Diyala Journal of Engineering Sciences

ISSN 1999-8716
Printed in Iraq

Vol. 10, No. 2, pp. 12-26, June 2017

EVALUATING THE CONNECTION AREAS BETWEEN BRICKS WALLS AND CONCRETE COLUMNS IN CONFINED MASONRY BUILDINGS IN IRAQ

Ali Fadhil Naser
Lecturer, Building and Construction Engineering Department, Al-Mussaib Technical College, Al-Furat Al-Awsat Technical University
(Received: 6/2/2016; Accepted: 22/5/2016)

ABSTRACT: - The objective of this study is to evaluate the construction methods of connection area between bricks walls and concrete columns. Damage inspection process was used to discover the damages in selected buildings. According to construction method, four buildings were selected as a case study. According to damage inspection results, the building without tooth edge (building B) and the building with bonding bars (building C) were appeared cracks with different widths and lengths. For building B, the maximum width and length of crack is equal to 3.5mm and 3.25m respectively. For building C, The maximum crack width is equal to 5mm with length 3m.

The buildings with tooth edge connection have no cracks in the area between bricks walls and concrete column because of the strong correlation between the concrete of column and the spaces of bricks (tooth edges). The tooth edge method of building construction did not appear cracks. Therefore, this study recommends to use the method of tooth edges in the construction of building in Iraq to prevent the cracks.

Key words: building, bricks walls, concrete column, masonry, inspection, cracks

INTRODUCTION

A building is a structure attached to the land and provides total cover for machines, processing equipment, performance of human activities, storage of human possessions, or any combination of these. Building construction is performed by using laborers and craftspeople. (1)

Confined masonry building includes three parts. These parts are masonry walls, horizontal reinforced tie-beam and vertical reinforced tie-columns. In confined masonry construction, masonry walls are constructed first, one story at a time, followed by the cast in-place reinforced concrete tie-columns. Finally, reinforced concrete tie-beams are constructed on top of the walls. Confined masonry has been professionally used for buildings construction in Latin-America, Northern-Africa and Asia. (2, 3)

Building design can be define as the process of providing all information necessary for construction of a building that will meet its owner's requirements and satisfy public health, welfare, and structural safety requirements. (4)

There are many studies about masonry buildings and most these studies were dealt with the effect of earthquake on the walls of buildings. D. Kusumastuti, et al, (2012) evaluated the performance of confined masonry structures under earthquake loads. They applied lateral cyclic loads to the model with increasing displacement. They concluded that confined masonry infill wall improved strength and stiffness on the structural response. Therefore, more masonry walls will give additional strength and ductility to the structure. There are many cracks were appeared at the corners of openings.(5)

Mohammad, et al, (2012) studied the importance of seismic behavior of masonry infill walls. They found that infill walls show high strength at the first step of seismic loading, but

by reaching to the maximum strength, the infill walls fail and high loss of strength occurs in small drifts.(6)

Roberto, et al, (2011) prepared a report under title seismic design guide for low-rise confined masonry buildings. This report discussed seismic response of confined masonry buildings, building components, and confined masonry construction.(7)

Bricks are oven parched from various clay and shale mixtures. The chemical and physical properties of the components differ greatly. These characteristics and the oven temperatures combine to produce brick in a variety of colors and harnesses. (8,9)

A reinforced concrete column is a confined masonry part and it can be defined as a structural members designed to carry compressive loads. It composed of concrete with an embedded steel frame to provide reinforcement. For design purposes, the columns are classified into two types. The first type is short columns and the second type is slender columns. Generally, the concrete column is one of the most interesting members in concrete structural design application. (8, 11, 12)

Reinforced concrete tie-columns are the main structural members to confine the masonry wall in order to increase the horizontal and vertical load-bearing capacities, deformation ability and a seismic reliability. According to the location of tie-column, it can be divided into two types, the first type is wall terminal tie-columns and the second type is wall intermediate tie-columns. It is poured after the make of masonry walls in the pre-formed vertical channels of the walls. The width of the cross-section of the tie-columns is equal to the thickness of the walls. (13)

The purpose of this study is to evaluate the connection between the bricks walls and reinforced concrete column in confined masonry buildings in Iraq and to explain the reasons of cracks in this location of buildings. Fig. (1) shows the confined masonry building.

