

# Studi karakteristik agregat kasar ringan buatan dari limbah botol plastik high density polyethylene (HDPE) dan pengaruhnya terhadap sifat-sifat mekanis beton ringan = Study of lightweight coarse aggregate properties made from waste plastic high density polyethylene (HDPE) bottle and its effect to the mechanical properties of lightweight concrete

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## Abstrak

Kebutuhan akan kemasan produk di bidang otomotif di Indonesia sangat tinggi. Salah satunya untuk kemasan pelumas kendaraan bermotor. Di Jakarta menurut data Dinas Pekerjaan Umum jumlah sepeda motor sampai Maret 2007 mencapai 3.325.790 unit, sehingga akan ada banyak limbah plastik yang dihasilkan dari produk kemasan itu. Akan tetapi kita tahu limbah plastic tersebut dapat di daur ulang.

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Botol plastik pelumas kendaraan bermotor merupakan polimer dari jenis polyethylene dengan nama kimiawinya *High Density Polyethylene* (HDPE) yang diproduksi melalui polimerisasi ethylene ( $C_2H_4$ ) dengan variabel proses seperti energi panas, tekanan, dan katalis. Mempunyai Berat jenis antara 0.941-0.965 dan akan mengeras bila dipanaskan.

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Berdasarkan karakteristik fisik dari HDPE, dalam studi ini telah dilakukan penelitian limbah botol plastik HDPE sebagai bahan baku pembuatan agregat kasar ringan dan menggunakannya dalam campuran beton ringan.

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Agregat kasar ringan dihasilkan dari pembakaran botol HDPE sisa kemasan pelumas kendaraan bermotor, hasil pembakaran diperoleh agregat dengan bentuk tidak beraturan dan bersudut dengan tekstur permukaan halus, licin dan mengkilap dan berwarna abu-abu, coklat dan hijau.

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Pengujian sifat fisik agregat diperoleh berat jenis sebesar 0,952, penyerapan air 0,817%, berat isi 545 kg/m<sup>3</sup>, dan keausan agregat 29,64%. Dari pengujian kuat tekan hancur agregat terhadap 2 ukuran spesimen kubus diperoleh kuat tekan hancur agregat plastik kubus (5×5×5) cm lebih besar 3,74 kali dibandingkan dengan kubus (15×15×15) cm, data tersebut tidak representatif karena benda uji telah mengalami retak sebelum di tes tekan.akibat dari susut yang ekstrim pada saat pengeringan sampel kubus plastik (15x15x15) cm.

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Dalam studi ini, agregat ringan plastik dan agregat halus normal (pasir alam) diklasifikasikan berdasarkan ukuran spesimen kubus yang digunakan yaitu kubus beton (5×5×5) cm dan (15×15×15) cm sehingga diperoleh beton ringan agregat bergradasi normal dan beton ringan agregat bergradasi modifikasi. Dari pengujian kuat tekan beton ringan agregat plastik terhadap 2 ukuran specimen kubus beton ringan, dihasilkan angka perbandingan rata-rata sebesar 1,07.

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Dari hasil pengujian beton ringan agregat plastik meliputi pengujian beton segar dan beton yang telah mengeras memperlihatkan beton segar agregat plastik mempunyai kelecakan yang sedang, berat isi kering

1607 kg/m<sup>3</sup>, kuat tekan rata-rata kubus beton ringan bergradasi normal (12,22 ? 12,44) MPa dan kuat tekan rata-rata kubus beton ringan bergradasi modifikasi (10,89 ? 12,33) MPa. Kuat tekan beton yang didapat dengan menggunakan kuat tekan mortar maksimum masih dibawah kuat tekan target rencana sebesar 28,72 MPa, modulus elastisitas sebesar (2609-2701) MPa, Poisson's Ratio (0,1592-0,1632).

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Pengaruh bentuk, tekstur permukaan dan gradasi agregat kasar ringan berpengaruh terhadap kuat tekan yang akan dihasilkan. Semakin kecil ukuran agregat kasar ringan maka kekuatan agregat kasar ringan tipe HDPE juga semakin rendah. Karena telah terjadi perlemahan pada ikatan mikro struktur agregatnya pada saat proses pemecahan yang berulang-ulang.

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The needs of product packaging in Automotive industry in Indonesia are very high. One of the examples is lubricant plastic bottle for motor cycle. Based on information from Public Work Department the sum of motor cycle until March 2007 has increased significantly to 3.325.790 units, thus it means that there are lots of wastes from the lubricant packs. However we know that plastic is a material that can be recycled.

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The Lubricant Plastic Bottle is classified as Polyethylene polymer as known as High Density Polyethylene (HDPE) that produces by ethylene polymerization with variable process like thermal energy, pressure, and catalyze. It has specific gravity range between 0,941-0,965 and become hardened if heated.

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This Research is to analyze HDPE that recycling as basic raw material for lightweight coarse aggregates and the usage of these aggregates in lightweight concrete base on its physical characteristic.

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First of all, burn the lubricant bottle to be a coarse lightweight aggregate so we will have aggregate with irregular and angular shape, smooth surface, shiny with grey, brown and green colors.

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The results of physical properties of aggregates are: specific gravity is 0,952, water absorption 0,817 %, density is 545 kg/m<sup>3</sup>, and the resistance of abrasion is 29,64%. The crushing test between 2 cube size show that crushing test of cube size (5x5x5)cm is 3,74 more larger than cube size (15x15x15) cm but this data isn't representative, the sample had crack before doing crushing and it because extreme shrinkage of cube size (15x15x15) cm.

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In this study, plastic lightweight aggregate and fine normal aggregate (sand) were classified according to cube specimen used (5x5x5 cm & 15x15x15 cm) so we got two different type of aggregate, they are normal gradation and modification gradation aggregate. The crushing test between 2 lightweight concrete cube size sample show the average ratio point is 1,07.

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From the test result of lightweight concrete including fresh and hardened concrete show that the fresh concrete has middle workability, dry weight of concrete 1607 kg/m<sup>3</sup>, the average strength of lightweight concrete with a normal grade were ranging between (12,22 ? 12,44) MPa and a modification grade were ranging between (10,89 ? 12,33) MPa, Concrete strength that we got with the used of maximum mortar strength were still below the target strength equal to 28,72 MPa, modulus of elasticity was ranging between (2609-2701) MPa, and Poisson's ratio was ranging between (0,1592-0,1632).

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The study shows that the effect of shape and surface texture of lightweight coarse aggregate has influenced crushing test result. Smaller size of lightweight coarse aggregate has resulted in lower strength of HDPE aggregate. In order to produce smaller size of lightweight coarse aggregate repetition of impact on bigger size aggregate were conducted resulting in weakening of micro structure bond of the aggregates.