INFUENCE OF DIAGONAL REINFORCEMENT WITH SPIRAL STIRRUPS ON SHEAR CAPACITY OF COUPLING BEAM IN SHEAR WALL

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DEDICATION

To my beloved father and mother

To my wife and children

To my brother and sisters

To my friends

I thank you to much for supporting me

AKNOWLEDGEMENT

Firstly, I thank Allah for his blessings that enabled me to my project.

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ABSTRACT

Concrete core-walls are penetrated by vertical families of openings for doors to stairs, lifts and other spaces. These openings separate the core as a whole into a number of sub-cores linked by coupling-beams being the residual strips of concrete core-wall above and below openings. The (span/depth) ratio of these beams is determined by non-structural considerations and usually well into the ‘deep beam’ range prone to brittle behavior. This paper presents the results of tests of three coupling beam specimens in which the influence of three types of shear reinforcement were studied. All specimens were of the same dimensions and provided with different types of shear reinforcement. In order to investigate the contribution of various types of shear reinforcement, one specimen was provided with diagonal bars confined by spiral stirrups, and the second one provided with diagonal bars without stirrups, and the third one provided with the steel plate. All fixed vertically from one side and let the second side free to the top and the load was applied to the top portion of coupling beam. The performances of coupling beam were measured in terms of crack development and drifts, failure mode and ultimate load. The results of the coupling beam reinforced with diagonal bars and spiral stirrups showed high resisting of shear capacity comparing with other specimens, and coupling beam with diagonal reinforcement only showed high performance same as to that with spiral stirrups, and the third specimen of coupling beam with steel plate showed weak performance to dissipate the shear stresses.

ABSTRAK

Teras dinding teras konkrit ditembusi olehbukaan-bukaan menegakuntuk pintu ke tangga, lif dan ruangan-ruangan lain. Bukaan-bukaan ini memisahkan teras secara menyeluruh ke dalam beberapa sub-teras yang dihubungkan oleh rasuk gandingan yang menjadi jalur sisa teras dinding konkrit di bukaan-bukaan atas dan bawah.Nisbah (rintangan/ketebalan) rasu kini ditentukan menggunakan pertimbangan bukan struktur dan selalunya sesuai bagi julat 'rasuk dalam' yang cenderung kepada sifat kerapuhan.Kajian ini membentangkan keputusan ujian tiga spesimen rasuk gandingan di mana pengaruh tiga jenis tetulang ricih dikaji. Semua spesimen adalah dengan dimensi yang sama dan dikenakan jenis tetulang ricih yang berbeza. Untuk menyiasat sumbangan pelbagai jenis tetulang ricih tersebut, satu spesimen telah disediakan dengan bar pepenjuru terkurung oleh lingkaran rakap, dan yang kedua disediakan dengan bar pepenjuru tanpa lingkaran rakap, manakala yang ketiga disediakan dengan plat keluli. Semua dipasang secara menegak dari satu sisi dan bahagian kedua dibiarkan bebas ke atas dan beban telah dikenakan ke bahagian atas rasuk gandingan. Prestasi rasuk gandingan diukur dari segi perkembangan rekahan dan hanyutan, mod kegagalan dan beban muktamad. Keputusan rasuk gandingan yang diperkukuhkan dengan bar-bar pepenjuru dan lingkaran rakap menunjukkan rintangan kapasiti ricihan yang tinggi berbanding dengan spesimen lain, manakala rasuk gandingan dengan tetulang pepenjuru hanya menunjukkan prestasi tinggi yang sama dengan rakap pilin,manakala spesimen ketiga rasuk gandingan dengan plat keluli menunjukkan prestasi lemah bagi menghilangkan tegasan ricih.

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LIST OF SYMBOLS

Symbol		Description
fck	-	Compressive strength for concrete
fyk	-	Tensile stress for steel
Vn	-	Total shear capacity for the coupling beam
Vsd	-	Shear capacity for diagonal bars
Vs	-	Shear for steel links
Vc	-	Shear of concrete
$\propto$	-	Angle of diagonal bars
Acw	-	Area for concrete
Vns	-	Shear capacity for steel plate
M	-	Moment
V	-	Shear capacity for the section

CHAPTER 1

INTRODUCTION

1.1 Background of study

A building cannot bear the load of lateral forces, internally (volumetric change or restrain thermal movement) or externally (wind, seismic, water, soil). Therefore, lateral force resisting system is crucial for a structure. A typical system comprises of lateral bracing, structural walls, or movement frame. Utilization of wall to wrap the building core and act as lateral force resisting system is a common practice in construction. The surrounding walls open the floor plans and reduced the obstructions at the building envelope. This will minimize the requirement of using other lateral load resistant. Well designed structural walls can create an efficient resisting system and concurrently satisfying other functional requirements.

Though the wall resisting system can be considered perfect, it still has one limitation. The rigidity of the system can be decreased by perforation on walls like the existence of doors, windows or any large openings. For that reason, the capacity of the perforated shear wall must be increased. The attempt made is by coupling two walls as single unit. Depicted the mean coupling wall, the coupled core wall system is like a simple frame: wall piers on either side of the opening act as columns while the header acts as beam. This design let the wall piers to only act during the lateral force event.

1.2. Problem statement

Limitation in core wall resisting system has led to a new design where the core walls are coupled in order to increase the performance of the perforated shear wall. As said earlier, the coupled system is like a simple frame with an advantage to allow the wall piers to act mainly in tension or compression. This study aims to increase the efficiency of the coupling beam in dissipating the generated and gathering shear stresses.

1.3. Aim and Objective

In general, this study aims to increase the shear capacity of the coupling beam by using different type of reinforcement represented by diagonal reinforcement with spiral stirrups. The aim was achieved with the following objectives:

i. To evaluate the ability of spiral stirrups to prevent pulling out of diagonal bars.
ii. To measure the shear capacity in coupling beams.
iii. To verify the rotation of beams.

1.4. Scope of study

The scopes of this study are:

a) Three reinforced concrete coupling beam were used as specimen in the experimental investigation to meet the research purpose.

b) The size of each specimen was identical; shear wall (1000 length x 500 width x 200 thick) and coupling beam (800 mm length x 500 mm width x 200 mm thick).

c) Shear wall was provided with the same amount of main reinforcement but different for coupling beam.

d) The beams were fixed horizontally from one side and tested to failure with cyclic load applied at the upper side of the specimen

e) The compressive strength of concrete was 40 Mpa.

f) The variable for specimens is the shear reinforcement systems. Different types of reinforcement were use: diagonal reinforced bars with spiral stirrups in the first specimen, diagonal reinforcement without stirrups in the second specimen, steel plate inside the beam in the third specimen.

1.5. Significant of study

In lateral force resisting system, the role played by coupling beams to dissipate energy cannot be denied. A properly designed system can ensure the coupling beams to have enough stiffness and strength, thus able to dissipate the energy away, by shear and/or flexure, through the formation of plastic hinge at the base of wall piers. Hence, the coupling beams are said to act as ‘fuse’ in providing elasticity to the systems and simultaneously decrease the damage from the wall piers.

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