DESCRIPTION OF SELECTED BUILDINGS

Four buildings are selected as a case study to evaluate the connection (bonding) between bricks wall and reinforced concrete columns. These building are located in Al-Mussaib Technical College in Babylon city in the middle of Iraq. This study will classify the building according to the occupants of the buildings.

BUILDING A

This building has two stories. The occupants of the building are employers and students. The construction method is a confined masonry by using brick wall and reinforced concrete tie-columns and tie-beams. Firstly, the brick walls were constructed then tie-columns and tie-beams were installed by using tooth edges method. Fig. (2) shows the construction method of building (A).

BUILDING B

Building B consists of one story and constructed by using confined masonry method but the reinforced concrete tie-columns were constructed firstly then the brick walls and reinforced concrete tie-beams were built. The building has ten columns. The connection between bricks wall and concrete tie-column didn't have tooth edges from brick wall or bonding bars from tie-column. The occupants of the building are employers and students but not always has people. Fig. (3) shows construction method of the building (B).

BUILDING C

This building has two stories, and it has 16 classrooms. Each classroom has 6 concrete columns. Therefore, the occupants of the building are students and the live load is high. The building was built by using confined method with bonding bars connect the concrete tie-column and brick walls. The distance between bonding bars along the tie-column length is

0.50m. The reinforced tie-columns with bonding bars were constructed first, and then the brick walls were built. Fig. (4) shows the construction method of building (C)

BUILDING D

The building (D) has two stories and the students are the main occupants of this building. The method of constriction is same as building (A). It was using tooth edge method. Fig. (5) gives the construction method of building (D).

DAMAGE INSPECTION OF THE SELECTED BUILDINGS

The inspection of structure is important for collecting information about the structural of buildings condition and adequacy. This information must be stored as a permanent building record. Such a record provides a useful and accurate history. It also contains information on previous repairs and provides others with ready access to information. Damage inspection and maintenance of all types of structures are significant to the safety of users and often very important to the economy of a region [(14)]

BUILDING A

The results of damage inspection show that the building has not cracks in the area of connection between concrete columns and bricks walls because of the types of connection is tooth edge of brick. Therefore, this method did not appear cracks. Fig. (6) shows the inside building.

BUILDING B

This building appeared cracks between bricks wall and columns. Table (1) shows the results of damage inspection for building B. From this table it can be noted that the area between bricks wall and concrete columns has cracks especially in the column which that located in the corners of building. The maximum width and length of crack is equal to 3.5mm and 3.25m respectively, and it is located within column C4. Fig. (7) shows the cracks in building B.

BUILDING C

The type of connection area of this building is bonding bars connect the tie-column and brick walls. According to inspection results, there are many cracks were appeared in this building due to the week connection between brick wall and concrete columns. The maximum crack width is equal to 5mm with length 3m. Fig. (8) shows the cracks in the building C.

BUILDING D

Damage inspection results show that there are no cracks in the region of connection between concrete columns and bricks wall because of the construction method which was used in this building is tooth edge connection. Fig. (9) shows the building D.

CONCLUSIONS AND RECOMMENDATIONS

In this study, four buildings were selected, which they had different construction methods. Two buildings were used tooth edge method, one building was used bonding bars method, and the other building was used the normal method (no tooth edge and bonding bars). According to damage inspection results, the building without tooth edge (building B) and the building with bonding bars (building C) was appeared cracks with different widths and lengths. For building B, the maximum width and length of crack is equal to 3.5mm and 3.25m respectively. For building C, The maximum crack width is equal to 5mm with length 3m.

