

## DAFTAR PUSTAKA

- AASHTO, (1998) : *Standard Specifications for Transportation Materials and Methods of Sampling and Testing*, Washington D.C.
- Affandi, F., 2006. *Hasil Pemurnian Asbuton Lawele sebagai bahan pada campuran beraspal untuk perkerasan jalan*. Jurnal jalan-jembatan, 23(3), pp.6-28.
- Affandi, F., 2008. *Karakteristik Bitumen Asbuton Butir untuk Campuran Beraspal Panas*. Jurnal Pusat Litbang Jalan dan Jembatan, Bandung.
- Affandi, F., Kusnanti, N. (2013). *Pengaruh Jenis Aspal pada Temperatur Pemadatan Berkaitan dengan Workability dari Campuran Beraspal Panas*. Jurnal Pusat Litbang Jalan dan Jembatan, 30(2), 108-109.
- Affandi, F. dan Kusnianti, N. (2013). *Kinerja Perkerasan Campuran Beraspal Hangat yang Mendukung Pembangunan Berwawasan Lingkungan*. Konferensi Regional Teknik Jalan (KRTJ) 12. Bandung.
- Al-Qadi, I.L., Aurangzeb, Q., Carpenter, S.H., Pine, W.J. and Trepanier, J., 2012. *Impact of high RAP contents on structural and performance properties of asphalt mixtures*.
- Anas Aly, M., (2007) : *Teknik Dasar Potensi Daur Ulang Konstruksi Jalan*, Yayasan Pengembang Teknologi dan Manajemen, Jakarta.
- Anindya Andana Ningrum., dan Yogie Risdianto. (2018). *Perbandingan Penggunaan Buton Granular Asphalt (BGA) dan Reclaimed Asphalt Pavement (RAP) sebagai Bahan Substitusi Agregat pada Campuran Aspal Wearing Course (AC-WC) dengan Fly Ash sebagai Filler*. Jurnal Rekayasa Teknik Sipil Vol.2, NO. 2/REKAT/18.
- Arabani M. and B. Ferdowski. (2009). *Evaluating The Semi-Circular Bending Test For HMA Mixtures*. IJE Transactions A: Basics Vol. 22, No. 1, February 2009 pg (47-58).
- ARRA, (2001) : *Basic Asphalt Recycling Manual*, U.S. Departement of Transportation, USA.
- Asphalt Institute, (1983) : *Principles of Construction of Hot Mix Asphalt Pavement*, Manual Series No.22, The Asphalt Institute.

- Asphalt Institute, (1989) : *The Asphalt Handbook*, Manual Series No.4 (MS-4), The Asphalt Institute.
- Asphalt Institute, (1986) : *Asphalt Hot mix Recycling: 2<sup>nd</sup> ed*, Manual Series No.20 (MS-20), The Asphalt Institute.
- Asphalt Institute, (1993). *Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types*. Manual Series 2 (MS-2), 6th Ed. Lexington, Ky.
- Ayman A., Mawjoud, A. dan Ismaeel, N.A. (2015). *Effects of Level of Reclamation on the Properties of Hot Mix Asphalt Concrete*. International Journal of Scientific Research in Knowledge, 3 (6): 162-171.
- Bethary RT, Subagio BS, Rahman H, Suaryana N. (2019). *Effect of Slag and Recycled Materials on The Performance of Hot Mix Asphalt (AC-BC)*. Journal of Civil Engineering. 2019; 26(1) : 1-9.
- Birgisson, B., Montepara, A., Romeo, E., Roque, R., Roncella, R. and Tebaldi, G., (2007). *Determination of Fundamental Tensile Failure Limits of Mixtures (With Discussion)*. Journal of the Association of Asphalt Paving Technologists, 76.
- Copeland, (2011) "*Reclaimed Asphalt Pavement in Asphalt Mixtures: State of the Practice*".
- Departemen Pekerjaan Umum, (1999) : *Pedoman Perencanaan Campuran Beraspal Panas dengan Pendekatan Kepadatan Mutlak*, No.025/T/BM/1999, Direktorat Jenderal Bina Marga.
- Departemen Pekerjaan Umum, (2008) : *Kajian dan Pengawasan Uji Coba Skala Penuh Recycling lapisan Beraspal dengan Campuran Beraspal Panas*, Pusat Penelitian dan Pengembangan.
- Departemen Pekerjaan Umum. 2006. Permen PU No. 35/PRT/M/2006. *Tentang Peningkatan Pemanfaatan Aspal Buton Untuk Pemeliharaan Dan Pembangunan Jalan*.
- Efendy, A., & Ahyudanari, E. (2019). *Analisis Perbandingan Kadar Aspal Optimum (KAO) untuk Perbedaan Gradasi (BBA, FAA dan BM)*. Jurnal Aplikasi Teknik Sipil, 17(1), 7-12.
- Fauzan, M., Saleh, S. M., & Isya, M. (2020). *Modifikasi Campuran Aspal AC-WC Menggunakan Buton Granular Asphalt Sebagai Bahan Substitusi*. Journal of The Civil Engineering Student, 2(2), 155-161.

