VALUE ENGINEERING SUMMARY
OF THE
INTERSTATE WIDENING PROJECTS
PAVEMENT DESIGNS
FRANKFORT, KENTUCKY

MARCH 23-27, 1998

Prepared by:
Ventry Engineering

In Association With:

Kentucky Transportation Cabinet

M. Jack Trickey, P.E., C.V.S.
C.V.S. Registration No. 950509 exp. 5/99

Date: Apr. 2, 1998

TABLE OF CONTENTS

I. EXECUTIVE SUMMARY

INTRODUCTION

This Value Engineering report summarizes the results of the Value Engineering study performed by Ventry Engineering for the Kentucky Transportation Cabinet. The study was performed during the week of March 23-27, 1998 in Frankfort, Kentucky.

The subject of the study was the Interstate Widening Projects Pavement Design.

PROJECT DESCRIPTION

The Kentucky Transportation Cabinet (KYTC) has plans to 6 lane (8 lane some sections) the remaining 4 lane sections of I-65 and I-75 in Kentucky. Much of the Interstate pavement is in need of rehabilitation as the pavements have exceeded their design life and several miles are being rehabilitated or resurfaced each year. Due to the need for additional capacity and the need to maintain two lanes of traffic in a direction during construction, the KYTC decided in October 1997 to expedite the project's design. The KYTC also desires to have plans ready in the event anticipated additional funding becomes available.

In order to expedite the design of the projects, the KYTC has undertaken to develop a catalog of pavement design thicknesses for both asphalt and PCC pavement overlays for given soil strengths (CBR's) and forecasted loadings (ESAL's). Based on the design thicknesses, life cycle cost comparisons were made for making the decision on the pavement type selection. The early decisions are needed for the project designers to establish grades, particularly for the design for structure modifications or replacements.

Since the catalog is to be the basis for pavement type selection and design thicknesses and due to the significance of the investment, the Kentucky Transportation Cabinet initiated a value engineering study of the catalog. The Value Engineering team was also charged with reviewing the life cycle cost analysis (LCCA) for appropriateness of design and cost effectiveness.

There are approximately 200 miles of the 4 lane roadways to be widened. Slightly over half of the mileage is for Interstate 75.

METHODOLOGY

The Value Engineering Team followed the basic Value Engineering procedure for conducting this type of analysis.

This process included the following phases:

1. Investigation
2. Speculation
3. Evaluation
4. Development
5. Presentation
6. Report Preparation

Evaluation criteria identified as a basis for the comparison of alternatives included the following:

- ESAL's based on lane assignments
- Cost per inch of paving and base materials
- Constructibility
- Expected subgrade CBR values
- Need for, and the ability to remove water from the pavement structure
- Need for continuing to design, construct and maintain both concrete and asphalt pavements in Kentucky

RESULTS

The following areas of focus were analyzed by the Value Engineering Team and from these areas the following Value Engineering alternatives were developed and are recommended for Implementation:

Recommendation Number 1-

The Value Engineering Team recommends that all subgrades having a CBR value of 6 or less be treated in areas when widening is planned.

Recommendation Number 2-

The Value Engineering Team recommends that the design for the widening be based on ESAL assignment recognizing the truck distribution across the 3 and 4 lanes in each direction, i.e. right lane 60% trucks, left lane (median) 5% trucks.

Recommendation Number 3-

The Value Engineering Team recommends that the catalog reflect fine tuning of the layer treatments to only provide the required SN using the most cost efficient materials (eg. thick Drainage Blanket in lieu of Asphalt Base).

Recommendation Number 4-

The Value Engineering Team recommends that Dense Graded Aggregate Base be substituted for Drainage Blanket (Type II) in the median of superelevated sections.

Recommendation Number 5-

The Value Engineering Team recommends that the need to drain AC pavement widening sections using the drainable base be re-evaluated.

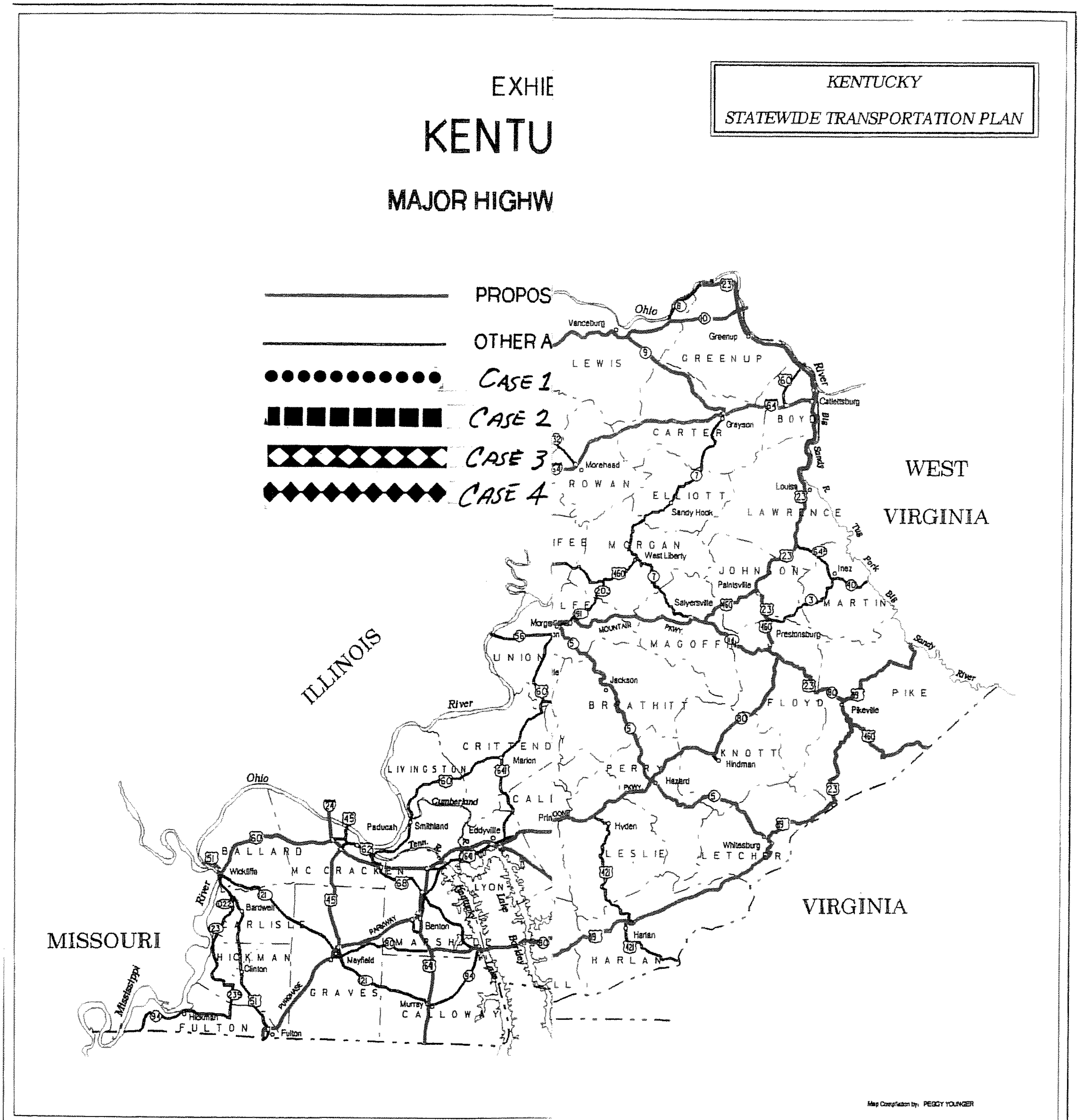
Recommendation Number 6-

The Value Engineering Team recommends that accelerated testing be conducted in areas with cracked and seated PCC pavement to determine actual support value appropriate for use in the design of the overlays.