The buildings with tooth edge connection have no cracks in the area between bricks walls and concrete column because of the strong correlation between the concrete of column and the spaces of bricks (tooth edges). The tooth edge method of building construction did not appear cracks. Therefore, this study recommends to use this method in the construction of building to prevent the cracks.

REFERENCES

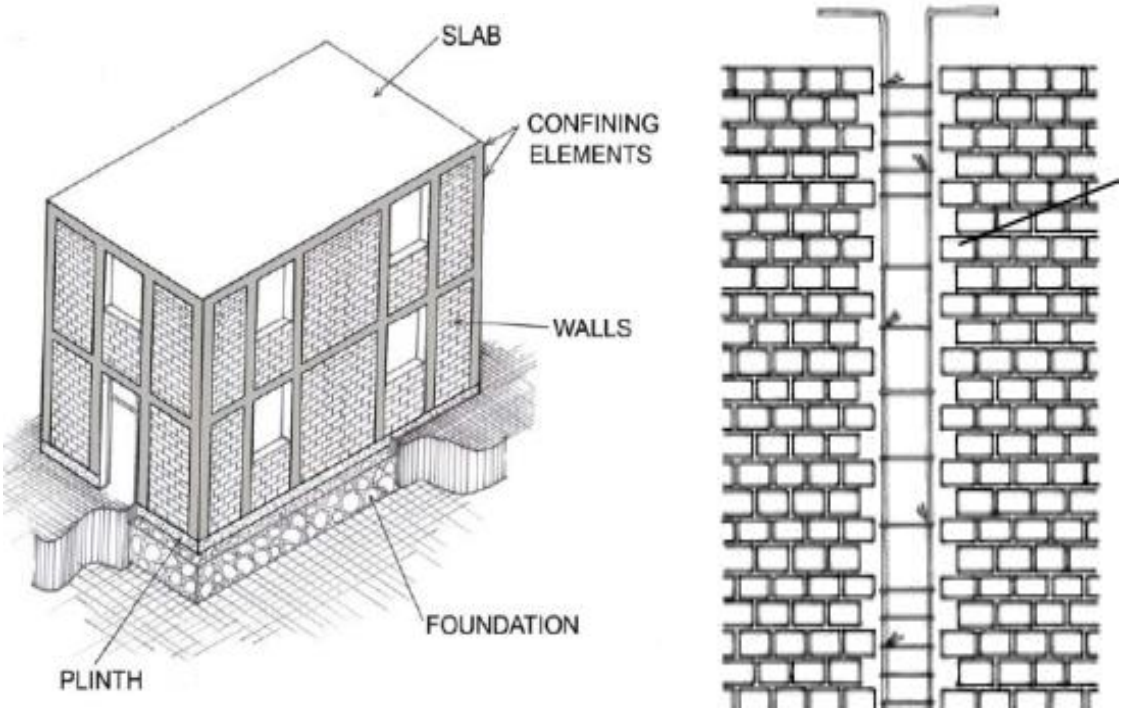
1) Frederick, S.; and Jonathan T., (2001), "Building design and construction", handbook, 6 edition, The McGraw-Hill Companies, Inc, pp: 1.1 to 1.3, New York, USA.
2) Roberto, M.; Svetlana, B.; Maximiliano A. et. al., (2011), "Seismic design guide for low-rise confined masonry buildings", a Project of the World Housing Encyclopedia, EERI & IAEE, California, USA, pp: 6-8.
3) Marques, R.; Lourenço, P. B., (2010), "A new proposal for the design of confined masonry buildings", 8th International Masonry Conference 2010 in Dresden, pp:2193-2202.
4) Philippe, P.; and Benoît, L., (2013), "Building and construction manual", the infrastructure unit of the sect-oral & thematic expertise department, pp: 11, Belgian Development Agency.
5) D. Kusumastuti, M.; Rildova.; Lie, T., (2012), "Experimental study on typical confined masonry structure under cyclic lateral load", The 15th World Conference on Earthquake Engineering (15WCEE), 24-28 September, 2012, Lisbon, Portugal.
6) Mohammad, R.; Amir, A., (2012), "Seismic behavior and retrofit of infilled frames, earthquake-resistant structures - design, assessment and rehabilitation, Prof. Abbas Moustafa (Ed.), ISBN: 978-953-51-0123-9, InTech.
7) Roberto, M.; Svetlana, B.; Teddy, B., (2011), "Seismic Design Guide for Low-Rise Confined Masonry Buildings", Earthquake Engineering Research Institute, Oakland, California, UAS.
8) David, L. H., (2014), "Fireclay bricks, building, construction and finishing", Sweet Haven Publishing Services, http://www.free-ed.net/free,Ed/Resources/Trades/carpentry/Building01/default.asp?iNum=0704.
9) U.S. Department of the Army, (1999), "Concrete, masonry and brickwork". General Publishing Company, Toronto, Canada. Pp: 244-245.
10) Clark, A. J., (2002), "Reinforced concrete design", Fifth Edition, Chapter 9b, Prentice Hall.
11) http://en.wikipedia.org/wiki/Reinforced_concrete_column, 2014.
12) Strunet Concrete Design, 2007, "Introduction to concrete column design flow charts", Concrete Column Design V1.01 Page 10, http://strunet.com/concrete_column/index.html.
13) Dahai, L.; and Maozheng, W., (2000), "Masonry structures confined with concrete beams and columns", The 12 WCEE conference (World Conference on Earthquake Engineering), pp: 2720.
14) Ali, F. N.; Zonglin, W., (2011), "Field damage inspection and static load test analysis of jiamusi highway prestressed concrete bridge in china", Advanced Materials Research Vols. 163-167 (2011) pp 1147-1156, Trans Tech Publications, Switzerland.

