength (f_c') MPa	Clear span (ln) mm	Effective depth (d) mm	Clear span to effective depth ratio (ln/d)
Rectangular	A11	29.39	1040	178	5.84
Rectangular	B11	41.4	1040	178	5.84
Rectangular	C11	49.2	1040	178	5.84
T- Sections	A22	29.39	852	146	5.84
T-Sections	B22	41.4	852	146	5.84
T- Sections	C22	49.2	852	146	5.84
I- Sections	A33	29.39	1343	230	5.84
I- Sections	B33	41.4	1343	230	5.84
I- Sections	C33	49.2	1343	230	5.84

Table (3): Chemical Composition of the Used Cement

Compound Composition	Chemical Composition	Percent	Limit of Iraqi specification No.5/1984[2]
Lime	CaO	61.67	-
Silica	SiO2	20.69	-
Alumina	Al2 O3	5.20	-
Iron Oxide	Fe2 O3	4.61	-
Magnesia	MgO	2.43	< 5
Sulfate	SO3	2.21	< 2.8
Loss on Ignition	L.O.I.	3.31	< 4
Insoluble Residue	I.R.	0.5	< 1.5
Lime Saturation Factor	L.S.F	0.90	0.66 – 1.02
Main Compounds (Bogue's Equation) Percentage by Weight of Cement			
Tricalcium Silicate	C3S	38.55	
Dicalcium Silicate	C2S	33.15	
Tricalcium Aluminate	C3A	7.12	
Tetracalcium Alumina Ferrite	C4AF	10.73	

Table (4): Physical Properties of the Used Cement

Physical properties	Test Results	Limit of Iraqi specification No. 5/1984 (2)
Specific Surface area (Blaine Method , cm^2/gm)	3043	≥ 2300.0
Setting time (Vicats Method) Initial Setting time, hrs. : min Final Setting time, hrs. : min	 174 3:54	 45 min> ≤ 10:00 hr
Compressive strength of mortar 2 days (MPa) 7 days (MPa)	 21.61 30.75	 ≥ 15 ≥ 23

Table (5): Typical properties of Glenium 51 (5)

No.	Main action	Concrete super plasticizer
1	Color	Light brown
2	pH. Value	6.6
3	Form	Viscous liquid
4	Subsidiary effect	Hardening
5	Relative density	1.1 at 20°C
6	Viscosity	128 ± 30 cps at 20°C
7	Transport	Not classified as dangerous
8	Labeling	No hazard label required

Table (6): Mix Design of SCC Mixes by Weigh

Group	comp. strength of cube specimens (f'_c) MPa	W/C Ratio	Mix proportions kg/m^3					lit /m^3	
			Cement	Limestone powder(lsp)	Total powder	Sand	Gravel	Water	Glenium 51
A	29.36	0.55	346	204	550	743	833	190	6.6
B	41.42	0.55	474	105.3	357.3	758.4	833	180	8.1
C	49.2	0.38	535	64	599	814	833	155	18

Table (7): Results of Testing Fresh SCC Property

Mix symbol	Slump flow (mm)	T50 Sec.	L-box (H2/H1)	T20 Sec.	T40 Sec.
A	750	2.6	0.96	1.8	3.5
B	715	3.8	0.90	2.1	3.9
C	685	4.9	0.88	2.3	4.2

Acceptance criteria for Self-compacted concrete (SCC) [8]

NO.	Method	Unit	Typical range of values	
			Minimum	Maximum
1	Slump flow	mm	650	800
2	T50	Sec	2	5
3	L-Box	(H2/H1)	0.8	1

Table (8): Comparisons of the Tested Results

Group	Beam	Ultimate shear strength (Vu kN)tested	Nominal shear strength (VnkN) ACI	Vu tested/Vn ACI ratio
Beams without stirrups	A10	25.31	16.47	1.5367
	B10	30.59	18.58	1.6464
	C10	33.27	19.79	1.6811
	A20	18.0	11.7	1.5384
	B20	24.0	13.3	1.8045
	C20	28.0	14.1	1.9858
	A30	38.56	14.13	2.7290
	B30	43.77	16.13	2.7135
	C30	45.862	17.27	2.6555
Beams with stirrups	A11	46.94	34.6	1.3566
	B11	51.68	36.18	1.4284
	C11	55.0	37.39	1.4710
	A22	42.0	29.3	1.4334
	B22	47.5	30.9	1.5372
	C22	54.0	31.7	1.7034
	A33	55.76	31.72	1.7578
	B33	60.45	33.72	1.7927
	C33	64.45	34.86	1.8488

Table (9): Effect of Compressive Strength (f_c')) on the Percentage Increase in the Ultimate Shear Strength of Tested Beams without Stirrups

Shapes	Beam	Comp. strength (f'_c) MPa	Ultimate shear capacity (Vu)kN	Percentage of increased %
Rectangular	A10	29.36	25.316	------
Rectangular	B10	41.42	30.59	20.832
Rectangular	C10	49.2	33.22	31.221
T- Sections	A20	29.36	18.0	--------
T-Sections	B20	41.42	24.0	33.333
T- Sections	C20	49.2	28.0	55.555
I- Sections	A30	29.36	38.56	--------
I- Sections	B30	41.42	43.77	11.903
I- Sections	C30	49.2	45.86	18.913

Table (10): Effect of Compressive Strength (f_c')) on the Percentage Increased in the Ultimate Shear Strength of Tested Beams with Stirrups.

