INTISARI

Berdasarkan Peta Geologi tahun 2012, terdapat sesar dengan arah baratlaut-tenggara yang melintasi Waduk Sermo dan kemungkinan juga melalui tubuh bendungan. Keberadaan waduk berpotensi meningkatkan aktivitas seismik sesar di sekitarnya. Demikian juga, sedimentasi berpotensi mempengaruhi deformasi tubuh bendungan. Oleh karena itu, pemantauan deformasi perlu dilakukan sejak dini dan secara periodik. Pemantauan deformasi dari aspek Geodesi salah satunya dapat dilakukan dengan pengamatan pada jaring pemantauan dengan metode GNSS. Pada desain jaring tersebut, faktor sensitivitas dalam mendeteksi deformasi menjadi sangat penting. Selama ini, desain tersebut seringkali hanya mempertimbangkan faktor geometri, sementara faktor sensitivitas kurang diperhatikan. Faktor sensitivitas ini sangat berpengaruh dalam efisiensi pengukuran lapangan. Oleh karena itu, jaring pemantauan Sesar Sermo perlu didesain dengan mempertimbangkan karakteristik sesar. Selanjutnya, laju sedimentasi berpengaruh terhadap deformasi tubuh bendungan. Informasi tersebut sangat bermanfaat dalam pengelolaan Waduk Sermo.

Pada penelitian ini, karakteristik sesar dianalisis berdasarkan *lineament* pada DEM SRTM dan peta batimetri yang dikaitkan dengan formasi batuan di sekitar Sermo. Berdasarkan asumsi sesar bertipe *strike-slip*, jarak optimum titik terhadap garis sesar didesain melalui optimasi dengan solusi program linier dan mempertimbangkan faktor sensitivitas jaring. Beberapa alternatif jaring didesain dengan mempertimbangkan jarak optimum dan kriteria lain berdasarkan penelitian terdahulu. Desain optimasi juga dilakukan untuk mendapatkan desain pengukuran optimum. Pengukuran GNSS dilakukan pada tahun 2016, 2017, dan 2018. Analisis pola pergeseran dan karakteristik sesar dilakukan berdasarkan data tersebut. Pemantauan laju sedimentasi dilakukan berdasarkan sampel sedimen yang diambil pada *inlet* dan *outlet*. Pengaruh sedimen terhadap deformasi bendungan dikaji dengan membandingkan hasil pemodelan deformasi bendungan dengan dan tanpa memperhitungkan sedimentasi.

Hasil analisis *lineament* menunjukkan Sesar Sermo berarah baratlaut-tenggara dan dimungkinkan bersifat aktif. Jarak titik optimum yaitu pada 4,5 s.d. 8 km terhadap garis sesar, sedangkan titik pada jaring yang sudah ada berjarak $< 4,5$ km. Alternatif desain jaring yang paling baik yaitu jarak antar titik bervariasi sehingga membentuk segitiga. Desain optimasi dengan model sederhana menunjukkan bahwa jaring yang ada sensitif terhadap pergeseran 7 jika ketelitian koordinat hasil pengamatan lebih teliti dari 3,75 mm. Ketelitian tersebut dapat dicapai dengan pengamatan GNSS selama empat hari. Desain optimasi dengan model sesar *strike-slip* dan *locking depth* 10 km, menunjukkan bahwa jaring yang ada sensitif terhadap *slip rate* yang lebih besar dari 32,5 mm/th. Pada kenyataannya, hasil pengamatan GNSS menunjukkan jaringan bergeser dalam fraksi sentimeter ke arah tenggara, dimana blok timur sesar bergerak lebih cepat daripada yang barat. Hal ini menunjukkan jenis pergerakan Sesar Sermo merupakan sesar mendatar menganan atau *right strike-slip* atau *dextral* sesuai dengan asumsi yang digunakan pada desain optimasi. Pergerakan sesar ini dimungkinkan tidak mengakibatkan kerusakan pada tubuh bendungan, karena tidak melintasi tubuh bendungan. Namun demikian, efek gempa yang ditimbulkannya (jika terjadi) tidak menutup kemungkinan mempengaruhi deformasi tubuh bendungan. Laju sedimentasi Waduk Sermo rata-rata tiga tahun terakhir 28,52 mm/th. Perubahan muka air disertai sedimen di dasar Waduk Sermo dengan tinggi muka sedimen 109 m mengakibatkan deformasi bendungan sebesar 7,20 s.d 74,50 mm. Sedimentasi dapat meningkatkan deformasi bendungan rata-rata 20,88 mm.