Table (1): The results of damage inspection for building B

Column No.	Crack width(mm)		Crack length(m)	
	Front side	Rear side	Front side	Rear side
C1	2.3	3.1	2.6	2.6
C2	No crack	No crack	No crack	No crack
C3	**1.7**	No crack	2.30	No crack
C4	2.4	**3.5**	2.50	3.25
C5	No crack	No crack	No crack	No crack
C6	No crack	No crack	No crack	No crack
C7	No crack	No crack	No crack	No crack
C8	2	3.2	2.55	2.75
Inside building	2.2		2.75	

Table (2): The results of damage inspection for building C

Classroom No.	Crack No.	Crack width(mm)	Crack length(m)
1	1	3.5	3
	2	2	2.65
	3	1.5	2.30
2	1	1.5	2.30
3	1	2	2.5
	2	6	2.75
4	1	1.5	1.75
Outside building	1	**5**	**3**
	2	2.5	2.20
	3	3	2.5
	4	2	1.5
	5	2.5	1.65
	6	1.5	1.30
	7	2.3	2.10



(a) (b)

Fig. (1): The confined masonry building: (a) parts of building, (b) tie-column (tooth edge)

(a)

(b)

(c)

(d)

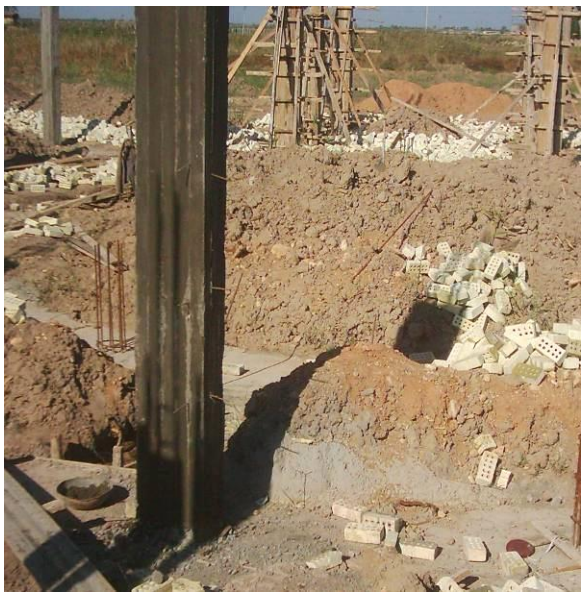
Fig (2): The building (A) during construction by using tooth edges connection