Shapes	**Beam**	**Comp. strength (f_c') MPa**	**Ultimate shear capacity (Vu)kN**	**Percentage of increased %**
Rectangular	A11	29.36	46.94	------
Rectangular	B11	41.42	51.687	10.113
Rectangular	C11	49.2	55.0	17.170
T- Sections	A22	29.36	42.0	--------
T-Sections	B22	41.42	47.5	13.09
T- Sections	C22	49.2	54.0	28.57
I- Sections	A33	29.36	55.76	--------
I- Sections	B33	41.42	60.45	8.411
I- Sections	C33	49.2	64.45	15.584

Table (11): Effect of Absence of Stirrups on the Percentage Increased in the Ultimate Shear Strength.

Beams	**Compressive strength (fc)MPa**	**Ultimate shear capacity (Vu)kN**	**Percentage of increased %**
A10	29.36	25.316	-------
A11	29.36	46.94	85.41
B10	41.42	30.59	------
B11	41.42	51.687	68.96
C10	49.2	33.227	-----
C11	49.2	55.0	65.52
A20	29.36	18.0	------
A22	29.36	42.0	133.33
B20	41.42	24.0	------
B22	41.42	47.5	97.92
C20	49.2	28.0	------
C22	49.2	54.0	85.92
A30	29.36	38.56	------
A33	29.36	55.76	44.60
B30	41.42	43.77	-------
B33	41.42	60.45	38.10
C30	49.2	45.862	-------
C33	49.2	64.45	40.53

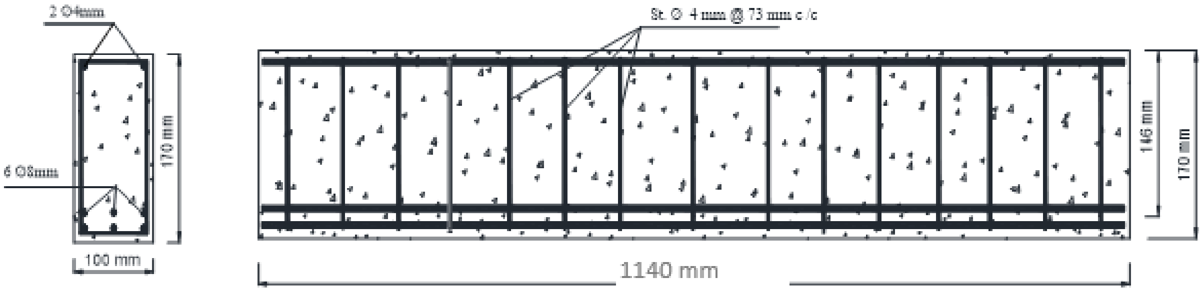

Fig. (1): Details of rectangular section (all dimensions in mm)

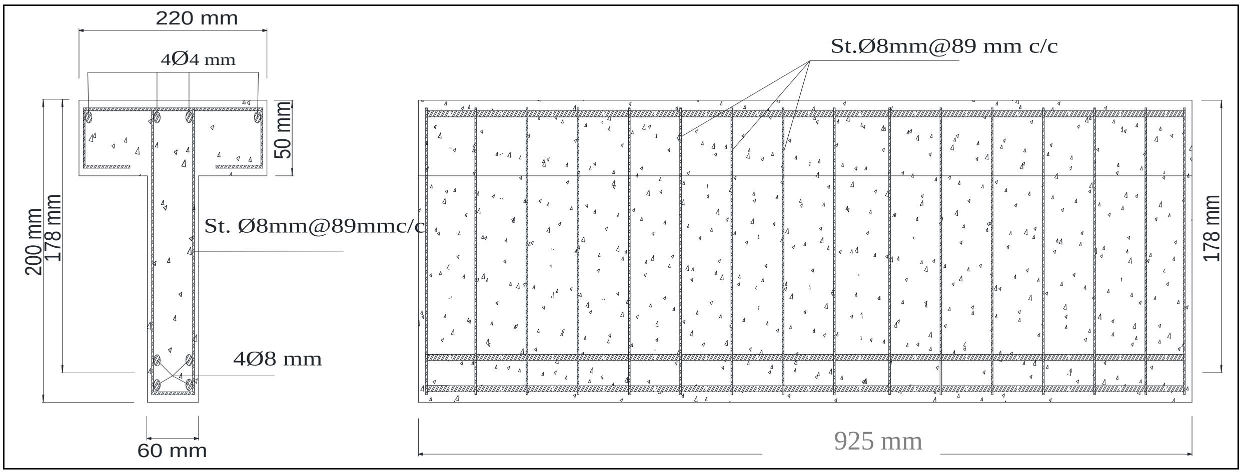

Fig. (2): Details of T-section (all dimensions in mm)