Recommendation Number 7-

The Value Engineering Team recommends that KYTC consider using a material for the drainage layer that has less permeability and more stability and can be constructed in thicker layers.

II. LOCATION OF PROJECT


EXHIE
KENTU
MAJOR HIGHW
PROPOS
OTHER A
CASE 1
CASE 2
CASE 3
CASE 4
KENTUCKY
STATEWIDE TRANSPORTATION PLAN
ILLINOIS
MISSOURI
WEST VIRGINIA
VIRGINIA
Ohio
River
Mississippi
Big Sandy R.
Tug Fork
LEWIS
GREENUP
BOYD
CARTER
ROWAN
ELLIOTT
LAWRENCE
MORGAN
JOHNSON
MARTIN
MAGOFFIN
FLOYD
PIKE
BREATHITT
KNOTT
PERRY
LESLIE
LETCHER
HARLAN
UNION
CRITTENDEN
LIVINGSTON
BALLARD
MC CRACKEN
LYON
MARSHALL
CARLISLE
HICKMAN
GRAVES
CALLOWAY
FULTON
Vanceburg
Greenup
Catlettsburg
Grayson
Morehead
Louisa
Sandy Hook
West Liberty
Paintsville
Inez
Salyersville
Prestonsburg
Pikeville
Jackson
Hindman
Hazard
Hyden
Whitesburg
Harlan
Marion
Paducah
Smithland
Eddyville
Wickliffe
Bardwell
Clinton
Benton
Mayfield
Murray
Hickman
Fulton
Cumberland
Kentucky Lake
Lake Barkley
Map Compilation by: PEGGY YOUNGER

III. TEAM MEMBERS AND PROJECT DESCRIPTION

TEAM MEMBERS

NAME	AFFILIATION	EXPERTISE	PHONE
Jack Trickey, P.E.,C.V.S.	Ventry Engineering	Team Leader	850/627-3900
Carolyn Stonecipher, P.E.	Ventry Engineering	Pavement Team Member	850/627-3900
Blair Golden, P.E.	Ventry Engineering	Pavement Team Member	850/627-3900
Newton Jackson, P.E.	Ventry Engineering	Pavement Team Member	850/627-3900
Duncan Silver. P.E.	Ventry Engineering	Pavement Team Member	850/627-3900
Dudley Brown, P.E.	FHWA	Pavement Team Member	502/223-6479

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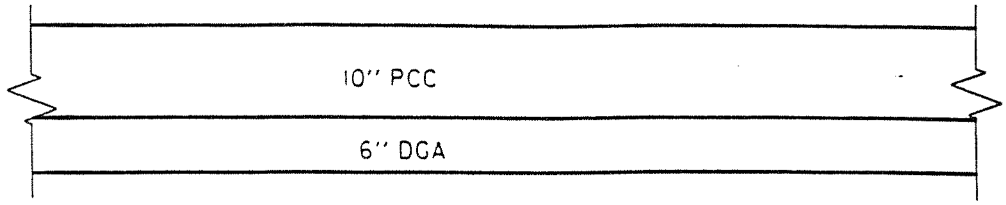
There are approximately 200 miles of the 4 lane roadway, to be widened. Slightly over half of the mileage is for Interstate 75.

The four cases of pavement involved with the widening and rehabilitation/resurfacing are as follows.

Case #1 is approximately 65 miles of PCC pavement; Case # 2 is approximately 30 miles of existing asphalt pavement (AC) on dense graded aggregate (DGA); Case #3 is approximately 94 miles of thick AC overlay on broken and seated (B&S) concrete pavement; Case #4 is approximately 9 miles of asphalt over PCC pavement (AC/PCC).

I. EXISTING PAVEMENTS THICKNESSES *

CASE I.



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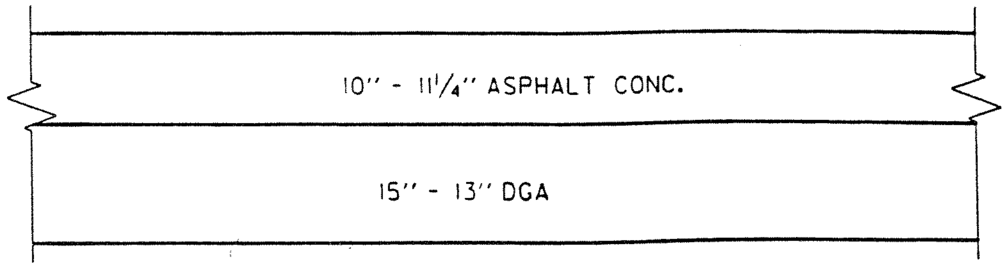
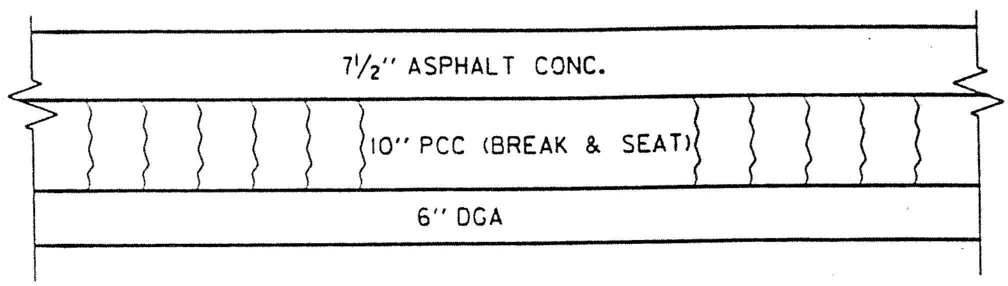
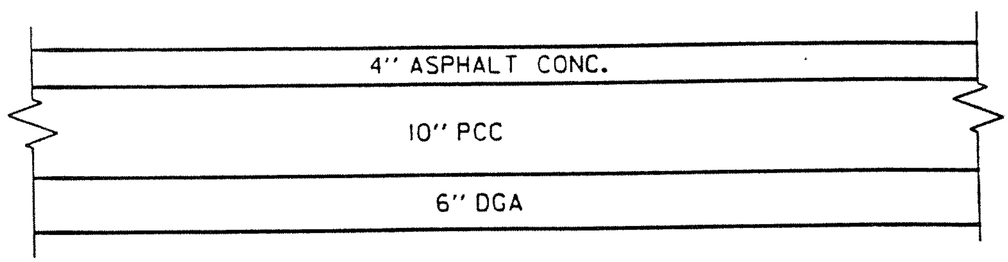


CASE III.



CASE IV.



* ADJUSTMENTS WILL BE MADE FOR EXISTING CONDITIONS NOT MATCHING THE CONDITIONS NOTED ABOVE.