(a)

(b)

(c)

Fig (3): The building (B) was constructed without tooth edge and bonding bar)



(a)

(b)

(c)

(d)

Fig (4): The building (C) was constructed by using bonding bars (0.50m)

(a)

(b)

(c)

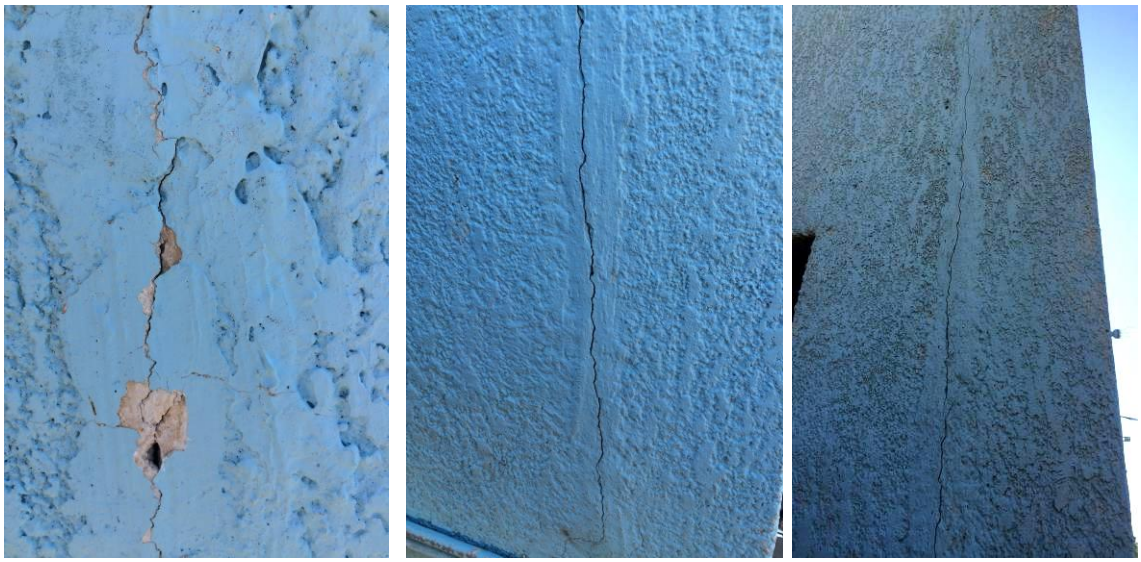
(d)

Fig (5): The building (D) was constructed by using tooth edge connection

(a)

(b)

Fig. (6): The inside of building A.



(a)

(b)

Fig. (7): The cracks in the outside and inside of building B.

