INTISARI

Pembangunan terowongan di wilayah beriklim tropis–kering seperti Provinsi Nusa Tenggara Timur menghadapi tantangan geologi teknik yang kompleks akibat keterbatasan data bawah permukaan, variabilitas litologi, serta pengaruh kondisi hidrogeologi dan kegempaan. Penelitian ini bertujuan untuk mengevaluasi kondisi geologi teknik, menentukan metode penggalian dan sistem penyangga, serta menilai kestabilan Terowongan Pengelak Bendungan Welikis. Metode penelitian meliputi pemetaan geologi teknik, evaluasi kualitas massa batuan menggunakan klasifikasi *Rock Mass Rating* (RMR) dan *Q-System*, serta analisis kestabilan terowongan melalui pemodelan numerik dua dimensi berbasis metode elemen hingga (*Finite Element Method*/FEM) pada kondisi beban statik dan pseudostatik. Hasil penelitian menunjukkan bahwa secara geomorfologi lokasi penelitian tersusun atas satuan dataran aluvial, perbukitan kuesta berlereng landai, dan agak curam, serta punggungan gawir sesar berlereng agak curam hingga curam. Secara litologi, satuan batuan penyusun terdiri atas kalkarenit, kalsilutit, batulempung, breksi polimik, dan pasir bongkah. Berdasarkan klasifikasi RMR, trase terowongan terdiri atas kalkarenit kualitas buruk (RMR 36,5–39,8), kalsilutit kualitas buruk hingga sedang (RMR 38,3–52,9), serta batulempung kualitas sedang (RMR 41,6–43,4). Sementara itu, berdasarkan *Q-System*, massa batuan memiliki kualitas sangat buruk hingga buruk, yaitu kalkarenit (Q 0,6–0,94), kalsilutit (Q 1,47–2,74), dan batulempung (Q 1,35–1,52). Metode penggalian yang direkomendasikan adalah metode *top heading and bench*. Sistem penyangga terowongan disarankan berupa kombinasi *rockbolt* dan *shotcrete* dengan dimensi yang disesuaikan terhadap kualitas. Hasil analisis FEM menunjukkan bahwa terowongan berada dalam kondisi stabil baik pada kondisi statik maupun pseudostatik, yang ditunjukkan oleh nilai *strength factor* lebih besar dari satu, meskipun terjadi peningkatan *total displacement* akibat beban pseudostatik.

Kata kunci: terowongan pengelak, Rock Mass Rating, Q-System, metode elemen hingga, sistem penyangga.

ABSTRACT

Tunnel construction in semi-arid climate regions, such as East Nusa Tenggara Province, faces complex engineering geological challenges due to limited subsurface data, lithological variability, and the influence of hydrogeological and seismic conditions. This study aims to evaluate the engineering geological conditions, determine the excavation method and support system, and assess the stability of the Welikis Dam Diversion Tunnel. The research methods include mapping of geological features relevant to engineering (engineering geological mapping), evaluating rock mass strength and conditions using Rock Mass Rating (RMR) and the Q-System, and analyzing tunnel stability using two-dimensional computer simulations (numerical modelling) with the Finite Element Method (FEM) to simulate both static and pseudostatic conditions. The results show that, geomorphologically, the study area consists of alluvial plains, gently sloping to moderately steep cuesta hills and fault-scarp ridges with moderately steep to steep slopes. Lithologically, the rock units comprise calcarenite, calcilutite, claystone, polymict breccia, and boulder sand. Based on the RMR classification, the tunnel alignment crosses poor-quality calcarenite (RMR 36.5–39.8), poor- to fair-quality calcilutite (RMR 38.3–52.9), and fair-quality claystone (RMR 41.6–43.4). The Q-System classification shows very poor to poor rock mass quality. This consists of calcarenite (Q 0.6–0.94), calcilutite (Q 1.47–2.74), and claystone (Q 1.35–1.52). The recommended excavation method is the top heading and bench method. The tunnel support system is recommended to consist of a combination of rock bolts and shotcrete, with dimensions adjusted to the quality of the rock mass. FEM analysis results indicate that the tunnel remains stable under both static and pseudostatic conditions, as evidenced by strength factor values greater than one; however, an increase in total displacement occurs under pseudostatic loading.

Keywords: diversion tunnel, Rock Mass Rating, Q-System, finite element method, tunnel support system.