INTISARI

Lokasi pembangunan Terowongan Pengelak Bendungan Bener sepanjang ±860m berada pada dua satuan batuan yaitu breksi andesit dan breksi polimik. Kondisi geologi teknik permukaan lokasi penelitian dibagi menjadi beberapa satuan antara lain satuan breksi andesit *completely weathered – residual soil*, breksi andesit *fair rock highly weathered*, breksi andesit *fair rock fresh rock – moderately weathered,* breksi andesit *good rock – very good rock fresh rock – moderately weathered,* breksi polimik *good rock – very good rock fresh rock – slightly weathered* , breksi polimik *fair rock moderately - highly weathered* dan breksi polimik *completely weathered – residual soill*. Berdasarkan hasil korelasi bawah permukaan terowongan akan menembus dua litologi yaitu breksi andesit dan breksi polimik serta menembus tiga kualitas massa batuan yang berbeda antara lain *good rock, fair rock* dan *poor rock*.

Kondisi geologi dan geologi teknik digunakan sebagai dasar dalam analisis kestabilan lereng portal, metode ekskavasi dan kestabilan bukaan dan penyangga terowongan. Kestabilan lereng portal dilakukan dengan metode empiris S*lope Mass Rating* (SMR) berdasarkan Romana dkk. (2015), dengan metode analisis kesetimbangan batas dengan *software Geostudio (Slope/W),* dan dengan metode elemen hingga dengan *software Rocscience (RS2).* Analisis metode ekskavasi dilakukan dengan cara empiris dengan grafik Pettifer dan Fookers (1994). Analisis kestabilan bukaan dan penyangga terowongan dilakukan dengan pendekatan empiris dan numerik. Secara empiris kestabilan bukaan dilakukan dengan metode Bieniawski (1993), sedangkan sistem penyangga dilakukan berdasarkan *Rock Mass Rating* (Bieniaswki, 1989) dan Q sistem (Barton, 2002). Hasil analisis empiris kestabilan sistem penyangga kemudian dievaluasi dengan metode elemen hingga.

Hasil analisis kestabilan lereng dengan analisis SMR, kesetimbangan batas dan elemen hingga menunjukan lereng portal berada pada kondisi aman dengan Faktor Keamanan terkecil 2.18 pada lereng *inlet* saat sudah digali sesuai desain dengan memasukan beban gempa. Metode ekskavasi yang paling sesuai diterapkan adalah dengan peledakan (*blasting*) termasuk memperhitungkan efektifitas dan efisiensi proyek. Zona paling rentan pada terowongan ini berada pada zona patahan (zona 3), namun secara umum berada pada kondisi yang aman. Evaluasi sistem penyangga berdasarkan RMR dan Q sistem dengan metode elemen hingga, menunjukan dapat menurunkan *total displacement* namun penurunan *total displacement* lebih besar dengan perkuatan *lining* komposit *shotcrete* dengan *wiremesh, steel ribs* dan *invert.*

ABSTRACT

A ± 860m Diversion Tunnel of Bener Dam is hosted in andesite breccia and polymic breccias lithology units. The research area consist of several engineering geology units including completely weathered - residual soil of andesite breccia, highly weathered fair rock andesite breccia, fresh - moderately weathered fair rock andesite breccia, fresh - moderately weathered good rock - very good rock andesite breccia, fresh rock - slightly weathered good rock - very good rock polymic breccia, moderately - highly weathered fair rock polymic breccias and completely weathered - residual soill of polymic breccia. Based on subsurface correlation, the diversion tunnel will penetrate andesite breccia and polymic breccia and three types of rock mass qualities including good rock, fair rock and poor rock.

The geological and engineering geology conditions were used as the basis of th portal slope stability analysis, excavation methods analysis and face tunnel and tunnel supports stability analysis. Portal slope stability analysis was conducted by the empirical method of Slope Mass Rating (SMR) based on Romana et al. (2015), limit equilibrium analysis methods with Geostudio (Slope/W) software, and finite element methods with Rocscience (RS2) software. Excavation methods analysis was carried out empiricaly by Pettifer and Fookers (1994) graphs. Face tunnel and tunnel support stability analysis was conducted with empirical and numerical approaches. Empirically the stability of the face tunnel with Bieniawski method (1993), while support system of tunnel was carried out based on Rock Mass Rating (Bieniaswki, 1989) and Q systems (Barton, 2002). The results of the empirical analysis were then evaluated by the finite element method analysis.

The slope stability analysis result by SMR, limit equilibrium and finite elements showed the portal slope were in a safe condition with the smallest safety factor 2.18. That condition was on the inlet slope position after slope excavation conducted and entering seismic load. The most appropriate excavation method to be applied is blasting. The most vulnerable zones in this tunnel are in the fault zone (zone 3), but generally whole of the tunnel are in a safe condition. The evaluation of the support system based on the RMR and Q systems with the finite element method, showed those can reduce the total displacement induce excavation. The composite linings with shotcrete, wiremesh, steel ribs and invert can reduce total displacement larger than the other approaches.