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Case #1 - Existing PCC

Route	County	Compl. Date	Milepoint	Length	Direction
I-65	Simpson	65 - 69	0-12.8	12.8 mi.	
I-65	Warren	66	33.2-35.6	2.4 mi.	
I-65	Warren	69	35.6-42.6	7.0 mi.	
I-65	Barren	68	46.9-48.5	1.6 mi.	
I-65	Barren	68	49.6-51.9	2.3 mi.	
I-65	Hart	67	58.1-61.2	3.1 mi.	
I-75	Whitley	62	0-0.5	0.5 mi.	
I-75	Whitley	62	0.5-20.2	19.7 mi.	
I-75	Laurel	69	29.4-49	19.6 mi.	
				62.2 mi. 4 lane	
				6.8 mi. 2 lane	

Case #2 Existing AC

Route	County	Compl. Date	Milepoint	Length	Direction
I-65	Hart-Lane	94 OL	01.2-76.1	14.9 mi.	B
I-75	Rockcastle	90 OL	50.8-65.2	14.4 mi.	B
				29.3 mi. 4 lane	

Case #3 Existing - AC/B&S

Route	County	Compl. Date	Milepoint	Length	Direction
I-65	Warren	97 OL	21.9-33.2	11.3 mi.	B
I-65	Warren	94 OL	33.2-35.6	2.4 mi.	SB
I-65	Warren/ Barren	94 OL	42.6-46.9	4.3 mi.	B
I-65	Barren	94 OL	46.9-49.6	2.7 mi.	NB
I-65	Barren	96 OL	48.5-51.9	3.4 mi.	SB
I-65	Barren/ Hart	88 OL	51.9-58.1	6.2 mi.	B
I-65	Larve/ Hardin	94 OL	76.1-90.6	14.5 mi.	B
I-75	Whitley	94 OL	0-0.5	0.5 mi.	NB
I-75	Whitley	91 OL	20.2-24.7	4.5 mi.	NB
I-75	Whitley/ Laural	96 OL	25.3-29.4	4.1 mi.	B
I-75	Rockcastle/ Madison	88 OL	65.2-77.0	11.8 mi.	B
I-75	Scott Grant Boone	84-86	138.2-173.3	35.1 mi.	B

Case 3 87.3 mi. 4 lane
13.5 mi. 2 lane

Total 3 Cases 188.0 mi. 4 lanes
20.3 mi. 2 lanes

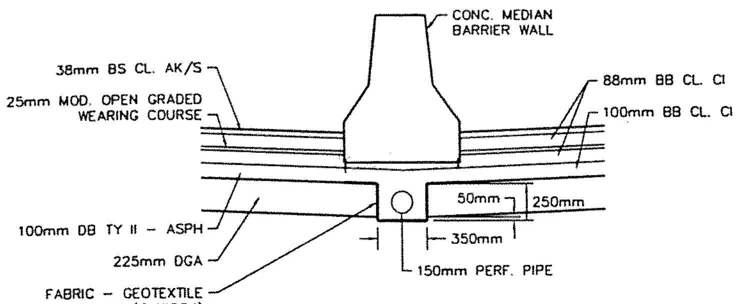
Case 1	Case 2	Case 3	Case 4
33.1%	14.8%	47.5%	4.6%

Case 4 - Existing AC/PCC

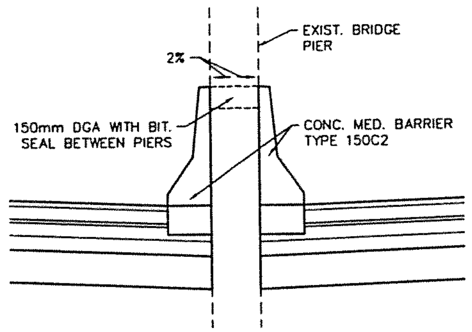
Route	County	Compl. Date	Milepoint	Length	Direction
I-65	Simpson/ Warren	65	12.8-33	9.2 mi.	B

TYPICAL SECTIONS

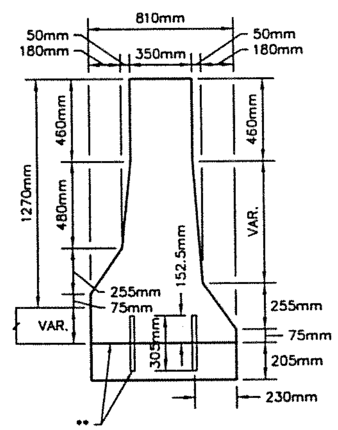
COUNTY OF	FISCAL YEAR	SHEET NO.
GRANT	1998	2



PERFORATED PIPE DETAIL



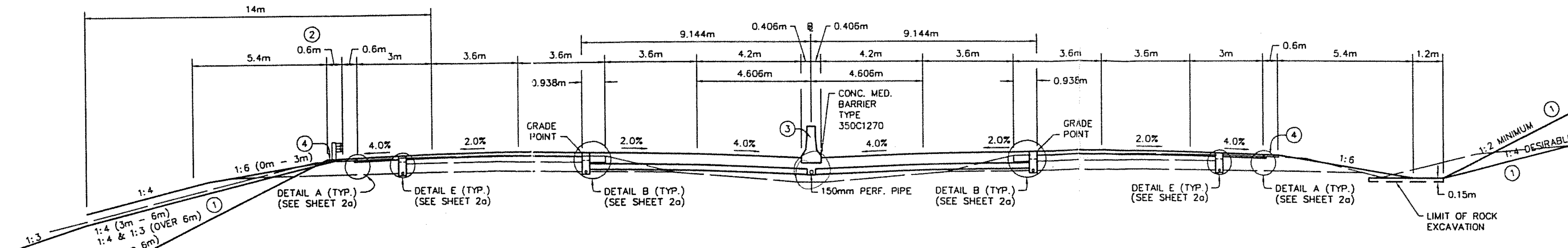
BARRIER DETAIL AT BRIDGE PIERS



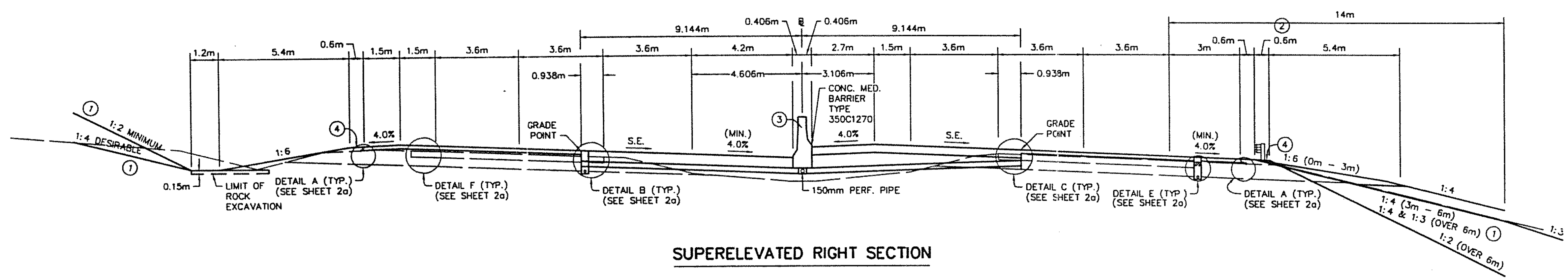
CONCRETE MEDIAN BARRIER TYPE 350C1270

** CONSTRUCTION JOINT PERMITTED WHEN FIXED FORMS OR SLIP FORMS USED. WHEN CONSTRUCTION JOINT USED, NO. 8 DOWEL BARS SPACED 1220mm O.C. AND STAGGERED 610mm WILL BE REQUIRED.