Kata kunci: deformasi, sensitivitas, Sesar Sermo, optimasi, GNSS, *baseline*, sedimentasi

ABSTRACT

Based on the 2012's geological map, a fault was found under the Sermo reservoir area in the northwest-southeast direction and possibly through the main dam. The presence of reservoir with a large amount of load potentially increases seismic activity in the surrounding fault. On the other hand, sedimentation may affect the main dam deformation. Therefore, deformation monitoring needs to be done periodically. Deformation monitoring in the Geodetic aspect could be performed using measurement on monitoring network by GNSS method. In designing a deformation monitoring network, the sensitivity criterion is critical. So far, the implementation of the design often only considers the geometric factor, while the sensitivity criterion is less considered. Considering the sensitivity will significantly affect the field survey efficiency. In the Sermo Fault deformation, the monitoring network also should be designed by considering the fault characteristics. The sedimentation rate may affect the deformation of the main dam. The sedimentation rate and its effect on the main dam deformation are beneficial in Sermo Reservoir management.

In this research, the fault characteristics were analyzed based on the lineament trend on SRTM DEM and bathymetric map associated with rock formations around the Sermo. Furthermore, assuming the fault is strike-slip, the optimum station distance from the fault line was obtained by optimization using a linear programming solution and considering the network sensitivity. Several network development alternatives were designed by considering the optimum distances and other factors from the previous research. Optimization was also carried out to obtain the optimum measurement plan. Only the baseline with the great contributes to the network sensitivity being measured. However, the network is still sensitive to the deformation. GNSS measurements were carried out in 2016, 2017, and 2018. Based on these data, the displacement pattern and the fault characteristics were analyzed. In this study, the sedimentation rate was also monitored based on the sediment samples taken at the inlet and outlet. The effect of sediment on dam deformation was studied by comparing the dam deformation modeling results with and without considering the sedimentation.

The lineament trend shows that the Sermo Fault is in the southeast-northwest direction and possibly active. The optimum station distance is 4.5 up to 8 km from the fault line, while the existing stations are < 4,5 km far from the fault line. The best alternative network design is the one with a varied distance of stations from the fault line to form triangles. The optimization design with a simple model shows that the existing network is sensitive to displacements of 7 mm with an accuracy of better than 3,75 mm. It can be achieved by GNSS observation for four days. The optimization design with a strike-slip fault model and a locking depth of 10 km show that the network is sensitive to a slip rate greater than 32 mm/year. In fact, the GNSS measurements show that the networks dominantly displace in centimetre to the southeast direction. The eastern block of the fault moves faster than the western one. It indicates that the type of Sermo fault movement is a right-slip-fault or right-lateral strike-slip fault or dextral fault as assumed in the optimization design. This fault movement may not affects the dam body deformation, because it does not cross the dam body. However, the earthquake caused by this fault (if it occurs) possibly affects the dam body deformation.The average sedimentation rate in Sermo Reservoir over the last three years is 28,52 mm/year. Water level changes accompanied by sediment in the Sermo Reservoir with a sediment level of 109 m caused the dam body deformation of 7,20 to 74,50 mm. The sedimentation increases the deformation by an average of 20,88 mm.

Keyword: deformation, sensitivity, Sermo Fault, optimization, GNSS, baseline, sedimentation