- Fawaz Kaseer, Akash Bajaj, Amy Epps Martin, Edith Arámbula-Mercado, and Elie Hajj. (2019). *Strategies for Producing Asphalt Mixtures with High RAP Content*. DOI:10.1061/(ASCE)MT.1943-5533.0002910.© 2019 American Society of Civil Engineers (ASCE)
- Gaus A., M.W. Tjaronge., Nur Ali dan Rudy Djamaluddin. (2015). *Compressive Strength of Asphalt Concrete Binder Course (AC-BC) Mixture using Buton Granular Asphalt (BGA)*. The 5<sup>th</sup> International Conference of Euro Asia Civil Engineering Forum (EACEF-5).
- Ghozali, I. (2018). *Aplikasi Analisis Multivariate Dengan Program IBM SPSS 25*. Semarang: Badan Penerbit Universitas Diponegoro.
- Gonzalo Valdés, Félix Pérez-Jiménez, Rodrigo Miró, Adriana Martínez, and Ramón Botella. (2011). *Experimental study of recycled asphalt mixtures with high percentages of reclaimed asphalt pavement (RAP)*. *Journal of Construction and Building Materials* 25 (2011) 1289–1297
- Gul, W. A., & Guler, M. (2014). *Rutting susceptibility of asphalt concrete with recycled concrete aggregate using revised Marshall procedure*. *Construction and Building Materials*, 55, 341-349.
- Haris, H. (2019). *Analisis Pengujian Stabilitas dan Durabilitas Campuran Aspal dengan Tes Perendaman*. *Jurnal Linears*, 2(1), 33-47.
- Hermadi, M., Ronny, Y., & Firdaus, Y. (2022). *Perbandingan Karakteristik Antara Campuran Beraspal Panas Asbuton Murni, Asbuton Butir B 50/30 Dan Aspal Minyak Pen 60*. Prosiding HPJI (Himpunan Pengembangan Jalan Indonesia), 18-18.
- Hermadi, M. (2007). *Pengaruh Penambahan Asbuton Butir Terhadap Karakteristik Beton Aspal Campuran Panas*. Laporan Penelitian, Puslitbang Jalan dan Jembatan, Departemen PU, Bandung.
- Howardy, H., Suparma, L.B. and Satyarno, I., 2008. *Perancangan Laboratorium Campuran Hrs-wc dengan Penggunaan Buton Granular Asphalt (BGA) sebagai Bahan Additive*. In *Civil Engineering Forum Teknik Sipil* (Vol. 18, No. 3, pp. 921-933).
- Huang, Y.H, (2012) : *Pavement Analysis and Design Second Edition*, Prentice-Hall, Inc, New Jersey
- Hugo M.R.D. Silva, Joel R.M. Oliveira, Carlos M.G. Jesus. (2012). *Are totally recycled hot mix asphalts a sustainable alternative for road*

- paving?*. Journal of Resources, Conservation and Recycling 60 (2012) 38–48.
- Iida A. and Maryuma, M., (1983) : *Surface Recycling as an Optimum Alternative for Pavement Rehabilitation*, The Fourth Conference of The Road Engineering Association of Asia and Australia, Jakarta, Indonesia.
- Illyin, A.B. (2012). *Produksi Aspal dari Asbuton dengan Ekstraksi Menggunakan Asam Asetat*. Skripsi tidak diterbitkan. Depok: Universitas Indonesia.
- Imad L. Al-Qadi., Qazi Aurangzeb., dan Samuel H. Carpenter (2012) *Impact of High RAP Content on Structural and Performance Properties of Asphalt Mixtures*, Research Report FHWAICT- 12-002, Illinois Center for Transportation.
- Irmawaty, R., & Djamaluddin, R. (2022, September). *Flexural behavior of monolith and hybrid concrete beams produced through the partial replacement of coarse aggregate with PET waste*. In Structures (Vol. 43, pp. 1134-1144). Elsevier.
- Jian Li, Fujian Ni, and Qingqing Lu. (2018). *Experimental Investigation into the Multiscale Performance of Asphalt Mixtures with High Contents of Reclaimed Asphalt Pavement*. DOI: 10.1061/(ASCE)MT.1943-5533.0002269. © 2018 American Society of Civil Engineers (ASCE).
- Kamba, C. (2013). *Pengaruh Penentuan Kadar Aspal Optimum Terhadap Kualitas Desain Campuran Beraspal*. In Seminar Nasional Teknik Sipil UKI Paulus (pp. 58-69).
- Kandhal, P. S. (1997). *Recycling: State of the Practice*. Journal of the Association of Asphalt Paving Technologists, Vol. 66, 1997, p. 686.
- Kandhal P.S., Rajib B Mallick, (1997), *Pavement Recycling Guidelines for State and Local Governments Participant's Reference Book*, Report No. FHWA-SA-98-042. <https://rosap.nrl.bts.gov/view/dot/33835>
- Karami, M. (2020). *Assessing the fatigue performance of buton rock asphalt modified mixtures*. International Journal of Pavement Research and Technology, 13(5), 536-547.
- Kaseer, F., Martin, A.E. and Arámbula-Mercado, E., 2019. *Use of recycling agents in asphalt mixtures with high recycled materials contents in the United States: A literature review*. Construction and Building Materials, 211, pp.974-987.