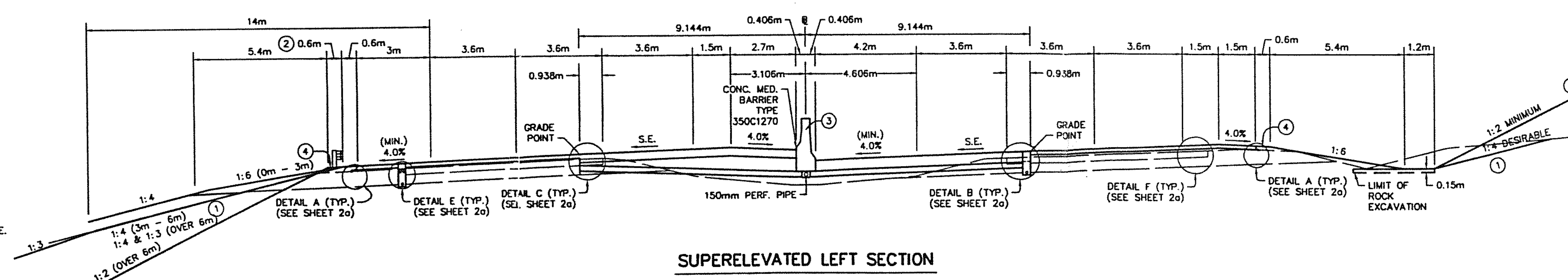
1. SEE CROSS-SECTIONS FOR SLOPES OUTSIDE THE LIMITS OF THE SHOULDER.
2. SHOULDER SHALL BE WIDENED 0.6m WHERE GUARDRAIL IS TO BE INSTALLED.
3. CONCRETE MEDIAN BARRIER WALL UTILIZED IN THE PERMANENT INSTALLATION INCLUDES TYPE 350C50, TYPE 350C1, & TYPE 350C. SEE PLANS FOR ACTUAL LIMITS. SEE DETAIL FOR BARRIER WALL AT MEDIAN BRIDGE PIERS.
4. BITUMINOUS SEAL REQUIRED FROM OUTSIDE EDGE OF PAVED SHOULDER TO A POINT 0.6m DOWN THE DITCH OR FILL SLOPE. TWO APPLICATIONS OF THE FOLLOWING:
   EMULSIFIED ASPHALT RS-2
   BITUMINOUS SEAL AGGREGATE



NORMAL SECTION



SUPERELEVATED RIGHT SECTION

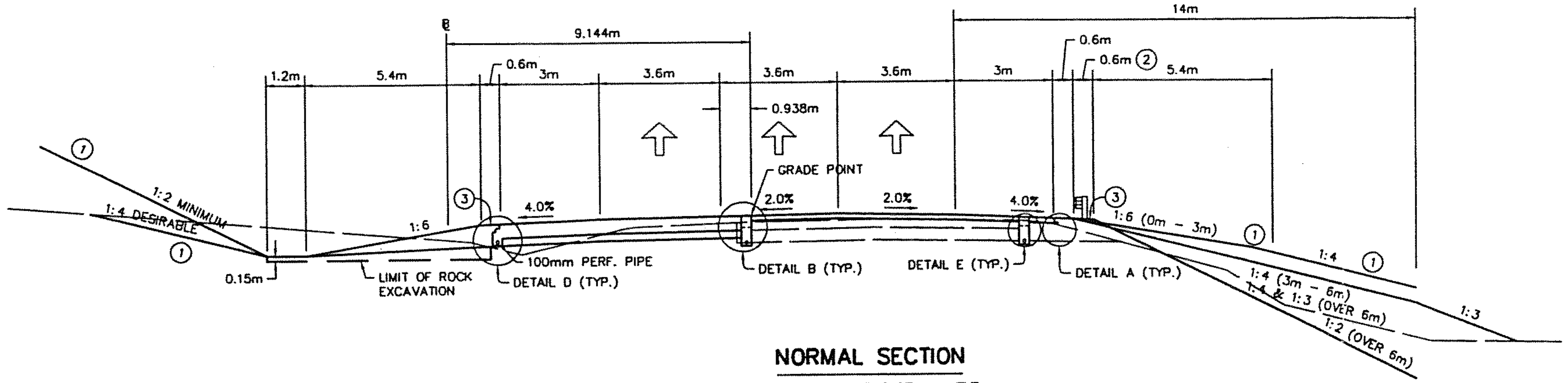


SUPERELEVATED LEFT SECTION

NOTE: SEE SHEET 2A FOR PAVEMENT SCHEDULE

COUNTY OF	FISCAL YEAR	SHEET NO.
GRANT	1998	2a

TYPICAL SECTIONS



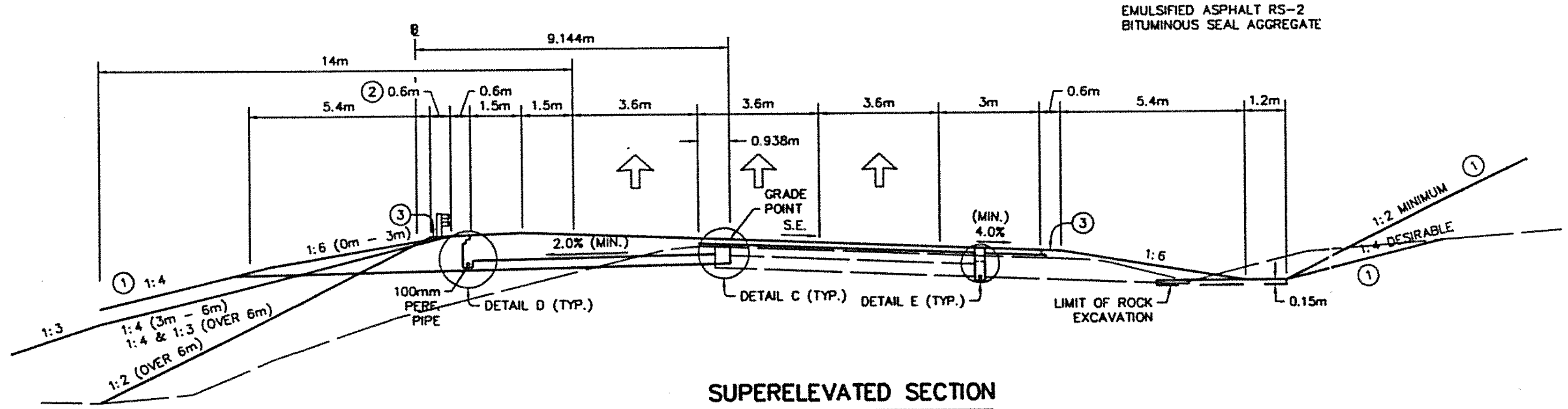
NORMAL SECTION
NORTH BOUND I-75

(1) SEE CROSS-SECTIONS FOR SLOPES OUTSIDE THE LIMITS OF THE SHOULDER.

(2) SHOULDER SHALL BE WIDENED 0.6m WHERE GUARDRAIL IS TO BE INSTALLED.