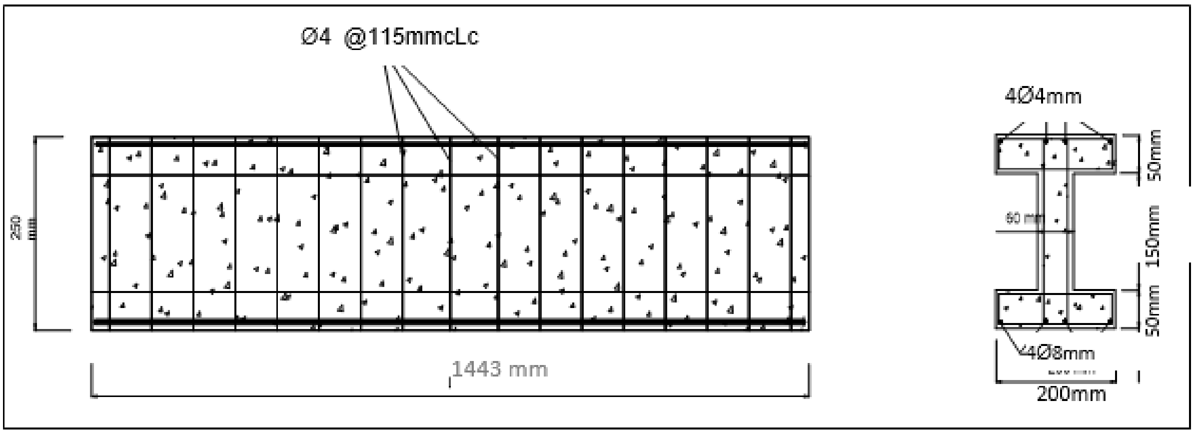

Fig. (3): Details of I-section (all dimensions in mm).