- Kementerian Pekerjaan Umum dan Perumahan Rakyat, (2018) : *Spesifikasi Umum untuk Pekerjaan Konstruksi Jalan dan Jembatan (Revisi 2)*.
- Kent R. Hansen, P.E., and Audrey Copeland, Ph.D., P.E. (2014) *Asphalt Pavement Industry Survey on Recycled Materials and Warm-Mix Asphalt Usage* "Information Series 138 (5th edition), National Asphalt Pavement Association 5100 Forbes Blvd. Lanham, MD 20706.
- Kusnianti, N. dan Affandi, F., 2013. *Pengaruh Jenis Aspal pada Temperatur Pemadatan Berkaitan dengan Workability dari Campuran Beraspal Panas*. Jurnal Jalan Jembatan, Vol. 30(No. 2), pp. 97-111.
- La One., M.W. Tjaronge, Rita Irmawaty dan Muralia Hustim. (2020). *Effect of Buton Granular Asphalt Gradation and Cement As Filler on Performance of Cold Mix Asphalt Using Limestone Aggregate*. Journal of Engineering Science and Technology. Vol. 15, No. 1 (2020) 419-433.
- Maha I., Bambang Sugeng S., Furqon Affendi., and Harmein Rahman (2015) *Performance of Warm Mix Asphalt Concrete Binder Course (AC-BC) With Reclaimed Asphalt Pavement*, Journal of the Eastern Asia Society for Transportation Studies, Vol.11, pp 1745-1753.
- Mahyuddin A., M.W. Tjaronge, Nur Ali dan M. Isran Ramli. (2017). *Experimental Analysis on Stability and Indirect Tensile Strength in Asphalt Emulsion Mixture Containing Buton Granular Asphalt*. International Journal of Applied Engineering Research. Vol. 12, No. 12 (2017) pp 3162-3169.
- Martins Zaumanis, Rajib B. Mallicka and Robert Frank. (2014). *100% recycled hot mix asphalt: A review and analysis*. Journal of Resources, Conservation and Recycling, 92, 230–245. doi: 10.1016/j.resconrec. 2014.07.007.
- Muhammad Fauzan., Sofyan M. Saleh dan M. Isya. (2019). *Modifikasi Campuran Aspal AC-WC Menggunakan Buton Granular Asphalt (BGA) sebagai Bahan Substitusi*. Journal of The Civil Engineering Student, Vol.1. No.3, Desember 2019 (155-161).
- Nasrul., (2020). *Kajian Teknologi Asbuton Lawele dalam Perkerasan Jalan*. Disampaikan pada Virtual Seminar Universitas Haluoleo "Perkembangan Teknologi Asbuton dan Sosialisasi SNI Asbuton, 27 Juli 2020.

- Nega, A., Karami, M., & Nikraz, H. (2019). *Permanent Deformation Characteristics of BRA Modified Asphalt Paving Mixtures Using Dynamic Creep Test Analysis*. In *Airfield and Highway Pavements 2019: Testing and Characterization of Pavement Materials* (pp. 75-87). Reston, VA: American Society of Civil Engineers.
- Ningrum, A. A., & Risdianto, Y. (2018). *Perbandingan Penggunaan Buton Granular Asphalt (Bga) Dan Reclaimed Asphalt Pavement (Rap) Sebagai Bahan Substitusi Agregat Pada Campuran Aspal Wearing Course (AC-WC) Dengan Fly Ash Sebagai Filler*. *Rekayasa Teknik Sipil*, 2(2/REKAT/18).
- Nono. (2015). *Pengaruh Bahan Peremaja Terhadap Kinerja Campuran Beraspal Panas Bergradasi Menerus Menggunakan Daur Ulang Perkerasan Beraspal*. *Jurnal Jalan Jembatan*, 33 (1): 27-42
- Nopiyanto, (2011), *Karakteristik Marshall Menggunakan Aspal Retona Blend 55 dengan Variasi Waktu Pengadukan Campuran*, Universitas Riau.
- Pradani Novita., Subagio, B.S. dan Rahman, H. (2011). *Kinerja Kelelahan Campuran Beton Aspal*. *Jurnal Transportasi*, 11 (3): 163-172.
- Rahim, I. R., Nakayama, H., & Shimaoka, T. (2012). *Cost analysis of municipal solid waste management in major Indonesian cities*. *Journal of Japan Society of Civil Engineers, Ser. G (Environmental Research)*, 68(6), II\_79-II\_88.
- Rahman, H., (2010) : *Evaluasi Model Modulus Bitumen Asbuton dan Model Modulus Campuran yang Mengandung Bitumen Asbuton*, Disertasi, Program Magister Teknik Sipil, Institut Teknologi Bandung.
- Reyes-Ortiz O., Berardinelli E., Alvarez, A.E., Carvajal-Munoz, J.S., and Fuentes, L.G. (2012) *Evaluation of Hot Mix Asphalt Mixtures with Replacement of Aggregates by Reclaimed Asphalt Pavement (RAP) Material*, *Procedia-Social and Behavioral Sciences* 53 (2012) 379 – 388.
- Rilem Report 17, (1998) : *Bituminous Binders and Mixes*, E & FN Spon an imprint of Routledge, London
- Rizal M., MW Tjaronge, N Ali, T Bahar. (2017). *Performance of porous asphalt affected by aging process*. *International Journal of Civil Engineering and Technology* 8(6):1023-1033.
- Saha Gourab dan Krishna Prapoorna Biligiri. (2016). *Fracture properties of asphalt mixtures using semi-circular bending test: A*

