KEY NOTE

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SITE CIVIL IMPROVEMENT · EROSION CONTROL · SURFACE WATER QUALITY

Geopro® Learning Tool

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Base Course - Road Longevity

Road performance longevity continues to nag Michigan road construction professionals. While a number of factors contribute to the relatively short periods our roads remain smooth, unrutted and relatively pothole free after construction, the lack of adequate drainage remains a, if not the, most critical factor. In standard flexible pavement construction, we deploy dense-graded bases, specifically MDOT 22A and 21AA. Both exhibit poor drainage characteristics and, consequently, significant strength loss when subjected to dynamic loads at elevated moisture levels. This relationship between strength loss and the combined effect of dynamic loads at elevated moisture levels is clearly recognized by AASHTO when calculating the Structural Number [SN] for a pavement system.

$$SN = a_1D_1 + a_2D_2 + a_3D_3m_3 + a_4D_4m_4$$

Where: m_3 = base coefficient modifier for moisture
m_4 = subbase coefficient modifier for moisture

As reported in the 1993 AASHTO Guidelines, the coefficient modifiers, m_i, for aggregate layers are as follows:

Quality of Drainage	m_3 & m_4 Factors			
	% of Time Pavement is Exposed To Moisture Levels Approaching Saturation			
	< 1%	1% - 5%	5% - 25%	> 25%
Excellent	1.40-1.35	1.35-1.30	1.30-1.20	1.2
Good	1.35-1.25	1.25-1.15	1.15-1.00	1.0
Fair	1.25-1.15	1.15-1.05	1.05-0.80	0.8
Poor	1.15-1.05	1.05-0.80	0.80-0.60	0.6
Very Poor	1.05-0.95	0.95-0.75	0.75-0.40	0.4

Given that our aggregates are subjected to high moisture levels at least 25% of the time [not including winter freeze down], that MDOT 22A and 21AA exhibit 'poor' drainage characteristics and that MDOT Class II exhibits a 'fair' drainage characteristic, the resulting m_3 and m_4 values that ***should*** be used in design are 0.6 and 0.8, respectively. In turn and with some variance associated with the asphalt/aggregate thickness ratio, the corresponding ESALs which produce the estimated failure criterion [usually rutting depth or roughness] resulting from the reduced SN is approximately ***50% to 65% less*** than what is predicted without accounting for moisture influences. Hence, a road designed to provide a 20 year useful life will likely need significant maintenance within 7 - 10 years. Realization of this premature pavement distress condition is readily apparent from a pragmatic review of our pavement surfaces - they are rough, in need of significant patching and/or are dangerously rutted long before the end of their design-predicted useful life.

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Michigan DOT funded critical research[1] conducted by Michigan Technological University in an effort to develop better aggregates for use within our road system. This research reviewed shear strength losses associated with dynamic load imposition on glacial and quarried origin aggregates, having widely varying mechanical and hydraulic characteristics, under conditions of both increased moisture levels and full saturation. Regardless of aggregate tested, increased moisture levels negatively affected strength retention. Similarly, all aggregates showed a strength loss with dynamic load impostion when fully saturated - significantly greater than the losses measured with elevated moisture levels. In essence, MDOT's research validates, relatively closely, the m_i factors published via AASHTO.

Our continued use of MDOT 22A and 21AA as base materials and Class II as a subbase, given their known outcome in performance longevity, is based on reaching a compromise among mutually interdependent and desirable characteristics:

1. Shear strength
2. Durability
3. Permeability
4. Stability during construction and in-use loads
5. Low cost

In essence, the compromise sacrifices long-term shear strength retention and road performance durability for construction load stability and low initial cost.

We can now benefit from the MDOT research and its application. A cooperative effort between the Kent County Road and Park Commission [KCRPC] and Grand Rapids Gravel Company [GRGC] indicates that an innovative refinement to processing aggregates results in achieving all four aggreagate performance characteristics with only a modest material cost increase. Specifically, KCRPC has been using a refined base aggregate, "Aggregate Base – Modified" or "21AA-Modified" for both wet, and more recently, competent subgrade supported roads. Typically, this refined aggregate is used full-depth, replacing both conventional base and subbase materials. The shaded box provides KCRPC's specifications for this aggregate.

According to GRGC, this aggregate is achieved by volume blending the following materials:

MDOT 6AA - 2 parts
MDOT 34R - 1 part
Stone Dust* - 1 part

* Stone dust = crusher fines: 99% P#8, 72% P#16, 50% P#30, 37% P#50, 26% P100, 17% LBW

Description:

Construct an aggregate base course on a prepared subbase or subgrade as shown on the plans or as directed by the Engineer. The aggregate base course shall be in accordance with Section 302 and 902 of the MDOT 2003 Standard Specifications for Construction, except as specified herein.

Materials:

The material for Aggregate Base – Modified shall be 21AA aggregate conforming to Table 902-1* and Table 902-2, except for the following modifications.

Sieve Analysis, Total Percent Passing

1.5"	1"	0.5"	No. 8	No. 30	LBW*
100	85-100	50-70	20-35	8-22	0-7

* Footnote "E" in Table 902-1 shall not apply to assure the base is permeable.

Physical Requirements:

Crushed material, Min. = 95%

Loss, % Max., LA Abrasion (MTM 102) = 50%

Price and Company, Inc. looks forward to placing its geosynthetics, both geotextiles and geogrids, in conjunction with this aggregate to achieve more durable and lower life-cycle cost roads.

[1] Wachholz, Mathew J., "An Experimental Study of Drainable Bases Under Dynamic Loads", Master Thesis, Michigan Technological University, 1998.

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