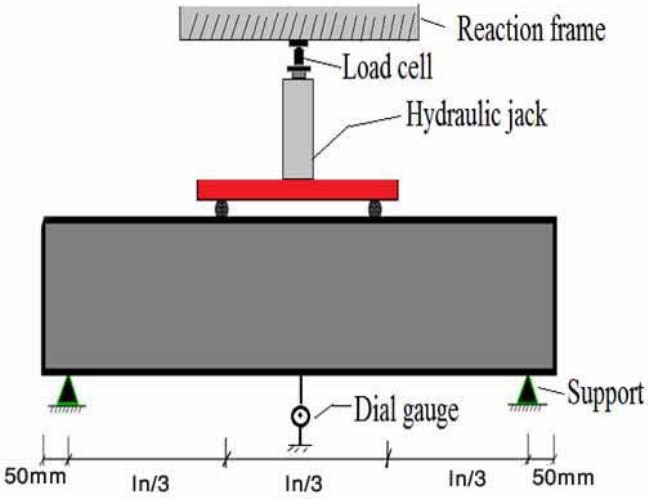

Fig. (4): Schematic diagram of test set-up

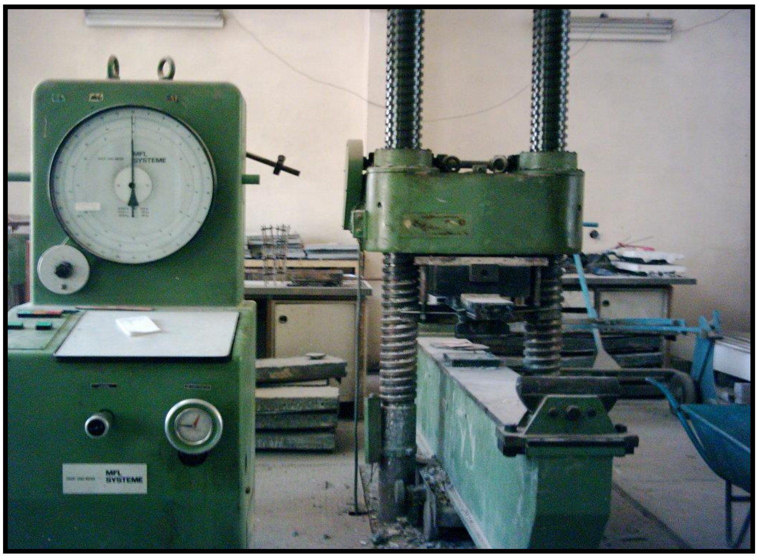

Fig. (5) Tested Machine

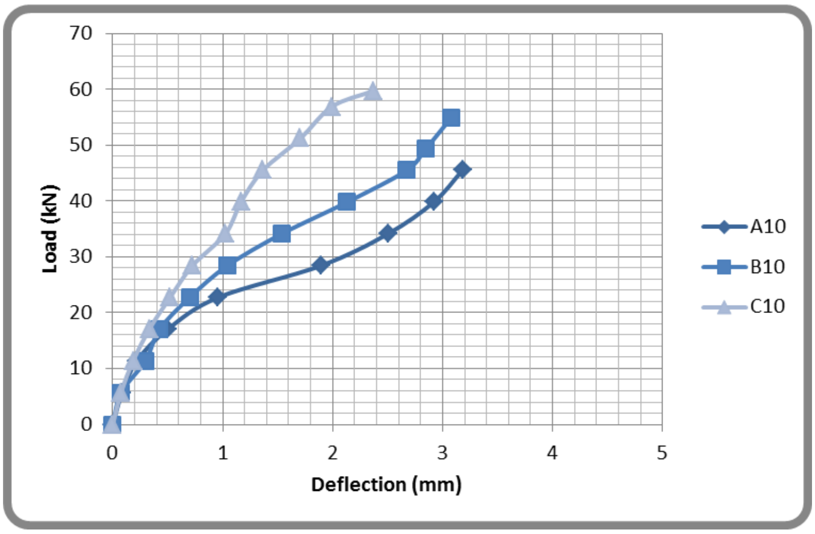

Fig. (6): Load –deflection curve for SCC Rectangular beam specimens without stirrups

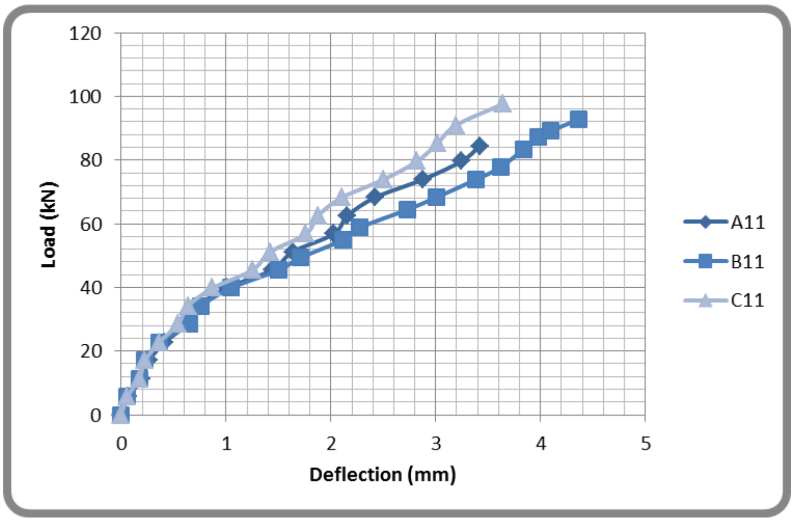

Fig. (7): Load –deflection curve for SCC Rectangular beam specimens with stirrups

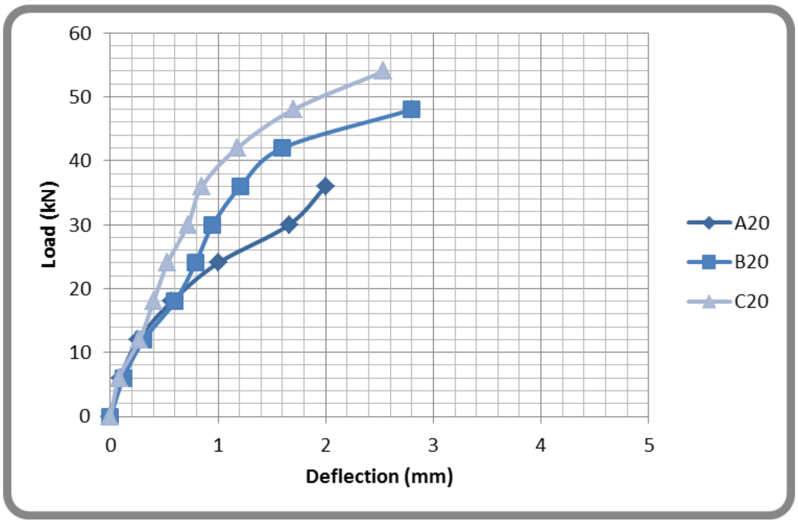

Fig. (8): Load –deflection curve for SCC T-section beam specimens without stirrups