- state-of-the-art review and future research*. Journal of Construction and Building Materials 105 (2016) 103–112.
- Saleh, S. M., Anggraini, R., & Salmannur, A. (2018). *Durabilitas Campuran Beton Aspal Memakai Agregat Karang Gunung dari Sabang dengan Bahan Pengikat Aspal Pen 60/70 dan Retona Blend 55*. Jurnal Transportasi, 18(2), 127-134.
- Setiadji, N. S. B. H. (2015). *Durabilitas Campuran Hot Rolled Sheet-Wearing Course (HRS-WC) Akibat Rendaman Menerus dan Berkalan Air Rob*. Jurnal Teknik Sipil, 13(2), 114-125.
- Setiobudi, A. (2017). *Analisis Kadar Aspal Optimum pada Lapis Asphalt Concrete Base Course di Pembangunan Jalan Tol Palembang “Simpang Indralaya (Palindra)*. Jurnal Deformasi, 2(2), 1-13.
- Shell Bitumen (2003) : *The Shell Bitumen Handbook*, Shell Bitumen, U.K.
- Sihombing, A. V. R., Subagio, B. S., Hariyadi, E. S., & Yamin, A. (2021). *Chemical, morphological, and high temperature rheological behaviour of Bioasbuton® as an alternative binder for asphalt concrete in Indonesia*. Journal of King Saud University-Engineering Sciences, 33(5), 308-317.
- Silva, H.M., Oliveira, J.R. and Jesus, C.M., 2012. Are totally recycled hot mix asphalts a sustainable alternative for road paving?. *Resources, Conservation and Recycling*, 60, pp.38-48.
- Standar Nasional Indonesia, SNI (2003) : *Metoda Pengujian Campuran Beraspal Panas dengan Alat Marshall*, RSNI M-01-2003, Badan Standar Nasional Indonesia.
- Suaryana, N., (2009) : *Kajian Pelaksanaan Teknologi Daur Ulang dengan Campuran Beraspal Panas di Ruas Jalan Cirebon - Losari*, Hasil Kolokium Penelitian dan Pengembangan Jalan dan Jembatan , Puslitbang Jalan dan Jembatan, Bandung.
- Suaryana N., (2016). *Performance Evaluation of Stone Matrix Asphalt Using Indonesian Natural Rock Asphalt as Stabilizer*. International Journal of Pavement Research and Technology 9 (2016) 387 – 392.
- Suryana. A., (2003), *Inventory on Solid Bitumen Sediment using ‘Outcrop Drilling’ in Southern Buton region, Buton Regency, Province Southeast Sulawesi*, Colloquium on Results Activities of Mineral Resources Inventory - DIM, the TA. 2003, Directorate Mineral Resources Inventory, Bandung (in Indonesian)

- Sugeng, B.S. dan Rahman, H. (2010) : *Kinerja Fatigue dari Campuran Lapis Pengikat (AC-BC) yang Memakai Material Hasil Daur Ulang (Recycling) dan Polimer Neoprene* , Jurnal FSTPT, Simposium XIII Forum Studi Transportasi antar Perguruan Tinggi, Semarang.
- Sugeng, B.S., Rahman, H. dan Yofianti D., (2010) : *The Performance of Stabilization Using Foam Bitumen with In-Place Method in the Cirebon–Losari Road* , APTE Journal, The 7<sup>th</sup> Asia Pacific Conference on Transportation and the Environment, Semarang, Indonesia.
- Suherman, (2012), *Kinerja Modulus Resilien dan Deformasi Permanen Dari Campuran Lapis Antara (AC-BC) Yang Menggunakan Material Hasil Daur Ulang RAP (Resilient Modulus Performance and Permanent Deformation of Layer-Between Mixtures (AC-BC) Using RAP Recycled Materials)*, Jurnal Sains, Teknologi dan Industri Vol 10 No.1, 2, 51-58.
- Sukirman, S., (2003) : *Beton Aspal Campuran Panas*, Granit, Jakarta.
- Sukirman, S., (2006) : *Perencanaan Tebal Perkerasan Lentur*, Institut Teknologi Nasional, Bandung
- SHRP, (1990) : *Summary Report on Fatigue Response of Asphalt Mixtures*, SHRP-A/IR-90-011, Strategic Highway Research Program, National Research Council, Washington DC.
- Tabakovic, A., Gibney, A., Gilchrist, M.D, McNally, C., (2010) : *The Influence of Recycled Asphalt Pavement on 20 mm Binder Course Mix Performance*, Scholl of Architecture, Landscape and Civil Engineering and School of Electrical, electronic and Mechanical, University Collage Dublin, Ireland.
- Tahir, A., dan Setiawan, A. (2009). *Kinerja durabilitas campuran beton aspal ditinjau dari faktor variasi suhu pemadatan dan lama perendaman*. SMARTek, 7(1).
- Tayfur, S., Ozen, H. and Aksoy, A., 2007. Investigation of rutting performance of asphalt mixtures containing polymer modifiers. *Construction and Building Materials*, 21(2), pp.328-337.
- Tjaronge, M.W. and Irmawaty, R., 2013, August. *Influence of water immersion on physical properties of porous asphalt containing liquid asbuton as bituminous asphalt binder*. In Proceedings of 3rd International conference and Sustainable Construction Material and Technologies-SCTM,, Kyoto, Japan (Vol. 153).
- Tricor Refining, LLC. <https://tricorrefining.com/specifications.php> (Diakses 27 November 2021)



