Effect Of Central Point Load Of Monopanel Slab Specimens

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Abstract

A monopanel is a system building which consists of two thin ferrocement block-like faces and thick layer of low strength, density and cost polystyrene foam insulation between them as a core. The simple structure idealization of monopanel system is that the core provides shear transfer between the faces that provide flexural resistance. Transverse trusses made of steel bars. In flexural bars connected by inclined steel bar forming trusses shape making an angle equal to 45° with the longitudinal bars. The core material can be made of low cost and low density. This core provides the excellent thermal and sound insulation properties.

The main object of this research is to present investigation on the behavior and load carrying capacity of monopanel slabs. The experimental results show that effect of number of internal lacing, number of layers of steel wire mesh in each of monopanel unit (one layer or two layer) . The experimental nominal loads of monopanel slab specimens were compared with the results computed of the ACI-318 M-08 code and save to use

الخلاصة

نظام المونوبنل هو نوع من البناء الذي يتكون من طبقتين رقيقتين من الفيروسمنت تتخللهما طبقة من مواد عازلة ذات مقاومة وكثافة قليلتين وترتبط هاتين الطبقتين بواسطة عوارض مصنوعة جملونيا من قضبان حديدية على هيئة قضبان طولية عدد2 تربطهما أخرى تميل بزاوية مقدارها 45 درجة مع القضبان الطولية ,هذه القضبان المائلة تقوم بمقاومة قوى القص المتولدة بين الوجهين من جراء تسليط الأحمال على أوجه وحدة المونوبنل المعرضة الأحمال الانحناء كما في السقوف.إن المادة التي تستعمل في لب المونوبنل ذات كلفة وكثافة واطئتين وهذا اللب بدوره يجهز المونوبنل بخاصية العزل الحراري والصوتي بصورة ممتازة.

تناول هذا البحث دراسة سلوك والتحمل الأقصى للسقوف المصنعة في المختبر بموجب نظام المونوبنل. ومن خلال التجارب العملية تمت دراسة تأثر قوى الفشل المتمركزة في منصف النماذج بعدد العوارض الجملونية الداخلية وكذلك بعدد طبقات المشبكات الحديدية في كل وجه من أوجه المونوبنل (طبقة أو طبقتين).

كذلك تم مقارنة النتائج العملية للتحمل الأقصى لأعتاب المونوبنل مع النتائج المستحصلة باستخدام علاقات دليل الخرسانة الامريكي ACI-318M-08حيث بالإمكان استخدامها بشكل أمين .

Introduction

The Monopanel structural building system is reinforced concrete that consists of two thin ferrocement exterior skins and a thick layer of low strength and low density polystyrene foam installed between the thin skins as a core. The simple structural idealization of monopanel system is that the core provides flexural and compression resistance. Ferrocement consists of a composite thin sheet of cement mortar, which reinforced with a cage made of wire mesh, and steel skeletal bars .The thickness of the composite thin sheet is about 15 mm for one layer and about 25 mm for two layer in each side.

Ferrocement components can be cast in any shape using suitable moulds. In addition, ferrocement requires only a few easily available materials including cement, sand, iron wire mesh and mild steel as skeletal bars in small amounts compared to reinforced concrete.

Experimental Work

The materials used for constructing the monopanel slabs and describes the method adopted in the preparation and testing of the monopanel structural elements. It also includes details of the testing procedures.

Ordinary Portland cement type (I) manufactured in Iraq designated as Kufa was used throughout this investigation. It was stored in airtight plastic containers to avoid the effect of dampness and to maintain uniform quality. The percentage oxide composition and physical properties of the cement are conforming to the Iraqi specification No. 5/1984.

Natural sand with maximum size of 2.36 mm was used in this investigation. It lies in zone (3). The sand was separated by sieving; its grading satisfies the fine grading in accordance with B.S. specification No.882/1992 and the Iraqi specification No.45/1984. Results indicate that the sulfate content and the fine materials content are within the requirements of the Iraqi specification No.45/1984.