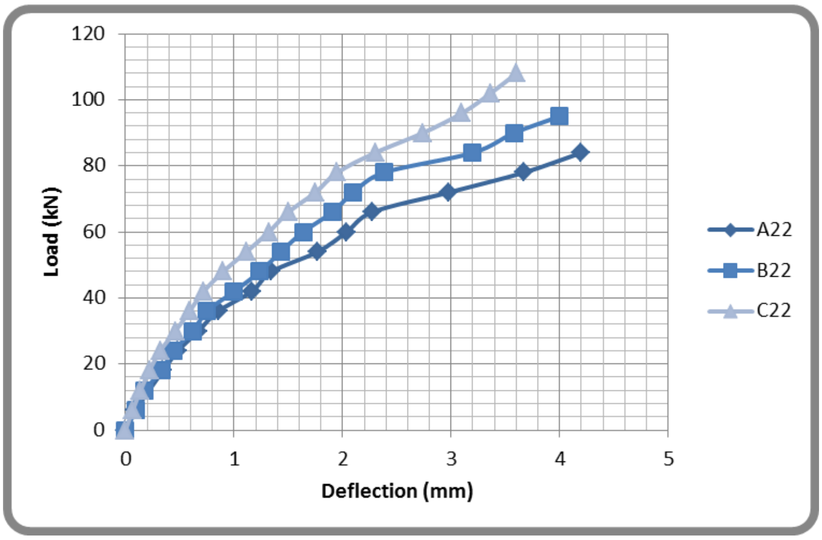

Fig. (9): Load –deflection curve for SCC T-section beam specimens with stirrups

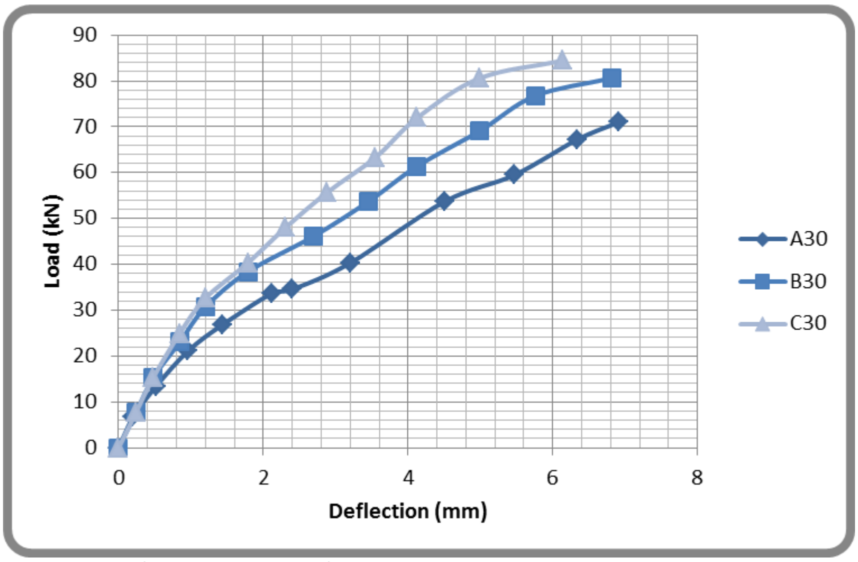

Fig. (10): Load –deflection curve for SCC I-section beam specimens without stirrups

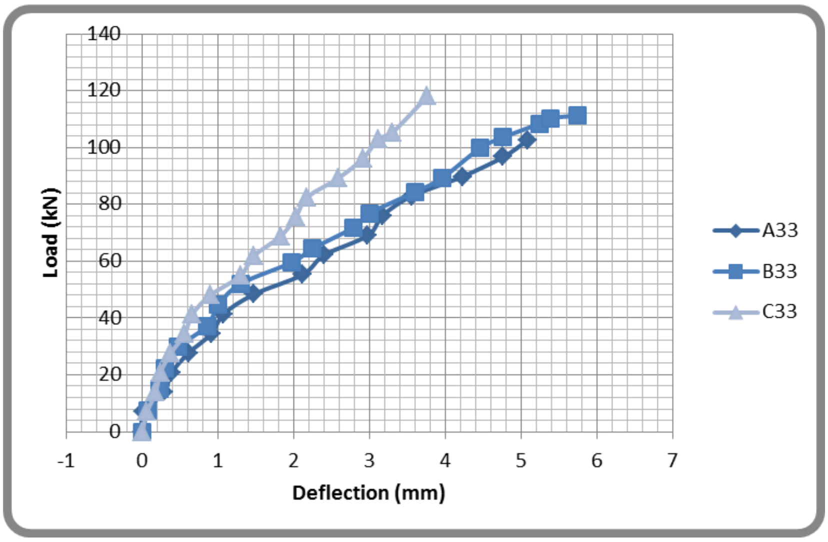

Fig. (11): Load –deflection curve for SCC I-section beam specimens with stirrups

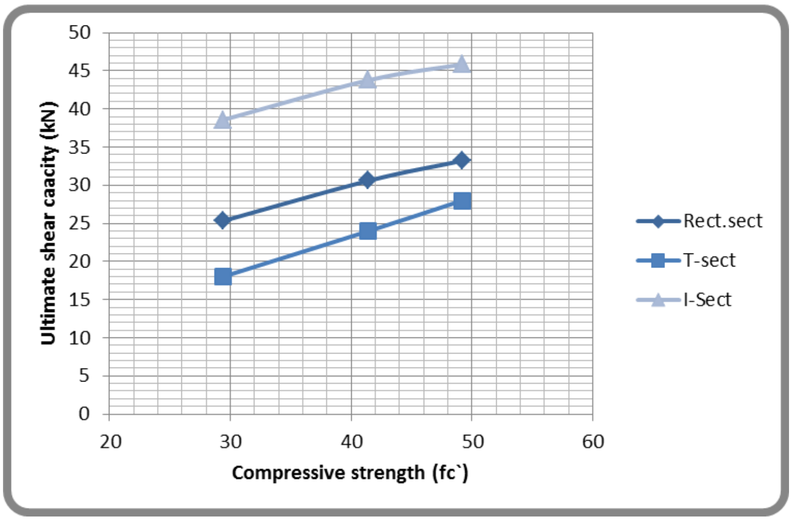

Fig. (12): Effect of compressive strength. (f_c') on the ultimate shear strength for SCC beam specimens without stirrups