- Valdes G, Felix Perez-Jimenez, Rodrigo Miro, Adriana Martinez dan Ramon Botella, (2011), Experimental study of recycled asphalt mixtures with high percentages of reclaimed asphalt pavement (RAP), *Construction and Building Materials* 25.
- Wicaksana, D. E., Suparma, L. B., & Triwiyono, A. (2018, October). *Penggunaan Asbuton Semi Ekstraksi Bna Blend 75/25 Dan Asbuton Butir Bga Tipe 20/25 Dalam Campuran Aspal Panas Lapis Aus (AC-WC)*. In *Prosiding Forum Studi Transportasi antar Perguruan Tinggi (FSTPT)*.
- Widajat, D., (2008) : *Daur Ulang Campuran Dingin dengan Bahan Pengikat Foam Bitumen*, Puslitbang Jalan dan Jembatan, Departemen Pekerjaan Umum.
- Widayanti A., Ria Asih Aryani Soemitro, Januarti Jaya Ekaputri dan Hitapriya Suprayitno. (2019). *Gradation Analysis of Reclaimed Asphalt Pavement from National Road as Asphalt Concrete Layer*. *Journal of Infrastructure and Facility Asset Management – Vol. 1, Issue 1, March 2019*.
- Wilis, A. R., & Risdianto, Y. (2018). *Pengaruh Penambahan Reclaimed Asphalt Pavement (RAP) dan Lawele Granular Asphalt (LGA) Sebagai Bahan Substitusi Agregat Pada Campuran Beton Aspal Wearing Course (AC-WC) Dengan Fly Ash Sebagai Filler*. *Rekayasa Teknik Sipil, 2(2/REKAT/18)*.
- Wirahaji, I. B. (2012). *Analisis Kadar Aspal Optimum LASTON Lapis Aus Pada Ruas Jalan Simpang Sakah-Simpang Blahbatuh*. *Jurnal Ilmiah Teknik Sipil Vol, 16(2)*.
- [www.training.ce.washington.edu](http://www.training.ce.washington.edu), (2005) : Washington Departement of Transport (WsDoT) Pavement Guide, USA
- Xiang, S. (2020). *Research Project Optimization Of Asphalt Mixture For Stability* (Doctoral dissertation, The University of Nottingham).
- Yamin, R.A., (2005) : *Model Konstitutif Modulus Kekakuan Resilien Cement Treated Asphalt Mixture*, *Jurnal Litbang Volume 22 No.2 Mei 2005*, Puslitbang Jalan dan Jembatan, Departemen Pekerjaan Umum.
- Yoder, E.J. And Witczak, M.W. (1975) : *Principles of Pavement Design*, Second Edition, John Wiley & Sons, Inc, New York.
- Yofianti, D., (2010) : *Kinerja Laboratorium Campuran Daur Ulang Base Beraspal Dingin dengan Foam Bitumen (CMRFB-Base) Menggunakan Filler Semen*, Tesis, Program Magister Sistem dan Teknik Jalan Raya (STJR), Institut Teknologi Bandung

- Zaumanis M. and R. B. Mallick. (2015). *Review of very high-content reclaimed asphalt use in plant-produced pavements: state of the art*. International Journal of Pavement Engineering, 16:1 pp 39-55.
- Zhang J, Sun H, Jiang H, Xu X, Liang M, Hou Y, Yao Z. 2019. *Experimental Assessment Of Reclaimed Bitumen And RAP Asphalt Mixtures Incorporating A Developed Rejuvenator*. Construction and Building Materials. 2019 Aug 10;215:660-9.

**Lampiran A. Perhitungan Proporsi Campuran akibat Gradasi Agregat pada RAP (*Reclaimed Asphalt Pavement*) dan Asbuton Butir (BGA)**

**A.1 Contoh perhitungan campuran A1 dengan 20% RAP dan 0% BGA**

| Contoh Perhitungan Campuran A1 dengan 20% RAP dan 80% Material Baru |                          |                                     |         |          |         |          |         |
|---|--------------------------|-------------------------------------|---------|----------|---------|----------|---------|
| No  | Kadar Aspal              |                                     | 5,0%    | 5,5%     | 6,0%    | 6,5%     | 7,0%    |
| A   | Berat Total Campuran     |                                     | 1200    | 1200     | 1200    | 1200     | 1200    |
| B   | Berat RAP                | $B = (20\% \times A)$               | 240     | 240      | 240     | 240      | 240     |
| C   | Berat Agregat+Aspal baru | $C = (80\% \times A)$               | 960     | 960      | 960     | 960      | 960     |
| D   | Berat Aspal Total        | $D = (\text{kadar aspal} \times A)$ | 60      | 66       | 72      | 78       | 84      |
| E   | Berat Aspal RAP          | $E = (5.16\% \times B)$             | 12,384  | 12,384   | 12,384  | 12,384   | 12,384  |
| F   | Berat Peremaja           | $F = (22\% \times E)$               | 2,72448 | 2,72448  | 2,72448 | 2,72448  | 2,72448 |
| G   | Berat Aspal Baru         | $G = (D - E - F)$                   | 44,8915 | 50,89152 | 56,8915 | 62,89152 | 68,8915 |
| H   | Berat agregat RAP        | $H = (B - E)$                       | 227,616 | 227,616  | 227,616 | 227,616  | 227,616 |
| I   | Berat Agregat Total      | $I = (A - D)$                       | 1140    | 1134     | 1128    | 1122     | 1116    |
| J   | Berat Agregat Baru       | $J = (I - H)$                       | 912,384 | 906,384  | 900,384 | 894,384  | 888,384 |