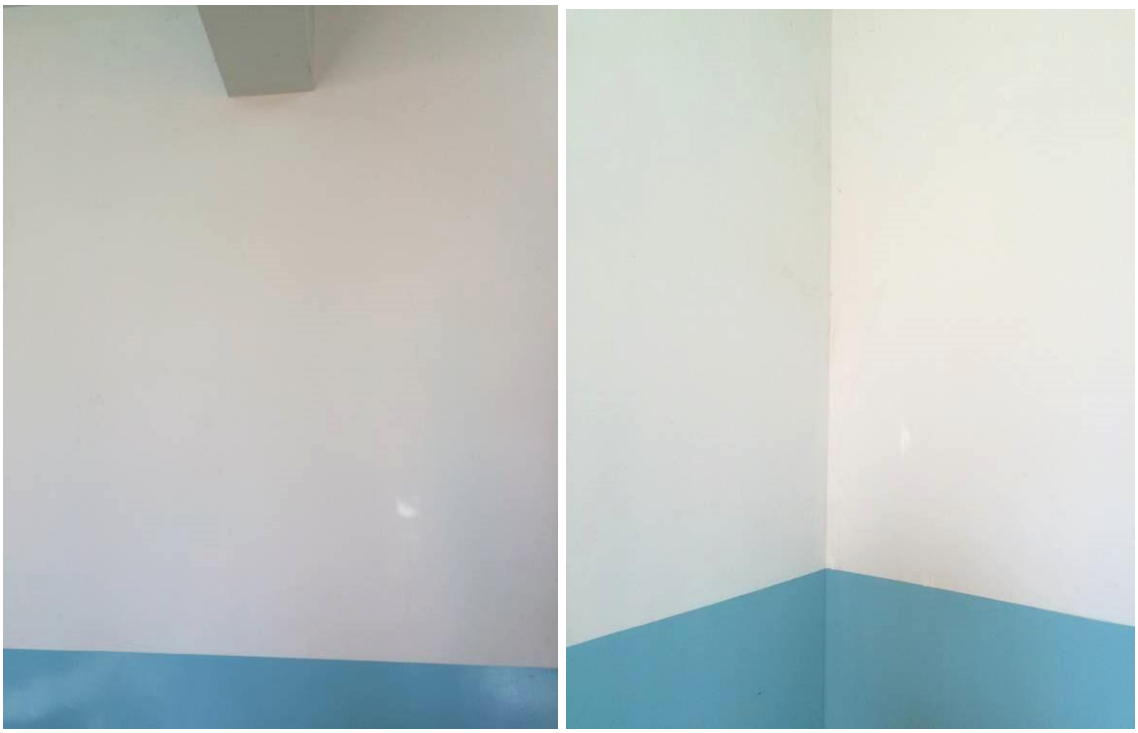
(a)

(b)

(c)

Fig. (8): The cracks in outside and inside of the building C.

(a)



(b)

Fig. (9): The inside of building D.

تقييم مناطق الربط بين الجدران الطابوقية والأعمدة الخرسانية في المباني ذات البناء المقيد في العراق

علي فاضل ناصر

مدرس

جامعة الفرات الأوسط التقنية/ الكلية التقنية المسيب/ قسم هندسة تقنيات البناء والإنشاءات

ali_hu73@yahoo.com

الخلاصة

إن الهدف من هذه الدراسة هو تقييم أساليب البناء في منطقة الاتصال بين الجدران الطابوقية والأعمدة الخرسانية. وقد استخدمت عملية تحري لاكتشاف الأضرار في المباني المختارة. وفقا لأسلوب البناء المستخدم، فقد تم اختيار أربعة مبان لدراسة حالة المباني. إن نتائج عملية اكتشاف الإضرار قد بينت إن المبنى (B) الذي لا يستخدم طريقة حافات الأسنان والمبنى (C) الذي يستخدم طريقة القضبان الرابطة قد اظهر عدد من الشقوق ذات أعراض وأطوال مختلفة. بالنسبة للبناء (B)، فان الحد الأقصى للعرض وطول الشق يساوي (3.5mm) و (3.25m) على التوالي. بالنسبة للبناء(C)، فان أقصى عرض للشق أقصى يساوي (5mm) مع طول (3m).

أثبتت الدراسة أيضا إن المباني التي استخدمت فيها طريقة حافة الأسنان ليس لها أي تصدعات ولم تظهر فيها أي تشققات في المنطقة الواقعة بين الجدران الطابوقية والأعمدة الخرسانية بسبب قوة الارتباط والتداخل القوي بين خرسانة العمود والمساحات الفارغة في نهاية الجدران الطابوقية (حافات الأسنان). لذلك توصي هذه الدراسة أن استخدام طريقة حواف الأسنان في إنشاء المباني التي تستخدم الأعمدة الخرسانية تعتبر الطريقة الأمثل لتجنب ظهور التشققات في المساحات الواقعة بين الجدران الطابوقية والأعمدة الخرسانية لذلك هذه الطريقة مناسبة لإنشاء المباني في العراق.