(3) BITUMINOUS SEAL REQUIRED FROM OUTSIDE EDGE OF PAVED SHOULDER TO A POINT 0.6m DOWN THE DITCH OR FILL SLOPE. TWO APPLICATIONS OF THE FOLLOWING:

EMULSIFIED ASPHALT RS-2
BITUMINOUS SEAL AGGREGATE



SUPERELEVATED SECTION
NORTH BOUND I-75

MAINLINE

NEW CONSTRUCTION: GRADE, DRAIN, & FLEXIBLE PAVEMENT
-USING-

TRAFFIC LANES

175mm DENSE GRADED AGGREGATE BASE
BITUMINOUS CURING SEAL (APPLY
100mm DRAINAGE BLANKET TYPE II - ASPHALT
276mm BIT. CONC. BASE CLASS "CI" (100mm + 88mm + 88mm COURSES)
38mm BIT. CONC. SURFACE CLASS "AK" SHLD.
BIT. TACK COAT BETWEEN COURSES (APPLY

SHOULDERS

FULL DEPTH DENSE GRADED AGGREGATE BASE
BITUMINOUS CURING SEAL (APPLY
179mm AVG. DEPTH DRAINAGE BLANKET TYPE II - ASPHALT
176mm BIT. CONC. BASE CLASS "CI" (88mm + 88mm COURSES)
38mm BIT. CONC. SURFACE CLASS "AK" SHLD.
BIT. TACK COAT BETWEEN COURSES (APPLY

GENERAL PAVING NOTES:

BITUMINOUS SEAL REQUIRED FROM OUTSIDE EDGE OF PAVED SHOULDER TO A POINT 0.6m DOWN THE DITCH OR FILL SLOPE. TWO APPLICATIONS OF THE FOLLOWING:
EMULSIFIED ASPHALT RS-2
BITUMINOUS SEAL AGGREGATE

FOR SUPERELEVATED SECTIONS, THE DRAINAGE BLANKET SHALL BE CONSTRUCTED TO PROVIDE POSITIVE DRAINAGE (2.0% OR GREATER) TO THE 100mm OR 150mm PERFORATED PIPE.

MATERIAL FROM THE REMOVAL OF THE EXIST. INSIDE SHOULDER MAY BE UTILIZED IN THE BOTTOM LIFT OF THE MEDIAN BACKFILL.

PAVEMENT WIDENING FOR EXTENSION OF TAPERS AT RAMP TERMINII SHALL BE THE SAME DESIGN SCHEDULE AS FOR THE ADDITION OF A FULL WIDTH TRAFFIC LANE.

EXIST. SHOULDERS THRU THE WIDENED OR NEW TRAFFIC LANE SHALL BE REMOVED AND REPLACED WITH THE NEW SHOULDER DESIGN.

THE CONTRACTOR HAS THE OPTION OF PROVIDING BIT. CONC. SURFACE CLASS AK/A IN LIEU OF CLASS AK/S FOR SHOULDER PAVING AT THE CONTRACT UNIT BID PRICE FOR CLASS AK/S.

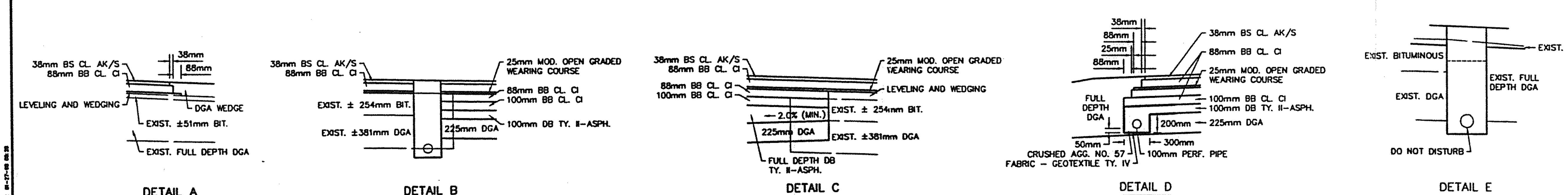
BITUMINOUS CURING SEAL MAY BE ANY OF THE FOLLOWING MATERIALS: RS-1, AE-60, SS-1, SS1-h, CRS-1, CSS-1, CSS-Ih, OR PRIMER L.

SAND FOR BLOTTING MAY BE REQUIRED BY THE ENGINEER TO CONTROL TRACKING OF THE BITUMINOUS CURING SEAL. NO DIRECT PAYMENT WILL BE ALLOWED FOR THIS WORK.

ALL EXIST. OPEN GRADED FRICTION COURSE THAT IS RAVELLED SHALL BE MILLED AS DIRECTED BY THE ENGINEER PRIOR TO THE PLACEMENT OF THE LEVELING AND WEDGING COURSE.

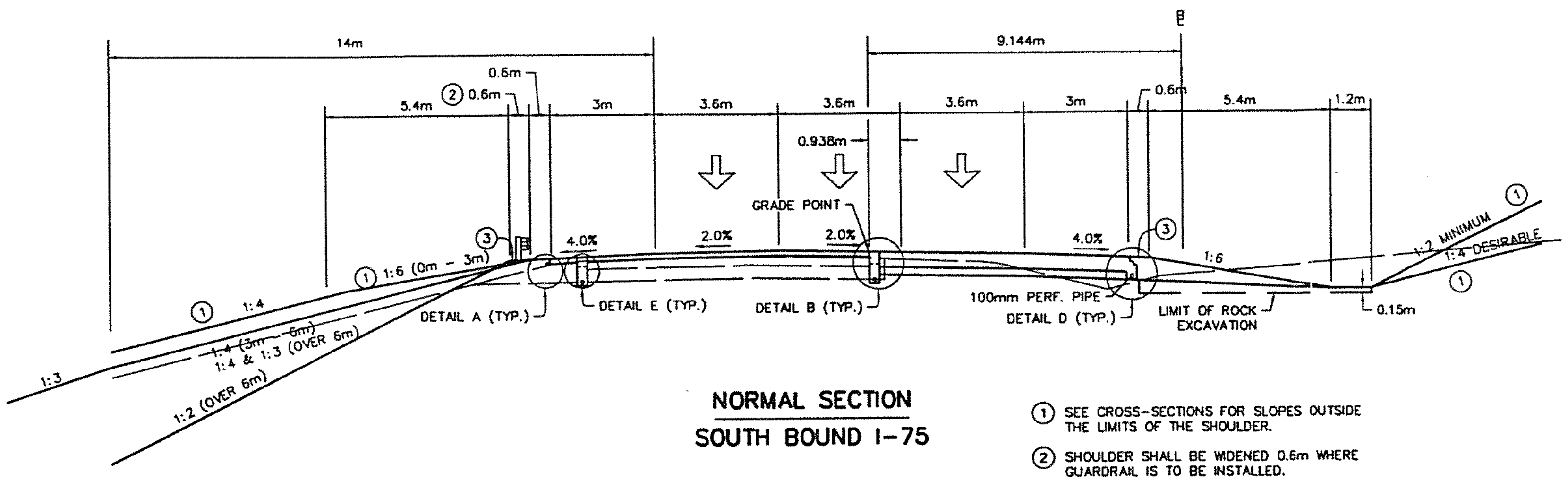
THE SURFACE COURSE AND THE TOP BASE COURSE OF THE TRAFFIC LANES SHALL BE MODIFIED WITH A RUT LESSENING MODIFIER. THE RUT LESSENING MODIFIER SHALL BE PMAC-1D. SEE PROPOSAL FOR MORE DETAILS.