Catatan:

Kadar Aspal dalam RAP = 5,16%

Bahan peremaja = 22% terhadap aspal RAP

Material RAP yang digunakan = 20%

Material Baru yang digunakan = 80%

## A.2 Contoh perhitungan campuran A2 dengan 20% RAP dan 3% BGA

| contoh perhitungan campuran A2 dengan 20% RAP, 3% BGA dan 77% Material Baru |                             |                                     |         |         |         |         |         |
|---|-----------------------------|-------------------------------------|---------|---------|---------|---------|---------|
| No  | Kadar Aspal                 |                                     | 5,0%    | 5,5%    | 6,0%    | 6,5%    | 7,0%    |
| A   | Berat Total Campuran (gram) |                                     | 1200    | 1200    | 1200    | 1200    | 1200    |
| B   | Berat RAP                   | $B = (20\% \times A)$               | 240     | 240     | 240     | 240     | 240     |
| C   | Berat BGA                   | $C = (3\% \times A)$                | 36      | 36      | 36      | 36      | 36      |
| D   | Berat Agregat+Aspal baru    | $D = (77\% \times A)$               | 924     | 924     | 924     | 924     | 924     |
| E   | Berat Aspal Total           | $E = (\text{kadar aspal} \times A)$ | 60      | 66      | 72      | 78      | 84      |
| F   | Berat Aspal RAP             | $F = (5,16\% \times B)$             | 12,384  | 12,384  | 12,384  | 12,384  | 12,384  |
| G   | Berat Peremaja              | $G = (22\% \times F)$               | 2,724   | 2,724   | 2,724   | 2,724   | 2,724   |
| H   | Berat Aspal BGA             | $H = (23,045\% \times C)$           | 8,296   | 8,296   | 8,296   | 8,296   | 8,296   |
| I   | Berat Aspal Baru            | $I = (E-F-G-H)$                     | 36,595  | 42,595  | 48,595  | 54,595  | 60,595  |
| J   | Berat agregat RAP           | $J = (B-F)$                         | 227,616 | 227,616 | 227,616 | 227,616 | 227,616 |
| K   | Berat agregat BGA           | $K = (C-H)$                         | 27,704  | 27,704  | 27,704  | 27,704  | 27,704  |
| L   | Berat Agregrat Total        | $L = (A-E)$                         | 1140    | 1134    | 1128    | 1122    | 1116    |
| M   | Berat Agregrat Baru         | $M = (L-J-K)$                       | 884,680 | 878,680 | 872,680 | 866,680 | 860,680 |

Catatan:

Kadar Aspal dalam RAP = 5,16%

Bahan peremaja = 22% terhadap aspal RAP

Material RAP yang digunakan = 20%

Material Baru yang digunakan = 77%

Material BGA yang digunakan = 3%

Kadar Aspal dalam BGA = 23,045%

### A.3 Contoh perhitungan campuran A3 dengan 20% RAP dan 6% BGA

| contoh perhitungan campuran A3 dengan 20% RAP, 6% BGA dan 74% Material Baru |                          |                                     |         |          |         |          |         |
|---|--------------------------|-------------------------------------|---------|----------|---------|----------|---------|
| No  | Kadar Aspal              |                                     | 5,0%    | 5,5%     | 6,0%    | 6,5%     | 7,0%    |
| A   | Berat Total Campuran     |                                     | 1200    | 1200     | 1200    | 1200     | 1200    |
| B   | Berat RAP                | $B = (20\% \times A)$               | 240     | 240      | 240     | 240      | 240     |
| C   | Berat BGA                | $C = (6\% \times A)$                | 72      | 72       | 72      | 72       | 72      |
| D   | Berat Agregat+Aspal baru | $D = (74\% \times A)$               | 888     | 888      | 888     | 888      | 888     |
| E   | Berat Aspal Total        | $E = (\text{kadar aspal} \times A)$ | 60      | 66       | 72      | 78       | 84      |
| F   | Berat Aspal RAP          | $F = (5,16\% \times B)$             | 12,384  | 12,384   | 12,384  | 12,384   | 12,384  |
| G   | Berat Peremaja           | $G = (22\% \times F)$               | 2,72448 | 2,72448  | 2,72448 | 2,72448  | 2,72448 |
| H   | Berat Aspal BGA          | $H = (23,045\% \times C)$           | 16,5924 | 16,5924  | 16,5924 | 16,5924  | 16,5924 |
| I   | Berat Aspal Baru         | $I = (E - F - G - H)$               | 28,2991 | 34,29912 | 40,2991 | 46,29912 | 52,2991 |
| J   | Berat agregat RAP        | $J = (B - F)$                       | 227,616 | 227,616  | 227,616 | 227,616  | 227,616 |
| K   | Berat agregat BGA        | $K = (C - H)$                       | 55,4076 | 55,4076  | 55,4076 | 55,4076  | 55,4076 |
| L   | Berat Agregrat Total     | $L = (A - E)$                       | 1140    | 1134     | 1128    | 1122     | 1116    |
| M   | Berat Agregrat Baru      | $M = (L - J - K)$                   | 856,976 | 850,9764 | 844,976 | 838,9764 | 832,976 |