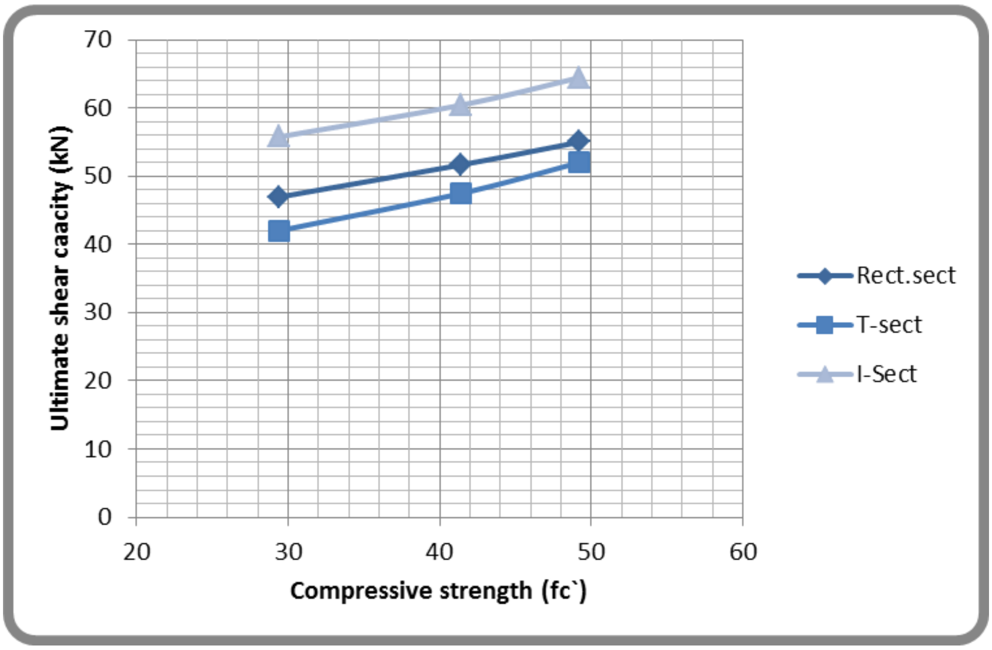

Fig. (13): Effect of compressive strength. (f_c') on the ultimate shear strength for SCC beam specimens with stirrups

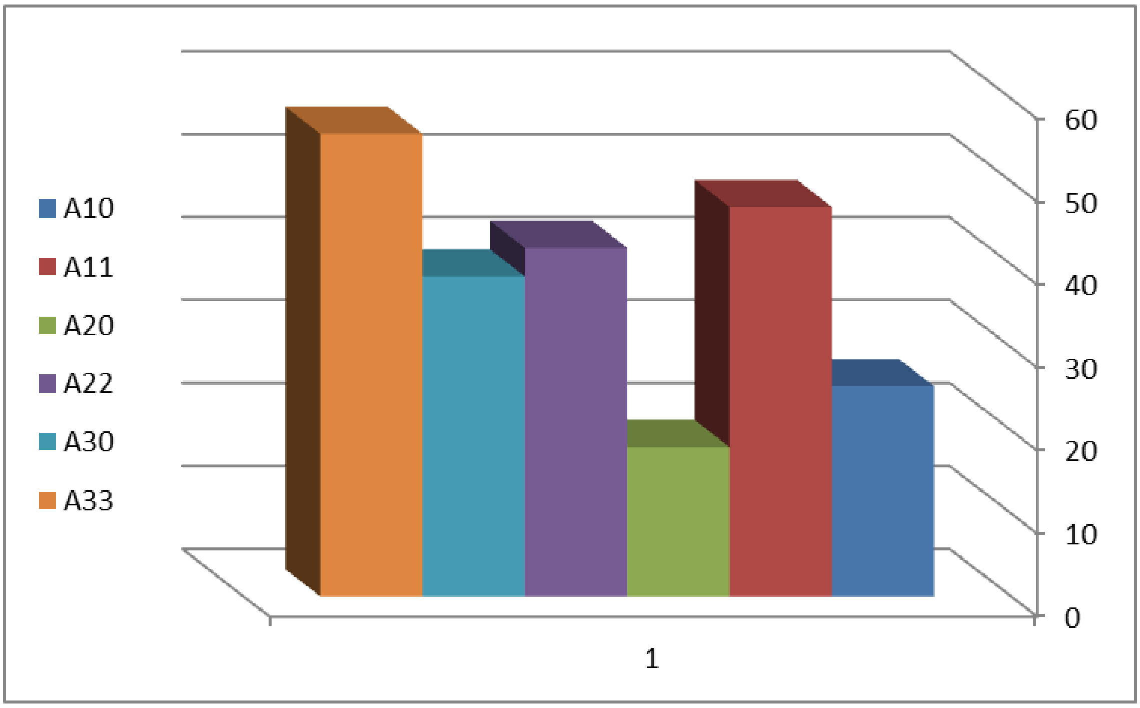

Fig. (14): Effect of absence of stirrups on the the ultimate shear strength at compressive strength (f_c') =29.36 MPa.

