PENGOLAHAN *SLUDGE* LIMBAH PRODUKSI BETON MENGGUNAKAN METODE STABILISASI DAN *DEWATERING* DI. X

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INTISARI

PT. X merupakan produsen beton pracetak yang dalam proses produksinya menghasilkan limbah padat berupa *sludge*. Fasilitas penyimpanan akhir *sludge* yang berdekatan dengan saluran air serta sistem pengelolaan yang masih sederhana berpotensi meningkatkan risiko pencemaran lingkungan di area sekitar pabrik. Penelitian ini bertujuan untuk menganalisis karakteristik *sludge* limbah produksi beton di daerah penelitian, menilai status mutu air sungai di sekitar lokasi yang berpotensi terpengaruh oleh aktivitas pengelolaan *sludge*, menentukan efektivitas pengolahan *sludge* melalui metode stabilisasi dan *dewatering*, serta menetapkan arahan pengelolaan yang sesuai dengan kondisi lapangan.

Penelitian ini dilakukan dengan menggunakan metode kuantitatif. Pengumpulan data diperoleh dari *grab sampling sludge* dan *purposive sampling* air sungai, kemudian diolah melalui analisis deskriptif dan matematis. Seluruh data pendukung diperoleh melalui survei lapangan, studi literatur, serta pengujian laboratorium menggunakan *X-Ray Fluorescence* (XRF) untuk mengetahui kandungan unsur dan perhitungan Indeks Pencemaran untuk menilai kondisi kualitas air. Selain itu, percobaan stabilisasi dan dewatering dilakukan sebagai bagian dari evaluasi efektivitas pengolahan sludge pada skala lapangan maupun laboratorium.

Hasil Hasil penelitian menunjukkan bahwa *sludge* memiliki pH 11, kadar air awal 75%, dan densitas 1,796 g/mL, dengan logam berat dominan berupa Cu, Zn, dan Ba. Penilaian kualitas air sungai pada tiga titik pengamatan menunjukkan kondisi tercemar berat dengan nilai Indeks Pencemaran 16,25; 97,25; dan 18,22 akibat tingginya padatan tersuspensi dan kandungan logam berat. Proses stabilisasi paling efektif diperoleh pada dosis CaO 15% dari berat basah *sludge* dengan lama pengadukan 4 jam pada 100 rpm, yang menurunkan Cu hingga 80,5% dan Zn sebesar 77,4%, sedangkan Ba tidak mengalami penurunan karena kelarutan $Ba(OH)_2$ yang tetap tinggi pada kondisi basa. Proses dewatering menggunakan *Sludge Drying Bed* (SDB) skala laboratorium juga menurunkan kadar air dari 75% menjadi 42,5% pada hari ke-7 dengan efektivitas 43,3%. Berdasarkan hasil tersebut, kombinasi stabilisasi dan *dewatering* direkomendasikan sebagai arahan pengelolaan *sludge* karena mampu menurunkan kadar logam berat dan kadar air secara signifikan. Arahan ini diperkuat melalui pendekatan teknologi yang, dimulai dari kebutuhan CaO sebesar 32,3 ton per minggu yang dicampurkan dalam dua unit stabilisasi berkapasitas masing-masing 60 m^3, lalu *sludge* hasil stabilisasi dialirkan langsung ke unit SDB berdimensi 8 m × 5 m × 4,4 m dengan ketebalan pengisian 3 meter dan waktu pengeringan 7 hari. Unit SDB disusun atas lapisan pipa underdrain, kerikil kasar, kerikil halus, dan pasir sebagai media filtrasi. Pendekatan ini memberikan gambaran teknis mengenai kebutuhan bahan, kapasitas unit, alur operasional, serta keterpaduan proses stabilisasi dan dewatering pada kondisi eksisting.

Kata kunci: *Dewatering, Sludge,* Stabilisasi, *Sludge Drying Bed*.

SLUDGE WASTE MANAGEMENT FROM CONCRETE PRODUCTION USING STABILIZATION AND DEWATERING METHODS AT PT.X

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ABSTRACT

PT. X is a precast concrete manufacturer whose production process generates solid waste in the form of sludge. The final sludge storage facility, which is located close to a drainage channel, combined with a relatively simple management system, may increase the risk of environmental contamination around the plant area. This study aims to analyze the characteristics of sludge from concrete production, assess the water quality status of nearby rivers potentially affected by sludge, determine the effectiveness of sludge treatment using stabilization and dewatering methods, and formulate appropriate management directions based on field conditions.

This research was conducted using a quantitative approach. Data were collected through grab sampling of sludge and purposive sampling of river water, followed by descriptive and mathematical analyses. Supporting data were obtained from field surveys, literature studies, and laboratory tests, including X-Ray Fluorescence (XRF) to determine elemental composition and the Pollution Index method to assess river water quality. In addition, stabilization and dewatering experiments were carried out to evaluate the performance of sludge treatment at both field and laboratory scales.

The results show that the sludge has a pH of 11, an initial moisture content of 75%, and a density of 1.796 g/mL, with dominant heavy metals including Cu, Zn, and Ba. River water quality assessments at three observation points indicate heavily polluted conditions, with Pollution Index values of 16.25, 97.25, and 18.22 due to high suspended solids and heavy metal concentrations. The most effective stabilization process was achieved using 15% CaO of wet sludge weight with a mixing duration of 4 hours at 100 rpm, reducing Cu by 80.5% and Zn by 77.4%, while Ba remained unchanged due to the high solubility of $Ba(OH)_2$ under alkaline conditions. Dewatering using a laboratory-scale Sludge Drying Bed (SDB) also reduced moisture content from 75% to 42.5% on day seven with an effectiveness of 43.3%. Based on these results, a combination of stabilization and dewatering is recommended as the sludge management directive, as it significantly reduces heavy metal concentrations and moisture content. This directive is strengthened through a technological approach beginning with the requirement of 32.3 tons of CaO per week, mixed within two stabilization units of 60 m^3 each, followed by transferring the stabilized sludge to an SDB unit measuring 8 m × 5 m × 4.4 m with a 3-meter filling depth and a 7-day drying period. The SDB consists of underdrain pipes, coarse gravel, fine gravel, and sand as filtration media. This approach provides a technical overview of material requirements, unit capacity, operational flow, and the integrated performance of stabilization and dewatering processes under existing conditions.

Keywords: Dewatering, Sludge, Sludge Drying Bed, Stabilization.