Catatan:

Kadar Aspal dalam RAP = 5,16%

Bahan peremaja = 22% terhadap aspal RAP

Material RAP yang digunakan = 20%

Material Baru yang digunakan = 74%

Material BGA yang digunakan = 6%

Kadar Aspal dalam BGA = 23,045%

#### A.4 Contoh perhitungan campuran A4 dengan 20% RAP dan 9% BGA

| contoh perhitungan campuran A4 dengan 20% RAP, 9% BGA dan 71% Material Baru |                          |                                     |         |          |         |          |         |
|---|--------------------------|-------------------------------------|---------|----------|---------|----------|---------|
| No  | Kadar Aspal              |                                     | 5,0%    | 5,5%     | 6,0%    | 6,5%     | 7,0%    |
| A   | Berat Total Campuran     |                                     | 1200    | 1200     | 1200    | 1200     | 1200    |
| B   | Berat RAP                | $B = (20\% \times A)$               | 240     | 240      | 240     | 240      | 240     |
| C   | Berat BGA                | $C = (9\% \times A)$                | 108     | 108      | 108     | 108      | 108     |
| D   | Berat Agregat+Aspal baru | $D = (71\% \times A)$               | 852     | 852      | 852     | 852      | 852     |
| E   | Berat Aspal Total        | $E = (\text{kadar aspal} \times A)$ | 60      | 66       | 72      | 78       | 84      |
| F   | Berat Aspal RAP          | $F = (5,16\% \times B)$             | 12,384  | 12,384   | 12,384  | 12,384   | 12,384  |
| G   | Berat Peremaja           | $G = (22\% \times F)$               | 2,72448 | 2,72448  | 2,72448 | 2,72448  | 2,72448 |
| H   | Berat Aspal BGA          | $H = (23,045\% \times C)$           | 24,8886 | 24,8886  | 24,8886 | 24,8886  | 24,8886 |
| I   | Berat Aspal Baru         | $I = (E - F - G - H)$               | 20,0029 | 26,00292 | 32,0029 | 38,00292 | 44,0029 |
| J   | Berat agregat RAP        | $J = (B - F)$                       | 227,616 | 227,616  | 227,616 | 227,616  | 227,616 |
| K   | Berat agregat BGA        | $K = (C - H)$                       | 83,1114 | 83,1114  | 83,1114 | 83,1114  | 83,1114 |
| L   | Berat Agregrat Total     | $L = (A - E)$                       | 1140    | 1134     | 1128    | 1122     | 1116    |
| M   | Berat Agregrat Baru      | $M = (L - J - K)$                   | 829,273 | 823,2726 | 817,273 | 811,2726 | 805,273 |

Catatan:

Kadar Aspal dalam RAP = 5,16%

Bahan peremaja = 22% terhadap aspal RAP

Material RAP yang digunakan = 20%

Material Baru yang digunakan = 71%

Material BGA yang digunakan = 9%

Kadar Aspal dalam BGA = 23,045%

### A.5 Contoh perhitungan koreksi gradasi agregat akibat RAP (*Reclaimed Asphalt Pavement*)

#### 1. Kadar Aspal 5%

| Ukuran Ayakan |       | RAP (20%) |              |           | Agregat Baru (80%) |          |        | Spesifikasi        |        |         |          |               |
|---------------|-------|-----------|--------------|-----------|--------------------|----------|--------|--------------------|--------|---------|----------|---------------|
|               |       | Lolos     | Tertahan RAP | Berat RAP | Berat Agregat      | Tertahan | Lolos  | % Berat yang Lolos |        |         | Tertahan | Berat Agregat |
| ASTM          | (mm)  | %         | %            | Gram      | Gram               | %        | %      | Min                | Maks   | Rencana | %        | Gram          |
| 1"            | 25    | 100,00    | 0,00         | 0,00      |                    | 0        | 100    | 100                | 100    | 100     | 0        | 0             |
| 3/4"          | 19    | 98,43     | 0,00         | 0,00      | 0,00               | 0,00     | 100,00 | 100,00             | 100,00 | 100     | 0        | 0             |
| 1/2"          | 12,5  | 89,43     | 9,00         | 20,80     | 36,20              | 3,97     | 96,03  | 90,00              | 100,00 | 95      | 5        | 57            |
| 3/8"          | 9,5   | 82,27     | 7,16         | 16,56     | 114,54             | 12,55    | 83,48  | 77,00              | 90,00  | 83,5    | 11,5     | 131,1         |
| No.4          | 4,75  | 66,68     | 15,60        | 36,06     | 220,44             | 24,16    | 59,32  | 53,00              | 69,00  | 61      | 22,5     | 256,5         |
| No.8          | 2,36  | 49,86     | 16,81        | 38,88     | 166,32             | 18,23    | 41,09  | 33,00              | 53,00  | 43      | 18       | 205,2         |
| No.16         | 1,18  | 36,87     | 12,99        | 30,03     | 112,47             | 12,33    | 28,76  | 21,00              | 40,00  | 30,5    | 12,5     | 142,5         |
| No.30         | 0,6   | 26,90     | 9,97         | 23,06     | 73,84              | 8,09     | 20,67  | 14,00              | 30,00  | 22      | 8,5      | 96,9          |
| No.50         | 0,3   | 15,59     | 11,32        | 26,17     | 47,93              | 5,25     | 15,42  | 9,00               | 22,00  | 15,5    | 6,5      | 74,1          |
| No.100        | 0,15  | 7,10      | 8,49         | 19,63     | 37,37              | 4,10     | 11,32  | 6,00               | 15,00  | 10,5    | 5        | 57            |
| No.200        | 0,075 | 3,86      | 3,24         | 7,48      | 38,12              | 4,18     | 7,14   | 4,00               | 9,00   | 6,5     | 4        | 45,6          |
| pan           |       | 0,00      | 3,86         | 8,93      | 65,17              | 7,14     | 0,00   |                    |        | 0       | 6,5      | 74,1          |
| Total         |       |           | 98,43        | 227,616   | 912,38             | 100,00   |        |                    |        |         | 100      | 1140          |