FABRIC AND THE SIZE NO. 57 AGGREGATE SHALL BE INCIDENTAL TO THE PERFORATED PIPE.



COUNTY OF	FISCAL YEAR	SHEET NO.
GRANT	1998	2b

TYPICAL SECTIONS



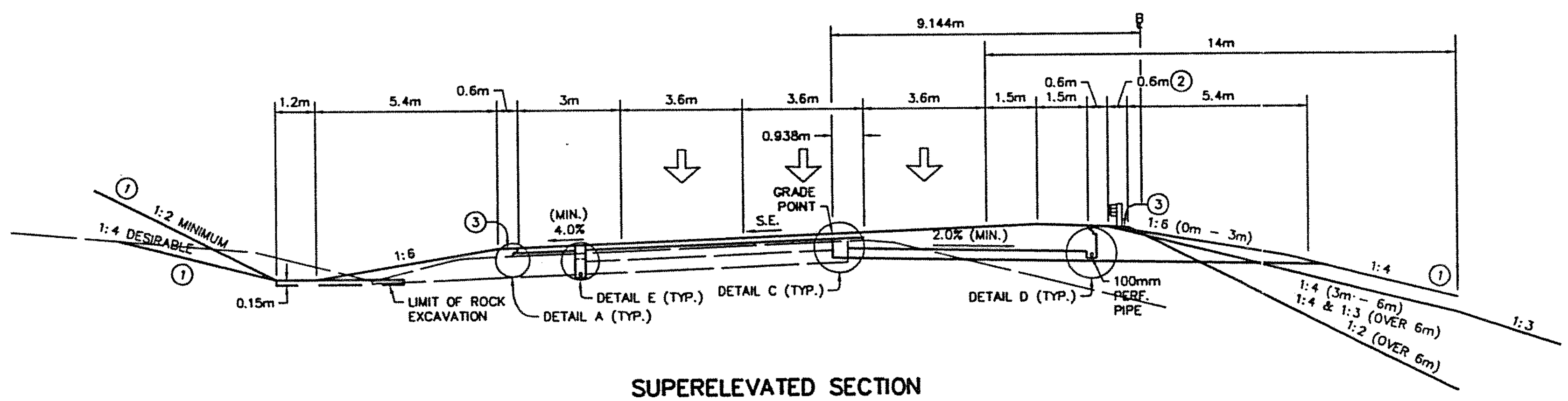
NORMAL SECTION
SOUTH BOUND I-75

① SEE CROSS-SECTIONS FOR SLOPES OUTSIDE THE LIMITS OF THE SHOULDER.

② SHOULDER SHALL BE WIDENED 0.6m WHERE GUARDRAIL IS TO BE INSTALLED.

③ BITUMINOUS SEAL REQUIRED FROM OUTSIDE EDGE OF PAVED SHOULDER TO A POINT 0.6m DOWN THE DITCH OR FILL SLOPE. TWO APPLICATIONS OF THE FOLLOWING:

EMULSIFIED ASPHALT RS-2
BITUMINOUS SEAL AGGREGATE



SUPERELEVATED SECTION
SOUTH BOUND I-75

MAINLINE

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-USING-

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BIT. TACK COAT BETWEEN COURSES (APPLY

SHOULDERS

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BITUMINOUS CURING SEAL (APPLY
179mm AVG. DEPTH DRAINAGE BLANKET TYPE II – ASPHALT
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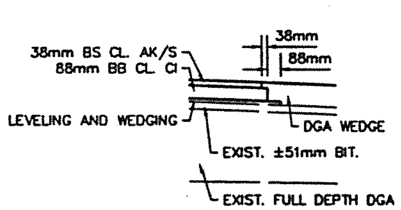
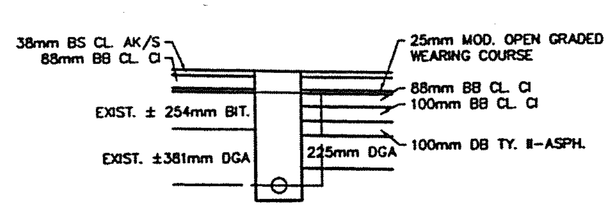
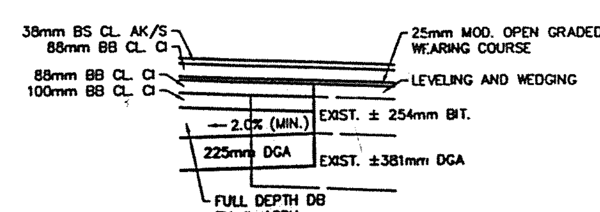


DETAIL A



DETAIL B



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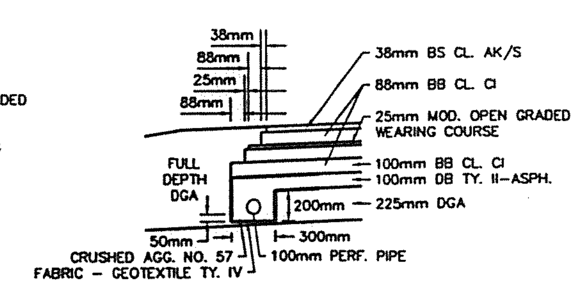
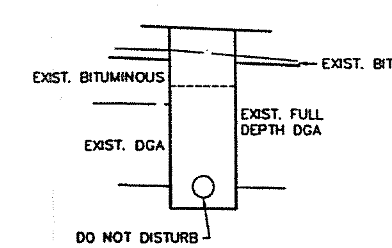