Two locally available types of reinforcement have been used in this investigation:

1- Skeletal steel bars with 3.4 mm diameter.
2- Galvanized square chicken wire mesh with 12 x12 mm opening and with an average wire diameter of 0.8 mm.

A polystyrene foam with low density of (20.2 kg/m^3) and low cost was used as a core filling material.

Potable water has been used throughout this investigation for mixing and curing.

Mix Design:

The mix proportion was considered throughout the investigation. The sand and cement were thoroughly mixed in a ratio of one part by weight of cement to two parts and half of sand (1:2.5). The water cement ratio used was 0.5. To establish the mortar mechanical properties shown in Table (1), a number of control specimens were cast and tested, three cylinders of 100 x 200 mm, three cubes of 50 x 50 x 50 mm and three cylinders of 150 x300 mm were used to estimate the compressive strength, the modulus of elasticity and the split tensile strength. Three prisms of 100 x 100 x 400 mm have been used to estimate the modulus of rapture. These tests were in accordance with the British standard BS.1881 and the American standards ASTM-C39, ASTM-C109, ASTM-C78 and ASTM -C469.

Table (1) Mechanical properties of mortar mix

Mix proportion (Cement-Sand)	Compressive strength (MPa)		Tensile strength (MPa)	Modulus of rupture (MPa)	Modulus of elasticity (MPa)
	f'_c	f_{cu}	f_{ct}	f_r	E_m
1:2.5	19.55	24.66	1.87	2.55	22647

Results of Monopanel slab Tests:

Six groups of Monopanel slab specimens with different dimensions were cast. Table (2) shows the slab specimens details of group with 28 day age and wet currying.

Table (2) Details of Monopanel slab specimen groups

Group	Height H(mm)	Width B (mm)	Length L (mm)	Face thickness t(mm)	No. of lacing	No. of wire mesh layers
A_1	110	1000	1000	15	3	1
A_2	110	1000	1000	15	5	1
A_3	110	1000	1000	15	9	1
B_1	110	1000	1000	25	3	2
B_2	110	1000	1000	25	5	2
B_3	110	1000	1000	25	9	2

In this research, the effect of some important parameters on the load carrying capacity of monopanel slab specimens has been investigated. And The number of wire mesh layers (one layer and two layers), and number of lacing were considered. Fig.(1) shows the geometry of monopanel slab specimens.