## A.6 Contoh perhitungan koreksi gradasi agregat akibat RAP (*Reclaimed Asphalt Pavement*) dan Asbuton Butir (BGA)

### 1. Kadar Aspal 5%

| Ukuran Ayakan |       | RAP (20%) |              |           | BGA (3%) |              |           | Agregat Target (77%) |          |        | Spesifikasi        |        |         |          |               |
|---------------|-------|-----------|--------------|-----------|----------|--------------|-----------|----------------------|----------|--------|--------------------|--------|---------|----------|---------------|
|               |       | Lolos     | Tertahan RAP | Berat RAP | Lolos    | Tertahan BGA | Berat BGA | Berat Agregat        | Tertahan | Lolos  | % Berat yang Lolos |        |         | Tertahan | Berat Agregat |
| ASTM          | (mm)  | %         | %            | Gram      | %        | %            | Gram      | Gram                 | %        | %      | Min                | Maks   | Rencana | %        | Gram          |
| 1"            | 25    | 100,00    | 0,00         | 0,00      | 100,00   | 0,00         | 0,00      |                      | 0        | 100    | 100                | 100    | 100     | 0        | 0             |
| 3/4"          | 19    | 98,43     | 0,00         | 0,00      | 100,00   | 0,00         | 0,00      | 0,00                 | 0,00     | 100,00 | 100,00             | 100,00 | 100     | 0        | 0             |
| 1/2"          | 12,5  | 89,43     | 9,00         | 20,80     | 100,00   | 0,00         | 0,00      | 36,20                | 4,09     | 95,91  | 90,00              | 100,00 | 95      | 5        | 57            |
| 3/8"          | 9,5   | 82,27     | 7,16         | 16,56     | 100,00   | 0,00         | 0,00      | 114,54               | 12,95    | 82,96  | 77,00              | 90,00  | 83,5    | 11,5     | 131,1         |
| No.4          | 4,75  | 66,68     | 15,60        | 36,06     | 84,36    | 15,64        | 4,33      | 216,10               | 24,43    | 58,53  | 53,00              | 69,00  | 61      | 22,5     | 256,5         |
| No.8          | 2,36  | 49,86     | 16,81        | 38,88     | 68,86    | 15,50        | 4,29      | 162,02               | 18,31    | 40,22  | 33,00              | 53,00  | 43      | 18       | 205,2         |
| No.16         | 1,18  | 36,87     | 12,99        | 30,03     | 54,98    | 13,88        | 3,85      | 108,62               | 12,28    | 27,94  | 21,00              | 40,00  | 30,5    | 12,5     | 142,5         |
| No.30         | 0,6   | 26,90     | 9,97         | 23,06     | 41,40    | 13,58        | 3,76      | 70,08                | 7,92     | 20,02  | 14,00              | 30,00  | 22      | 8,5      | 96,9          |
| No.50         | 0,3   | 15,59     | 11,32        | 26,17     | 28,13    | 13,27        | 3,68      | 44,25                | 5,00     | 15,02  | 9,00               | 22,00  | 15,5    | 6,5      | 74,1          |
| No.100        | 0,15  | 7,10      | 8,49         | 19,63     | 21,11    | 7,02         | 1,95      | 35,43                | 4,00     | 11,01  | 6,00               | 15,00  | 10,5    | 5        | 57            |
| No.200        | 0,075 | 3,86      | 3,24         | 7,48      | 18,72    | 2,39         | 0,66      | 37,46                | 4,23     | 6,78   | 4,00               | 9,00   | 6,5     | 4        | 45,6          |
| pan           |       | 0,00      | 3,86         | 8,93      | 0,00     | 18,72        | 5,19      | 59,98                | 6,78     | 0,00   |                    |        | 0       | 6,5      | 74,1          |
| Total         |       |           | 98,43        | 227,616   | 617,58   | 100,00       | 27,70     | 884,68               | 100,00   |        |                    |        |         | 100      | 1140          |