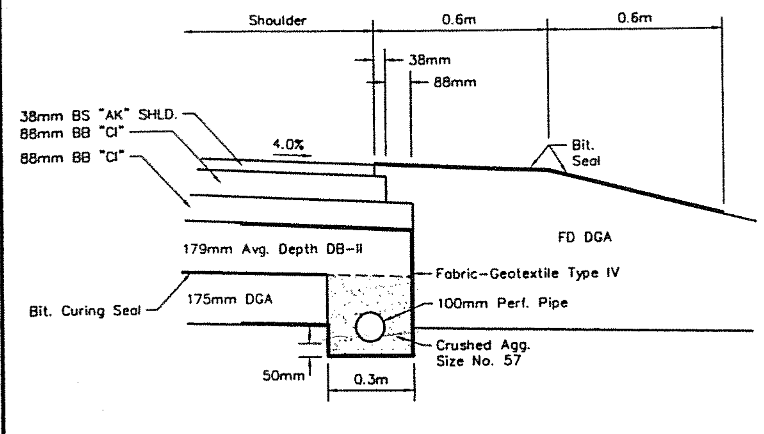
DETAIL D



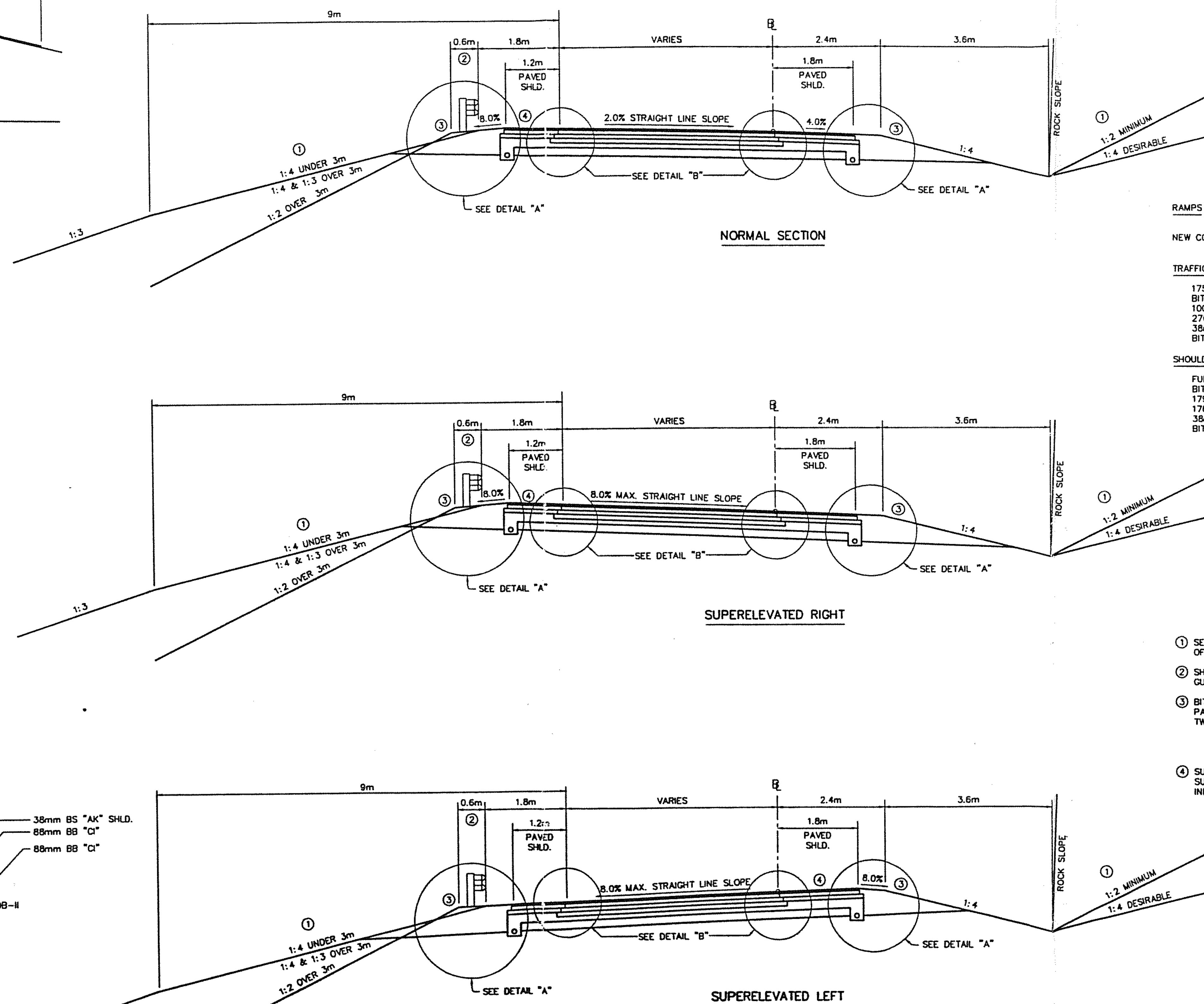
DETAIL E

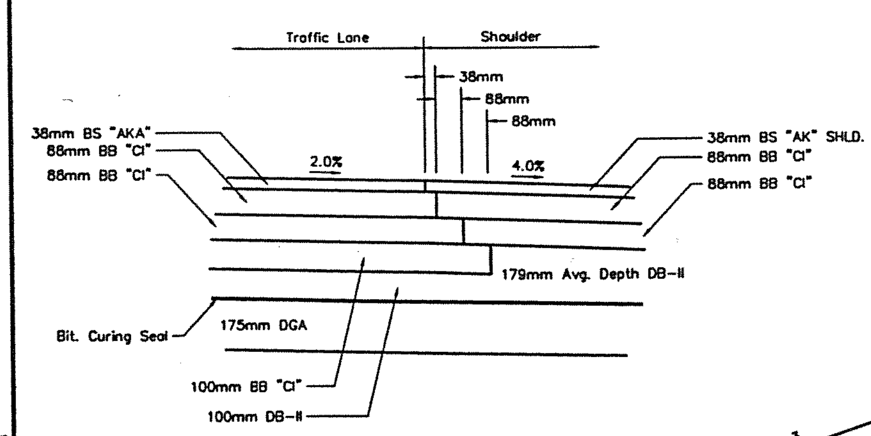
COUNTY OF	FISCAL YEAR	SHEET NO.
GRANT	1998	2c

TYPICAL SECTIONS
1-LANE RAMP



DETAIL "A"





DETAIL "B"

RAMPS

NEW CONSTRUCTION: GRADE, DRAIN, & FLEXIBLE PAVEMENT
-USING-

TRAFFIC LANES

175mm DENSE GRADED AGGREGATE BASE
BITUMINOUS CURING SEAL (APPLY
100mm DRAINAGE BLANKET TYPE II - ASPHALT
276mm BIT. CONC. BASE CLASS "CI" (100mm + 88mm + 88mm CO[...]
38mm BIT. CONC. SURFACE CLASS "AK" SHLD.
BIT. TACK COAT BETWEEN COURSES (APPLY

SHOULDERS

FULL DEPTH DENSE GRADED AGGREGATE BASE
BITUMINOUS CURING SEAL (APPLY
179mm AVG. DEPTH DRAINAGE BLANKET TYPE II - ASPHALT
176mm BIT. CONC. BASE CLASS "CI" (88mm + 88mm COURSES)
38mm BIT. CONC. SURFACE CLASS "AK" SHLD.
BIT. TACK COAT BETWEEN COURSES (APPLY

1. SEE CROSS SECTIONS FOR SLOPES OUTSIDE THE LIMITS OF THE SHOULDERS.
2. SHOULDER SHALL BE WIDENED 0.6m WHERE GUARDRAIL IS TO BE INSTALLED.
3. BITUMINOUS SEAL REQUIRED FROM OUTSIDE EDGE OF PAVED SHOULDER TO A POINT 0.6m DOWN THE DITCH OR FILL SLOPE. TWO APPLICATIONS OF THE FOLLOWING:

   EMULSIFIED ASPHALT RS-2
   BITUMINOUS SEAL AGGREGATE

4. SUPERELEVATED SHOULDERS, CONSTRUCT TO STANDARD SUPERELEVATION EXCEPT NOT FLATTER THAN SLOPES INDICATED FOR NORMAL SLOPES.

