

**THE EFFECTS OF VOID COMBINATIONS AT
RECTANGULAR PLAN HIGH RISE RESIDENTIAL
BUILDING TO THE NATURAL VENTILATION
PERFORMANCE**

BY

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ABSTRACT

The natural ventilation in living units of high-rise residential buildings are commonly assisted by mechanical ventilation systems to achieve desired indoor environment quality. The usage of mechanical ventilation is also due to different reasons like the climate condition and the overall buildings design. However, because of its disadvantages, such as the negative impacts on the occupants health and the overall energy consumption, there is a necessity to ameliorate natural ventilation performance as a passive cooling strategy. Improvement made through suitable design configurations to improve the internal environment quality may reduce heavy electricity consumption. Hence the research aims to investigate if the integration of voids combinations as passive design feature in high rise residential buildings can enhance the indoor air velocity in the living units of high-rise rectangular plan residential buildings. The hypothesis is good control of the configuration of voids combinations can lead to better naturally ventilated living units. The research evaluates the introduction of various horizontal voids sizes and positions, combined with the commonly used vertical voids to optimize natural ventilation. The methods used in this research are the field measurement as a full-scale experiment and the computational fluid dynamic (CFD) simulation using Ansys CFX. The results of the high-rise residential buildings inventory were used to determine the appropriate building for the field measurements. The validation of the CFD building model against the field measurements data ensures the reliability and the accuracy of the CFD simulation. CFD simulation includes three main experiments which are the CFD building validation against the field measurements data, the effects of voids combinations on the air velocity inside the voids of building models and finally the influence of the proposed voids combinations on the internal air velocity in the living units of the building models. The experiments are done in living units under different openings conditions located at different heights and orientations. This study found that the provision of double-sided horizontal voids larger by 50 % connected directly to central vertical void can improve the indoor air velocity (m/s) in the living units by 1.23 % to 0.179 m/s under north east (NE) and by 4.59 % to 0.165 m/s under east (E) wind directions. The suitable voids combinations were recommended to improve the natural ventilation performance. This study contributes to a better understanding of ventilation performance in high rise rectangular plan residential buildings designed with voids configurations. It also recommends the possible voids combinations as design strategy for indoor air velocity (m/s) performance in the living units of the high-rise rectangular plan residential buildings in Malaysian for adequate thermal comfort level.

ملخص البحث

عادةً ما يتم دعم التهوية الطبيعية في الوحدات السكنية الكائنة بالمباني الشاهقة بواسطة أنظمة تهوية ميكانيكية لتحقيق الجودة المرغوبة للبيئة الداخلية. وعادة ما تستخدم التهوية الميكانيكية بسبب الظروف المناخية وأيضاً بسبب التصميم العام للمباني. ولكن ونظراً لبعض العيوب التي تشوب التهوية الميكانيكية مثل أثارها السلبية على صحة السكان واستهلاكها للطاقة بشكل عام، وجب تحسين أداء التهوية الطبيعية كإستراتيجية تبريد سلبي. وقد يؤدي هذا التحسين الذي سيتم إجراؤه من خلال تحسين وتطوير مكونات التصميم لتحقيق جودة البيئة الداخلية وأيضاً تقليل استهلاك الكهرباء، تهدف الدراسة الحالية إلى معرفة ما إذا كان دمج مجموعات الفراغات مميزة تصميم في المباني السكنية الشاهقة قد يعزز سرعة تدفق الهواء الداخلية في الوحدات السكنية المستطيلة الكائنة بالبنائات الشاهقة. أما عن فرضية الدراسة فتتمثل في أن التحكم الجيد في تكوين مجموعات الفراغات يمكن أن يؤدي إلى وحدات سكنية جيدة التهوية بشكل طبيعي. لقد قامت الدراسة الحالية بتقييم إدخال فراغات أفقية مختلفة المقاسات والمواقع، جنباً إلى جنب مع الفراغات العمودية شائعة الاستخدام والتي تهدف إلى تحسين التهوية الطبيعية. أما عن الطريقة المنهجية التي استخدمتها الدراسة فقد تمثلت في القياس الميداني كتجربة كاملة النطاق وبرنامج محاكاة ديناميكية السوائل الحسابية وتم استخدام نتائج جرد المباني السكنية الشاهقة لتحديد المبنى المناسب للقياسات الميدانية. يضمن التحقق من صحة نموذج البناء مقابل بيانات القياسات الميدانية موثوقية ودقة المحاكاة. وتتضمن طريقة استخدام المحاكاة القيام بثلاث تجارب رئيسية وهي التحقق من صحة المبنى مقابل بيانات القياسات الميدانية، وتأثير مجموعات الفراغات على سرعة الهواء داخل الفراغات لنماذج البناء وأخيراً تأثير مجموعات الفراغات المقترحة على سرعة الهواء الداخلية في الوحدات السكنية في نماذج البناء. وقد تم إجراء هذه التجارب في وحدات سكنية تحت ظروف فتحات مختلفة تقع على ارتفاعات واتجاهات مختلفة. وقد توصلت هذه الدراسة إلى أن توفير فراغات أفقية على الوجهين أكبر بنسبة 50% متصلة مباشرة بالفراغ العمودي المركزي يمكنها أن تحسن سرعة الهواء الداخلية (م / ث) في الوحدات السكنية بنسبة 1.23% إلى 0.179 م / ث في الإتجاه شمال شرق. وبنسبة 4.59% إلى 0.165 م / ث تحت اتجاه الرياح الشرقية. لذلك توصي هذه الدراسة بتركيب الفراغات المناسبة لتحسين أداء التهوية الطبيعية. وقد تساهم هذه الدراسة في فهم أفضل للتهوية في المباني السكنية ذات التخطيط المستطيل الكائنة بالمباني الشاهقة والمصممة باستخدام الفراغات. كما توصي هذه الدراسة أيضاً باستخدام تقنية الفراغات المحتملة كإستراتيجية تصميم من أجل تحسين سرعة تدفق الهواء الداخلي (م / ث) في الوحدات السكنية في المباني السكنية سالفة الذكر في ماليزيا للحصول على مستوى مناسب من الراحة الحرارية.