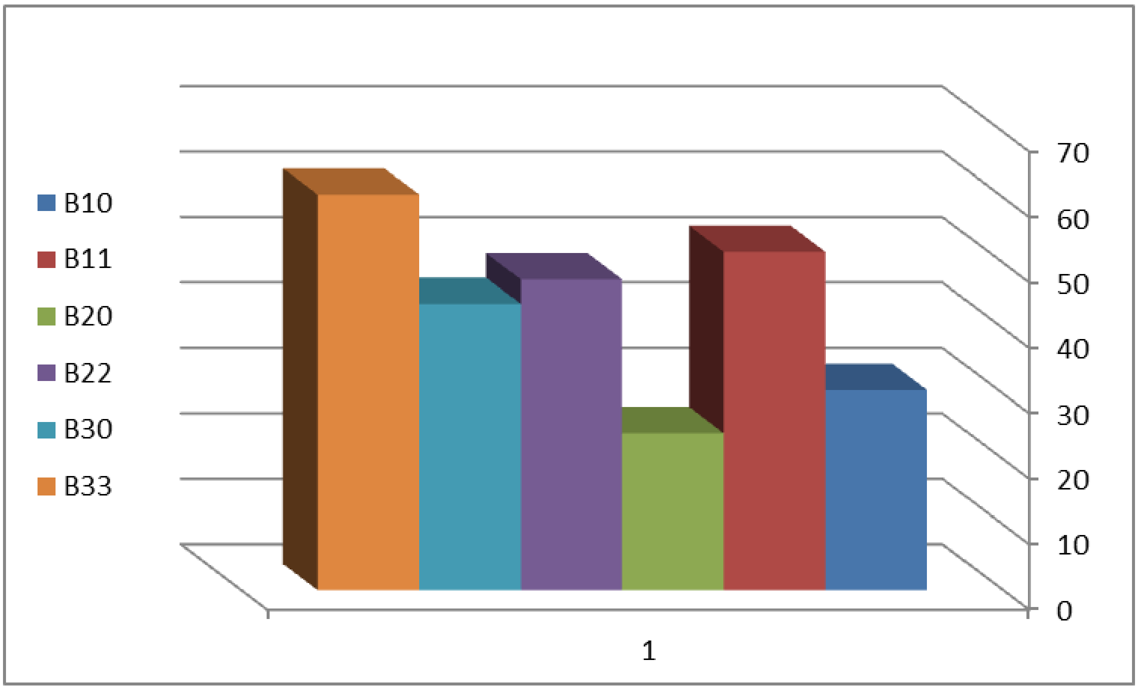

Fig. (15): Effect of absence of stirrups on the ultimate shear strength at compressive strength (f_c') =41.42 MPa.