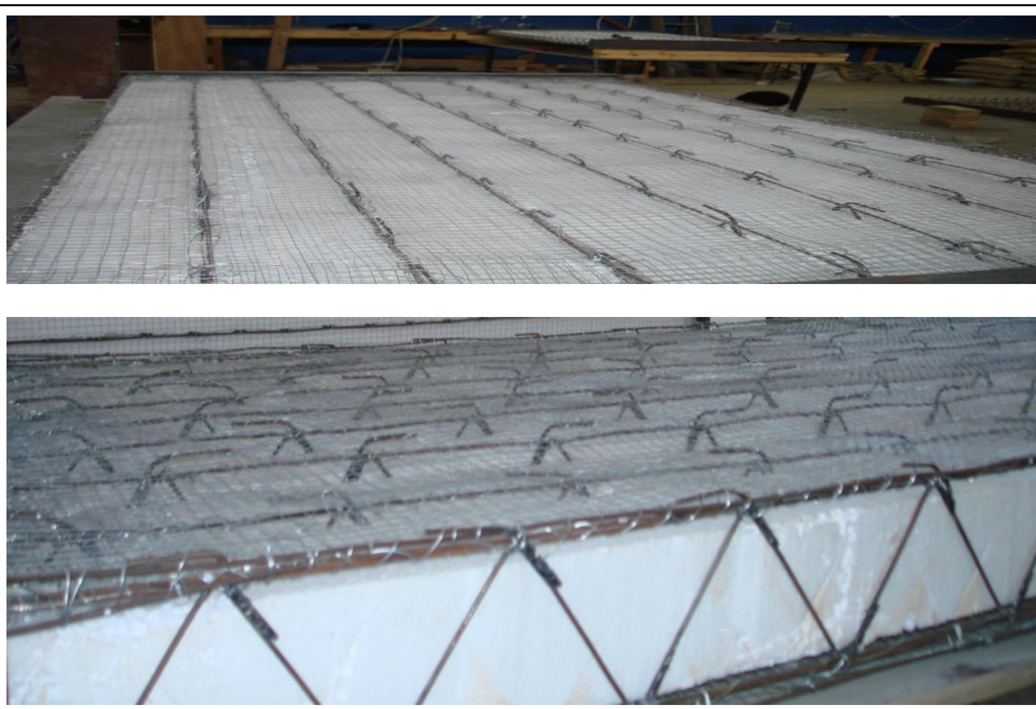

Fig. (1) Geometry details of monopanel slab specimens

The experimental work of the six Monopanel slabs groups was divided into two groups (A and B). each group consisted of three different monopanel slabs .The results included the measured failure loads, effect of number of lacing trusses, effect of number of wire mesh layers, mid span deflection, and failure modes. Table (3) shows the value of deflection at different loading stages for all slabs specimens.

Table (3) Ultimate loads for monopanel slab specimens

Specimens name	Experimental ultimate load (KN)	Theoretical ultimate load (kN) from direction of mesh reinforcement 0nly *	$\frac{P_{ACI}}{P_{Exp.}}$	Theory ultimate load (kN) from direction of mesh and lacing Reinforcement *	$\frac{P_{ACI}}{P_{Exp.}}$
A_1	13	2.964	0.20	7.105	0.55
A_2	17	2.964	0.18	9.852	0.58
A_3	22	2.964	0.14	13.77	0.63
B_1	15	5.616	0.37	9.549	0.64
B_2	20	5.616	0.28	12.156	0.61
B_3	25	5.616	0.23	17.33	0.69

* **Theoretical** value was obtained according ACI-Code 318 M-08

According to the experimental results, when using one layer of reinforcement wire mesh of each side for monopanel slab specimens, the central ultimate point load increases by 30.08 percent and the central deflection at ultimate stage decreases by 13.85 percent if the number of lacing increases from 3 to 5. In addition, if the number of lacing increases from 5 to 9, the central ultimate point load increases by 29.41 percent and the central deflection at ultimate stage decreases by 16.08 percent. While, when the number of lacing increasing from three to nine, the central ultimate point load increases by 69.23 percent and the central deflection at ultimate stage decreases by 27.71 percent.

Beside that, when the number of wire mesh layer in each side for monopanel slab specimens increases from one to two, the central ultimate point load increases by 15.38 percent and the central deflection at ultimate stage decreases by 33.18 percent when the number of lacing equals to three. While the central ultimate point load increases by 17.64 percent and the central deflection at ultimate stage decreases by 24.90 percent when the number of lacing equal five. In addition, when the number of lacing equal to nine the central ultimate point load increases by 13.63 percent and the central deflection at ultimate stage decreases by 33.69 percent when number of layer of wire mesh increases from 1 to 2 too .

Moreover, when using two layer of reinforcement wire mesh of each side for monopanel slab specimens, the central ultimate point load increases by 33.33 percent and the central deflection at ultimate stage decreases by 3.18 percent if the number of lacing increases from 3 to 5. In addition, if the number of lacing increases from 5 to 9, the central ultimate point load increases by 25.0 percent and the central deflection at ultimate stage decreases by 26.59 percent. While, when the number of lacing increases from three to nine, the central ultimate point load increases to 66.66 percent and the central deflection at ultimate stage decreases by 28.26 percent.

Figure (2) exhibits the central point load vs mid span deflection behavior obtained at different loading stages for Monopanel slab specimens when using one layer of wire mesh in each side of Monopanel slab specimens.

