INTISARI

Pada masa pendudukan Belanda, pembuatan bangunan tembokan di Indonesia mengikuti bangunan tembokan dari Eropa. Ketebalan dindingnya lebih dari satu bata dan menggunakan pilar bata sebagai kolom maupun balok. Pada waktu itu Belanda menggunakan campuran adukan yang terdiri atas bubuk bata merah, bubuk kapur dan pasir yang dicampur dengan air. Bangunan dari dinding bata tersebut sudah berusia sangat tua dan banyak mengalami penurunan kualitas dan juga mengalami kerusakan dengan tingkat yang berbeda. Penelitian ini bertujuan untuk mendeteksi lokasi dan mengetahui tingkat kerusakan dinding pasangan bata ketebalan satu batu dengan mortar campuran kapur, bubuk batu bata dan pasir menggunakan analisis getaran.

Penelitian ini terdiri dari 4 pengujian, yaitu mendeteksi lokasi kerusakan pada dinding pasangan bata skala 1:3. Model dinding tersebut dirusakkan dengan cara dilubangi. Awalnya dinding dilubangi ditengah dinding dan dengan metode dinamis dideteksi letak lubangnya sehingga diperoleh ragam bentuk yang berupa kontur perpindahan, selanjutnya dinding dilubangi lagi sehingga menjadi dua lubang dan dideteksi letak lubangnya dengan analisis getaran. Menggunakan analisis numerik, mendeteksi lokasi kerusakan dinding sesuai dengan pengujian eksperimen. *Software* yang digunakan adalah SAP 2000. Deteteksi lokasi dan tingkat kerusakan pada dinding pasangan bata skala 1:1. Dinding dibebani arah *in plane* dan dianalisis ke arah *out of plane*. Model dianalisis dengan menggunakan getaran setiap tahap kerusakan. Analisis numerik model skala 1:1 untuk menvalidasi lokasi kerusakan dinding sesuai dengan pengujian eksperimen. *Software* yang digunakan adalah Abaqus.

Untuk melihat gradasi kerusakan struktur, gambar kontur perpindahan dapat digunakan dan dapat juga menggunakan pola kelengkungan karena lebih sensitif. Tingkat kerusakan dinding dapat dihasilkan melalui nilai banding perubahan luasan kontur puncak dan luasan dinding. Akibat beban *in plane*, nilai banding sebesar 10,88 % dengan lebar retaknya 12 mm pada pembebanan step ke-6 dan menurut PUPR tingkat kerusakan dinding tersebut termasuk kerusakan struktur tingkat sedang. Nilai banding 1,65% sampai 8,70% adalah lebar retak 1,2 sampai 4 mm pada pembebanan step ke-4 dan step ke-5 dan menurut PUPR tingkat kerusakan struktur ringan sedangkan di bawah 0,52% di mana tidak ada retak yang terjadi adalah kondisi utuh. Dari studi eksperimen diperoleh kekakuan dinding utuh adalah 44,60 kN/mm sedangkan dinding setelah dibebani hingga pembebanan step ke-6 sebesar 44,04 KN (35,54 % dari beban maksimum), nilai kekakuan adalah 4,82 kN/mm. Perubahan kekakuan berturut-turut sebesar 13,39 % drift ratio 0,03750; 46,96 % drift ratio 0,0750; 56,26 % drift ratio 0,1250; 70,57 % drift ratio 0,1500; 89,19 % drift ratio 0,300. Perubahan rasio redaman berturut-turut sebesar 7,45 % drift ratio 0,01875; 15,29 % drift ratio 0,03750; 22,55 % drift ratio 0,0750; 28,24 % drift ratio 0,1250; 30,98 % drift ratio 0,1500; 34,90 % drift ratio 0,300. Perubahan frekuensi alami berturut-turut sebesar 8,68 % drift ratio 0,01875; 16,54 % drift ratio 0,03750; 19,82 % drift ratio 0,0750; 28,35 % drift ratio 0,1250; 39,23 % drift ratio 0,1500; 42,72 % drift ratio 0,300. Hasil simulasi numerik tervalidasi dengan baik oleh hasil eksperimental, yang ditunjukkan pola kerusakan yang terjadi pada model dinding akibat pembebanan gaya leteral siklik.

Kata kunci: Dinding, Mortar, Drift Ratio, Kontur, Kerusakan.

ABSTRACT

During the colonization of Indonesia by the Dutch, construction of masonry buildings in Indonesia follow European masonry buildings with a wall thickness of more than one brick and using brick pillars without reinforced concrete columns or beams. At the time, the Dutch used a mortar mixture consisting of red brick powder, lime powder and sand mixed with water. The buildings made of brick walls are very old and have suffered deterioration and damage to different degrees. This study aimed to identify the location and degree of damage to masonry walls with a thickness of one stone with a mixture of lime mortar, brick powder and sand using vibration analysis.

This study consisted of 4 stages of testing. Stage I was carried out to detect damage to the wall model with a scale. The wall model was damaged by making holes. Initially, a hole was made in the centre of the wall and with a dynamic method the location of the hole was detected, so that shapes in the form of displacement contours were obtained. Then, another hole was made, so that there were two holes, and its location was detected with vibration analysis. Stage II used numerical analysis to detect the location of damage to the wall in accordance with the experimental testing in the stage I of the study. The software used was SAP 2000. Stage III was carried out using a wall model with a mortar mix of 1 lime: 1 brick powder: 3 sand. The wall had dimensions of 3.00 m x 3.00 m and a thickness of 1 brick. The wall was loaded in the in-plane direction and analyzed in the out-of-plane direction. The model was analyzed using vibrations for each stage of damage. In stage IV of the study the damage was analyzed numerically to validate the locations of wall damage in accordance with the experimental testing in stage III. The software used was Abaqus.

To determine the gradient of structural damage, displacement contour images were used and can also use curvature pattern because it is more sensitive. Indicators of change in contour elevation area with increasing damage level were used. Due to in-plane loading, the wall damage percentage of 10.88% with a crack width of 12 mm at loading step 6 was observed, which is considered moderate structural damage. Damage percentages of 1.65% to 8.70% with crack widths of 1.2 to 4 mm, respectively, at loading step 4 and 5 are considered minor structural damage, while below 0.52% without any crack is considered an intact condition. From the experimental study, an intact wall rigidity of 44.60 kN/mm was obtained, while after loading up to the loading step 6 of 44.04 kN (35.54 of the maximum load), the rigidity was 4.82 kN/mm. Changes in rigidity successively were 13.39% drift ratio 0.03750; 46.96 % drift ratio 0.0750; 56.26% drift ratio 0.1250; 70.57% drift ratio 0.1500; 89.19% drift ratio 0.300. Changes in damping ratio successively were 7.45% drift ratio 0.01875; 15.29% drift ratio 0.03750; 22.55% drift ratio 0.0750; 28.24% drift ratio 0.1250; 30.98 % drift ratio 0.1500; 34.90% drift ratio 0.300. Changes in natural frequency successively were 8.68% drift ratio 0.01875; 16.54% drift ratio 0.03750; 19.82% drift ratio 0.0750; 28.35% drift ratio 0.1250; 39.23% drift ratio 0.1500; 42.72% drift ratio 0.300. The results of numerical simulation were well validated by the experimental results, which are indicated by the damage pattern that occurred in the wall model due to the cyclic lateral loading.

Key word: Masonry, Mortar, Drift Ratio, Contour, Damage.