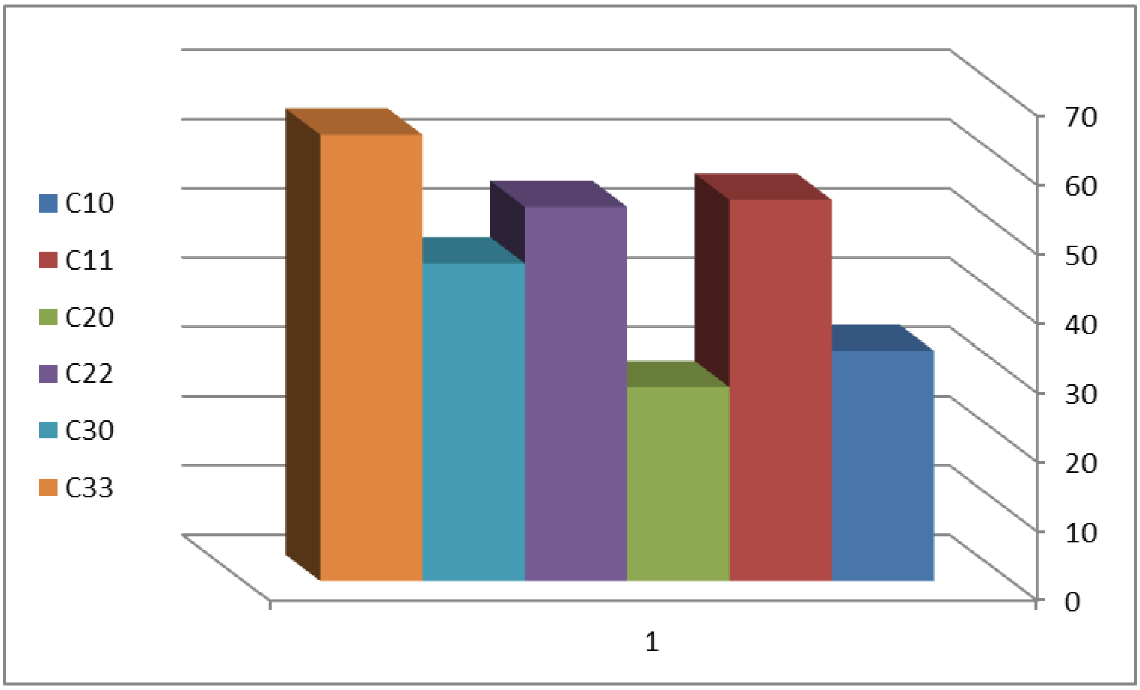

Fig. (16): Effect of absence of stirrups on the ultimate shear strength at compressive strength (f_c')=49.2 MPa.

Fig (17): Crack pattern of the tested SCC beam specimens

Fig (18): Crack patterns of the tested SCC beam specimens

الخلاصة

يتم في هذة الدراسة تصميم و فحص ثمانية عشر عتبة خرسانية ذاتية الرص ذوات اشكال متنوعة لدراسة مقاومتها القص تحت تاثير حملين مركزين. قسمت العتبات المفحوصة إلى ثلاثة مجاميع (حسب شكل المقطع) الى مقاطع مستطيلة ومقاطع شكل حرف (T)ومقاطع شكل حرف (I)، كل مجموعة قسمت إلى متواليتين ,متوالية مسلحة بحديد تسليح القص (الأطواق) والأخرى غير مسلحة بحديد تسليح القص(الأطواق). تحوي المتوالية الواحدة على نفس نسبة حديد تسليح الطولي ومساحة المقطع العرضي ونسبة الطول الصافي إلى العمق الفعال ولكن بمقاومة انضغاط مختلفة. وجد من خلال نتائج الفحص إن مقاومة القص القصوى المستحصلة باستخدام معادلة المدونة الأمريكية (318M−08) متحفظة مقارنة مع النتائج المستحصلة من الجانب العملي وان مقاومة القص القصوى للعتبات الخرسانية المسلحة الحاوية وغير الحاوية على حديد تسليح القص (الأطواق) تزداد عند زيادة مقاومة الانضغاط، حيث إن مقاومة القص القصوى للعتبات الخرسانية الغير حاوية على حديد تسليح القص (الأطواق) للمقاطع المستطيلة ومقاطع شكل حرف (T) ومقاطع شكل حرف (I)تزداد بمقدار 31.22% و55.55% و 18.93 % على التوالي عند زيادة مقاومة الانضغاط من 29.36 إلى 49.2 نت/ملم^{2}وإن مقاومة القص القصوى للعتبات الخرسانية الحاوية على حديد تسليح القص (الأطواق) للمقاطع المستطيلة ومقاطع شكل حرف (T) ومقاطع شكل حرف (I) تزداد بمقدار 17.17% و 28.57% و 15.84 % على التوالي عند زيادة مقاومة الانضغاط من 29.36 إلى 49.2 نت/ملم^2, كما ان مقاومة القص القصوى للعتبات الخرسانية الذاتية الرص المستطيلة الحاوية على حديد تسليح القص (الأطواق) تزداد بمقدار 85.41% و 68.96%و 65.52 % بالمقارنة معمقاومة القص القصوى للعتبات الخرسانية الذاتية الرص المستطيلة غير الحاوية على حديد تسليح القص (الأطواق) بمقاومة انضغاط 29.36 نت/ملم^{2}و41.42 نت/ملم^{2}و49.2 نت/ملم^2 على التوالي ,وان مقاومة القص القصوى للعتبات الخرسانية الذاتية الرص ذات الشكل حرف(T) الحاوية على حديد تسليح القص (الأطواق) تزداد بمقدار 133.33 %و 97.91 % و92.85% بالمقارنة معمقاومة القص القصوى للعتبات الخرسانية الذاتية الرص ذات الشكل حرف(T) غير الحاوية على حديد تسليح القص (الأطواق) بمقاومة انضغاط 29.36 نت/ملم^{2}و41.42 نت/ملم^{2}و49.2 نت/ملم^2 على التوالي. واخيرا فان مقاومة القص القصوى للعتبات الخرسانية الذاتية الرص ذات الشكل حرف(I) الحاوية على حديد تسليح القص (الأطواق) تزداد بمقدار 44.6 %و 38.1%و40.53% بالمقارنة معمقاومة القص القصوى للعتبات الخرسانية الذاتية الرص ذات الشكل حرف(I) الغير حاوية على حديد تسليح القص (الأطواق) بمقاومة انضغاط 29.36 نت/ملم^{2}و41.42 نت/ملم^{2}و49.2 نت/ملم^2 على التوالي.

كلمات مفاتحية: مقاومة القص، مقطع خرساني مستطيل، مقطع خرساني شكل حرف(I)، مقطع خرساني شكل حرف(T)، خرسانة ذاتية الرص.