Also figure (3) explains the central point load vs mid span deflection behavior obtained at different loading stages for Monopanel slab specimens when using two layer of wire mesh in each side of Monopanel slab specimens.

While, Figure (4) present the crack pattern for Monopanel slab specimens for different groups.

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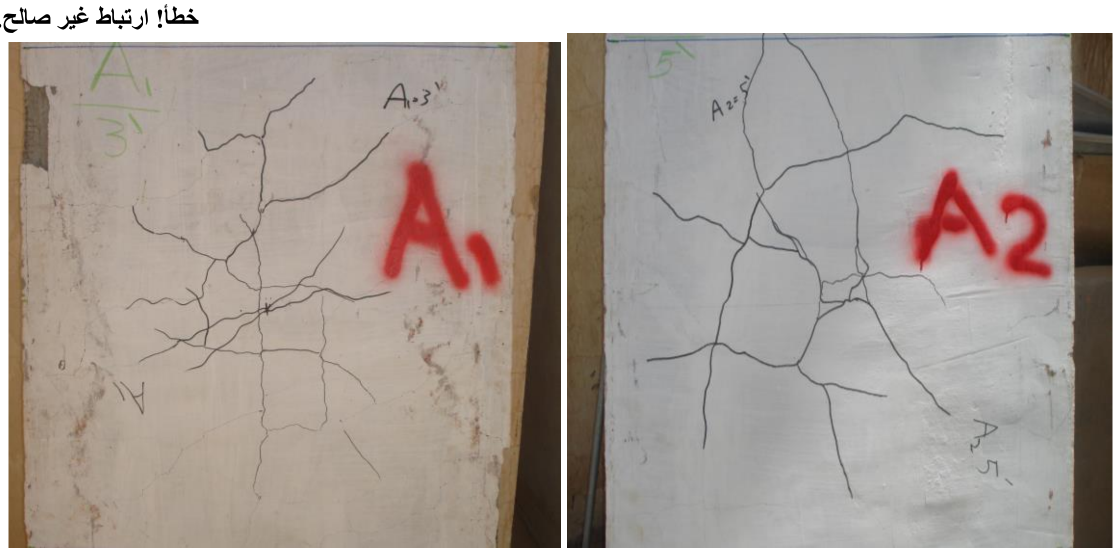

