ROCK CAP
A TRUE FREE DRAINING BASE

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ABSTRACT

Free draining bases, while not new, are enjoying a resurgence in Idaho construction. An opengraded relatively large maximum size "rock cap" (100% -3" and 0-5% passing the 3/4" screen) is increasingly being incorporated into the pavement structural section. Absolute data on strength, permeability and long term performance has not yet been developed. Substitution ratios i.c. 1:1 equivalency with conventional graded base and current bid costs of about 1/3 that of graded base are very favorable.

Current bid costs for rock cap range from $2.50 to $3.00/CY. Graded 3/4 aggregate bid prices range from $8.50 to $10.50/Ton. With Idaho's substitution ratio making the two materials structurally equivalent, the economics are excellent.

INTRODUCTION

This glaring contradiction to long established data that drainage is the major item to be considered in providing a lasting pavement. While much as been done in providing adequate subdrainage, until recently rather less effort has been expended in providing effective drainage immediately below the pavement.

Subdrainage can control groundwater if attention is given to drawdown curves but does little to mitigate the phenomena of hydrogenesis and nothing to convey water which passes thru the bound section. The literature contains numerous speculations that in pavements two or more years old as much as 80% of the water falling.on the surface penetrates to the base.

In a somewhat radical departure from established procedure a coarse very clean material, typically with 100% -3" and 0-5-3/4" has been incorporated into the pavement section to provide a positive drainage blanket under the bound pavement. One of the first modern projects to utilize what we now term as rock cap was Lewiston Hill, constructed in 1981. Subsequently, rock cap has been used on two US-95 projects south of CDA (Mica Hill N&S) and one north of Sandpoint and on three I-90 projects (Cedar Canyon & 4th July and Hilltop-Bennett Bay, all east of CDA. The remaining Interstate projects, Sherman-Hilltop and Bennett Bay to Wolf Lodge are also designed with rock cap sections.

STRUCTURAL DESIGN

No attempt has been made to date to develop direct measurement of strength data principally because of equipment limitations with respect to the grain size of the material. Moduli backcalculated from falling weight deflectometer testing has a very wide scatter ranging from 25,000 psi to 60,000 psi. Very interestingly, however, is the fact that these moduli show very little sensitivity to season of the year, something not true of conventional bases.

Current structural design of flexible pavements is based on R valve using Hveem's procedure. Traffic projections, climate, cohesion and economics. The various parameters are combined to develop a gravel equivalent thickness requirement. This requirement can be satisfied by various layer combinations with untreated base having a substitution ratio of 1.0 and plantmix pavement having rations of 1.4 to 2.4 with a traffic index as the argument. In this scheme rock cap is currently used at a 1.0 substitution ratio.

CONSTRUCTION

Rock cap has presented special problems in construction. Since virtually no -3/4 material compaction consists of producing good orientation and aggregate interlock. It is most desirable to produce the material from quarry type sources to assure 100% fracture. We have used one gravel source and by rejecting most of the -2" prior to crushing, provided an acceptable product.

With surface stability being achieved thru aggregate interlock, the material must be confined to preserve this condition. As the thickness increases, the ability of traffic of any kind to travel on an unconfined surface decreases. At depths in excess of 2' the material acts much like an arrestor bed on a truck escape ramp. Partly for this reason and partly to control degradation construction traffic is not allowed after the material is placed.

This raises the obvious question..."How do we provide the initial containment to allow pavement to be placed?"

As previously discussed two methods are used, each unique to the District doing the design. One district uses a thickness of conventional base over the rock cap. While this achieves the objective of containment, provides a material that can be fine graded to closer tolerances and perhaps produces a better final ride, it also may, by placing a partial aquaclude directly under the pavement, negate a critical portion of the drainage system. Long term migration of the base material into the void spaces in the rock cap could also result in localized deformation.

Design and construction in District 1 employs a 0.1' plantmix binder course directly on top of the rock cap. Initially, the

paving contractors protested loudly that such construction was impossible. However, as usual, contractors faced with the "impossible" become very innovative and quickly reduced their category to merely "difficult". Fine grading of the material must employ higher tolerance typically 0 high to 0.1" low. This could result in mix overruns but has not been a problem to date. The binder course is considered to be sacrificial and is assigned no structural value or thickness. The concept of complete intrusion into the rock cap void space is only partially realized in the field which results in a variable depth of plantmix in the first lift. Compaction of this variable depth obviously cannot be uniform and some pavement roughness results. However, with multiple lifts superior rides can be acheived.

On the Hilltop-Bennett Bay project, the design included 2.67' of rock cap on the mainline with 1.0' on some accessory roads. As noted previously, the thicker sections become virtually impassable for normal asphalt hauling units. Working with the contractor, we ok'd the use of 631 scrapers to haul and spread the binder course reasoning that the increased floatation from the large footprint would allow reasonable haul with minimum disruption to the rock cap. The process worked and after blade laying and rolling, a good surface was obtained.After finishing the mainline and flushed with success we turned our attention to the accessory roads. Near Disaster! The 1' section was not sufficiently strong to prevent distortion of the subgrade under the high loading. We immediately returned to the usual on-highway type hauling units and completed these sections in the more conventional manner.

With the current cost of aggregate base at $9.00/Ton and rock cap at $2.50/Ton (both produce haul & place bid costs) the economics for substitution on a 1:1 basis are extremely favorable.

It is also important to provide a separation fabric when rock cap is placed over soils which could, with time, intrude into the voids. This consideration should also be given to design using graded base material. Equally important is providing free lateral drainage which requires that ditch and foreslope design be compatible with the pavement section.

PERFORMANCE

Long term performance data is limited. The Lewiston Hill section with a 10 year history had rock cap placed directly on rocksubgrade and choked with 0.2' of aggregate base.

N. Mica incorporated 2.0' of rock cap separated from the clayey silt subgrade material with a geotextile blanket on a portion of the project with the rest using 3/4" aggregate base. Some premature pavement failure which from test pits appeared to be related to hydrogenisis occurred on the 3/4" base section with free water evident at the bound pavement - base interface.

CONCLUSIONS

Drainage has long been recognized to be of paramount importance in attaining the design life of a pavement. Incorporation of a truely free draining material immediately below the pavement provides a vital link in the overall system functioning as a capillary break as well as a high capacity conduit to convey both surface and subsurface water to outflow facilities.