APPROVAL PAGE

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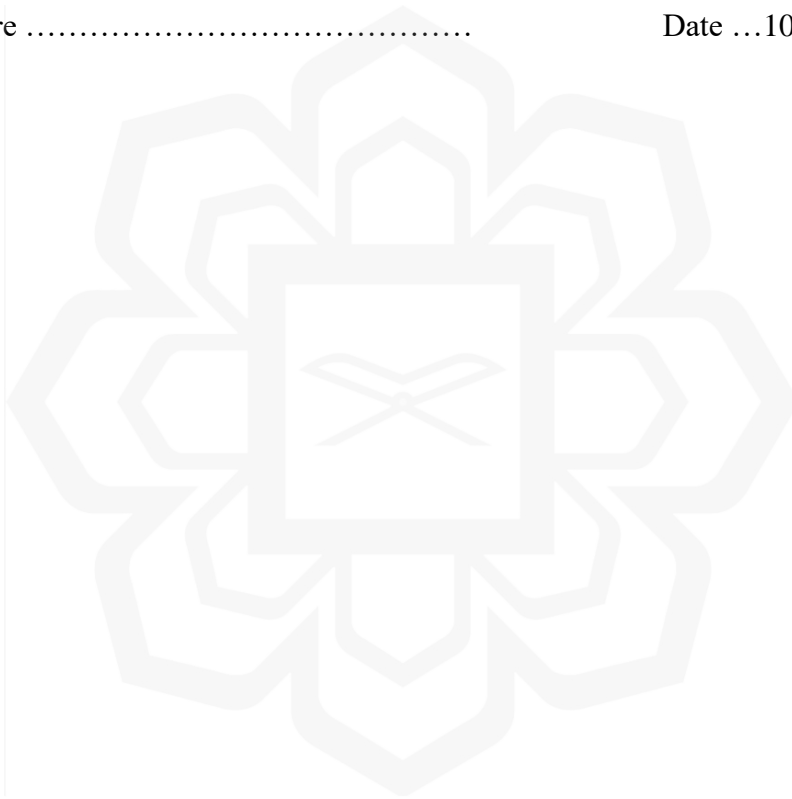
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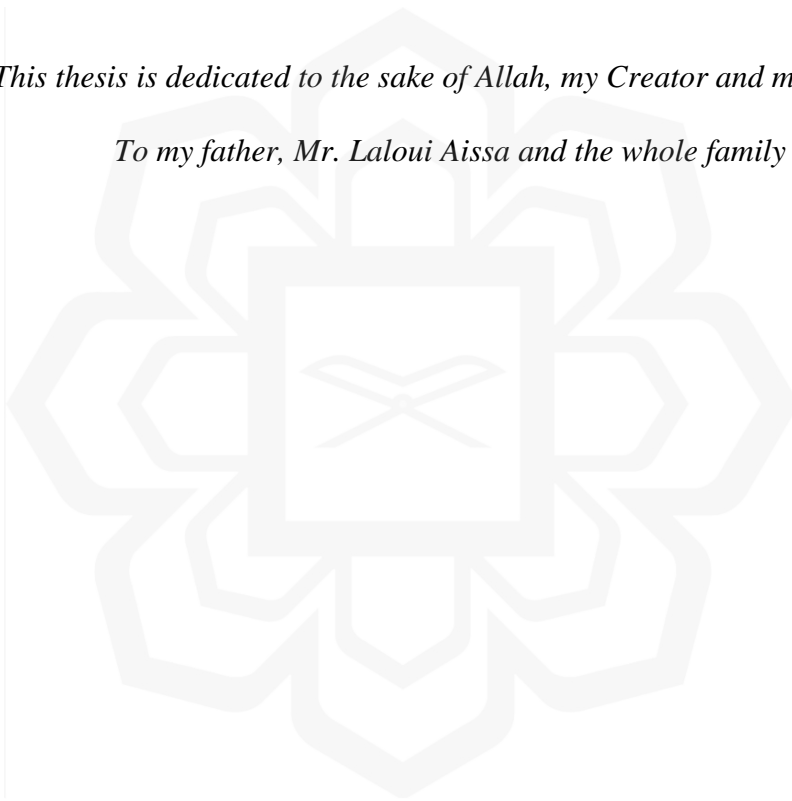
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This thesis is dedicated to the sake of Allah, my Creator and my Master

To my father, Mr. Laloui Aissa and the whole family



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