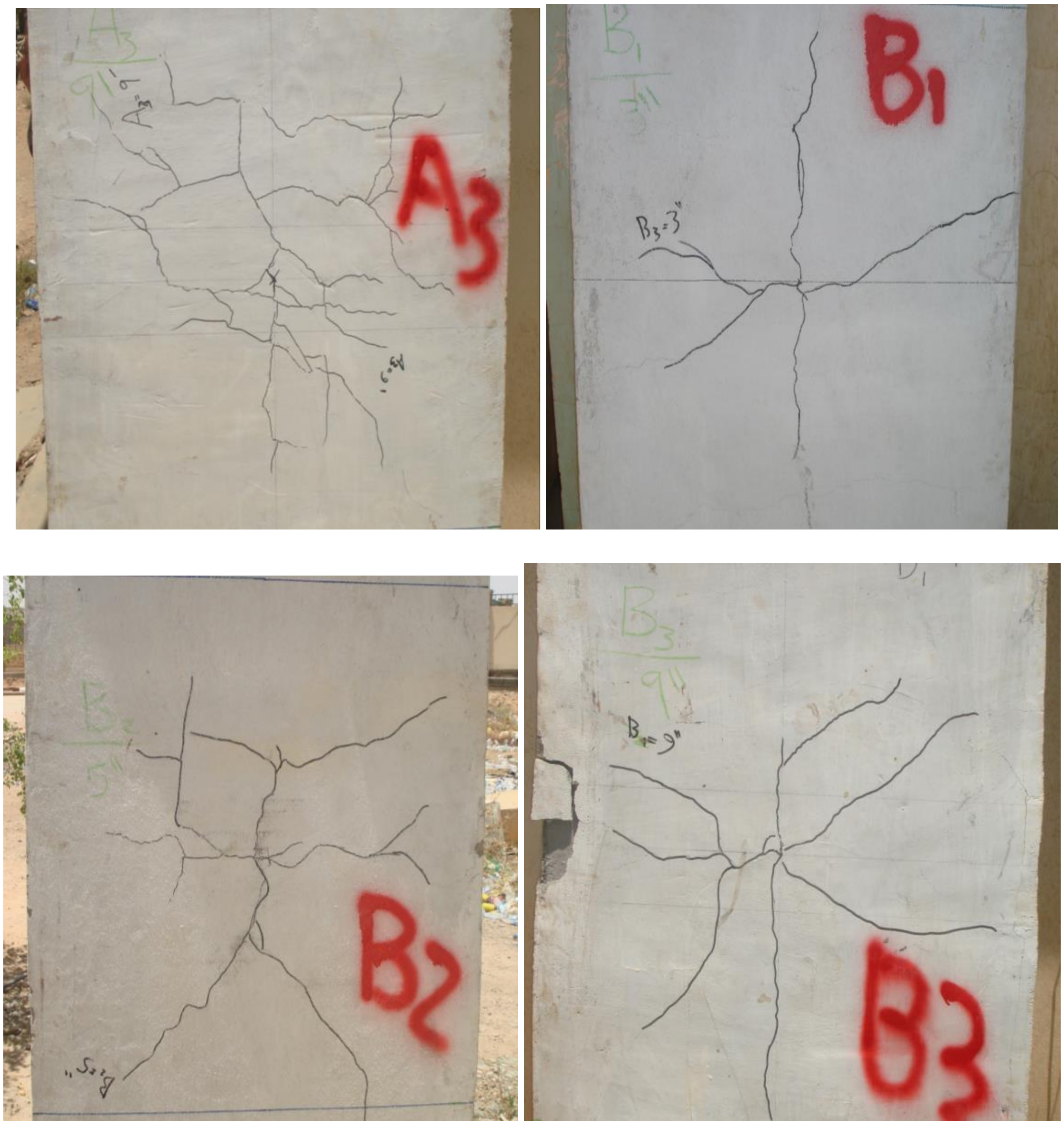

Fig. (4) Crack pattern for Monopanel slab specimens

Conclusions

Based on the results obtained from the experimental work, conducted in this research the following conclusions:

1-The central ultimate point load increases by 69.23 percent when the number of lacing increases from three to nine with using one layer of reinforcement wire mesh of each side for monopanel slab specimens .

2- The central deflection at ultimate stage decreases by 27.71 percent when the number of lacing increases from three to nine with using one layer of reinforcement wire mesh of each side for monopanel slab specimens.

3- The central ultimate point load increases by 13.63 percent when the number of wire mesh layer in each side for monopanel slab specimens increases from one to two with number of lacing equal to nine.

4- When the number of wire mesh layer in each side for monopanel slab specimens increases from one to two with number of lacing equal to nine the central deflection at ultimate stage decreases by 33.69 percent.
5- When using two layer of reinforcement wire mesh of each side for monopanel slab specimens with increases the number of lacing from three to nine, the central ultimate point load increases by 66.66 percent.
6- The central deflection at ultimate stage decreases by 28.26 percent with using two layer of reinforcement wire mesh of each side for monopanel slab specimens and the number of lacing increases from three to nine.
7- It can be noted that the ratio between the theoretical to the experimental ultimate load in the direction of mesh reinforcement only is 0.2 with using one layer of wire mesh while, when using two layer of wire mesh layer this ratio equal to 0.3 compared with the ACI-code 318M-08 provisions requirements.
8- The ratio between the theoretical to the experimental ultimate load in the direction of lacing and wire mesh reinforcement equals to 0.6 with using one layer of wire mesh while, when using two layer of wire mesh layer this ratio equal to 0.7 compared with the ACI-code 318M-08 provisions requirements.

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