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IV. INVESTIGATION PHASE

INTERSTATE WIDENING PROJECTS PAVEMENT DESIGNS
V.E. STUDY BRIEFING
MARCH 23, 1998

NAME	AFFILIATION	PHONE
Jack Trickey	Ventry Engineering	850/627-3900
Carolyn Stonecipher	Ventry Engineering	850/627-3900
Blair Golden	Ventry Engineering	850/627-3900
Duncan Silver	Ventry Engineering	850/627-3900
Newton Jackson	Ventry Engineering	850/627-3900
Dudley Brown	FHWA	502/223-6479
Daryl Greer	Kentucky Transportation Cabinet	502/564-3280
Robert Semones	Kentucky Transportation Cabinet	502/564-3280
Joette Fields	Kentucky Transportation Cabinet	502/564-3280
Gary Sharpe	Kentucky Transportation Cabinet	502/564-3280
Dan Hite	Kentucky Transportation Cabinet	502/564-3280
Dave Allen	Kentucky Transportation Center	606/257-4513 ex250
Clark Graves	Kentucky Transportation Center	606/257-4513 ex248

PERSONS CONTACTED

NAME	AFFILIATION	PHONE
Bill Gulick	Kentucky Transportation Cabinet Design	502/564-3280
Rob Bostrom	Kentucky Transportation Cabinet Planning	502/564-7183

RESOURCE MATERIAL

1. I-75 Pavement Condition Forms
2. Derivation of Overlay Thickness (Culc's used in Tables, AASHTO "A" Coeff)
3. Kentucky Asphalt Design Curves
4. Comparison of Rigid Pavement Designs
5. R/CHRP 99 - Resurface of Portland Cement Concrete
6. Design Curves for AC overlay of Broken PCC
7. Typical Sections of Overlay and Widening Details
8. LCC Analysis of Interstate Widening
9. Typical Sections from Contract Plans on I-75 - 11" x 17"
10. Memo - Interstate MOT Brainstorming Ideas
11. Design Memo No. 5-98 Traffic Control Policy
12. I-65 pavement Condition Survey Forms
13. Typical Design Contract
14. I-75 Pavement Condition Summary Sheets
15. I-65 pavement Condition Summary Sheets
16. Interstate Widening Projects Matrix of Pavement Designs
17. Value Engineering Study Summary I-75 Widening Boon, Kenton, Grant Co. (6-16.00)
18. Value Engineering Study Summary I-75 Widening - KY36 to KY491 (6-72.00 & 6-72.01)
19. Memo - Phase I Design Concept for Interstate Widening
20. Policy for RRR Projects
21. FHWA Technical Advisory - Incentive/Disincentive
22. Design Procedure for Pavements
23. I-265 PCC Overlay Pavement Design
24. I-75 Break, Seat overlay with Asphalt Pavement Design
25. I-75 Traffic Forecast, ADT's 20 year ESAL's
26. I-75 Pavement Design Reconstruct Ramp with Asphalt
27. Unit Bid Prices 95-97

IV. SPECULATION PHASE

SPECULATION

Ideas generated, utilizing the brainstorming method, for performing the functions of previously identified areas of focus.

- Treat all subgrades having a CBR value of 6 or less in the areas where widening is planned.

- Design the widening for the ESAL lane assignment recognizing the truck distribution across the 3 and 4 lanes in each direction, i.e. right lane 60% trucks, left lane (median) 5% trucks (approx. 10% of ESAL's shown on the table)

- Fine tune the layer treatments to only provide the required SN using the most cost efficient materials.

- Stage the initial asphalt construction to only provide the pavement structure required for the immediate 10 year design loadings (ESAL's) and then design the periodic rehabilitation for the next 10 year forecasted ESAL's.

VI. EVALUATION PHASE

VI.(a) ALTERNATIVES

ALTERNATIVES

Value Engineering Alternative No. 1 - Treat all subgrades having a CBR value of 6 or less in the areas where widening is planned.

Value Engineering Alternative No. 2 - Design the widening for the ESAL lane assignment recognizing the truck distribution across the 3 and 4 lanes in each direction, i.e. right lane 60% trucks, left lane (median) 5% trucks (approx. 10% of ESAL's shown on the table)

Value Engineering Alternative No. 3 - Fine tune the layer treatments to only provide the required SN using the most cost efficient materials.

Value Engineering Alternative No. 4 - Stage the initial asphalt construction to only provide the pavement structure required for the immediate 10 year design loadings (ESAL's) and then design the periodic rehabilitation for the next 10 year forecasted ESAL's.

VI.(b) ADVANTAGES AND DISADVANTAGES

EVALUATION

The following Advantages and Disadvantages were developed for the Value Engineering Alternatives previously generated during the speculation phase.

1. GENERAL

Value Engineering Alternative No. 1 - Treat all subgrade having a CBR value of 6 or less in the areas where widening is planned.

Advantages

- reduces the thickness of the required pavement section
- provides long term stability to the pavement
- provides a more uniform subgrade throughout the corridor
- consistent with KYTC practices in new construction (see appendix)

Disadvantages

- adds construction time due to the curing period of the treated subgrade
- requires use of specialized equipment to construct
- the structural benefits are not fully captured due to the overlay design thickness being based on the existing pavement

Conclusion

Carry forward for further consideration

Value Engineering Alterative No. 2 - Design the widening for ESAL.s based on lane assignments recognizing truck distribution across the pavement, i.e. right lane 60% truck, left lane 5% trucks on 6 & 8 lane sections (approx. 10% of ESAL's shown on the table).

Advantages

- reduces the required pavement section
- reflects actual load demands

Disadvantages

- None

Conclusion

Carry forward for further consideration

Value Engineering Alternative No. 3 - Fine tune the layer treatments to only provide the required SN using the most cost efficient materials.

Advantages

- allows for more cost effective use of paving materials
- increases the drainability due to the greater use of permeable material
- reduces the number of layers required
- reduces the amount of subgrade excavation required for widening in two cases (2A and 4B)
- more defensible than using full SN's

Disadvantages

- use of 10" DB requires extra effort during construction

Conclusion

Carry forward for further evaluation

Conclusion

Value Engineering Alternative No. 4 - Stage the asphalt construction to only provide the initial pavement structure required for the immediate 10 year ESAL,s and then design the periodic rehabilitation for the 10 year forecasted ESAL's.

Advantages

- reduces initial cost
- allows for the rehabilitation design based on current traffic projections and existing pavement conditions
- eliminates one milling operation from the future rehabilitation program

Disadvantages

- may increase the potential for rutting due to the construction of two layers of dense asphalt mix
- adds an additional ½ " of asphalt to the 40 year pavement structure

Conclusion

Drop from further consideration

Example:

DUE TO THE NUMBER OF CELLS CONTAINED IN THE CATALOG (144), THE VALUE ENGINEERING TEAM CHOSE TO ONLY COMPARE THE DESIGN FOR EACH MATERIAL USING A CBR 7 AND 50 X 10^6 ESAL'S. IT WAS FELT THIS EXAMPLE WOULD BE THE MOST PREVALENT FOUND, IF IT WAS AGREED TO TREAT ALL SUBGRADE HAVING A CBR LESS THAN 6. ALL OF THE FOLLOWING EVALUATION PHASE AND THE DEVELOPMENT PHASE ARE BASED ON THIS COMPARISON.

REQUIRED OVERLAY THICKNESS

CBR	2	4	7	11
ESAL'S	"A" DIMENSIONS			
30×10^6	12"	11"	8.5"	7"
50×10^6	13"	12"	9.5"	8"
70×10^6	14"	13"	10.5"	9"

TYPICAL ASPHALT OVERLAY DIMENSIONS DETAIL "1A"

ASSUMING THAT THE PREVIOUS VALUE ENGINEERING ALTERNATIVES 1, 2,& 3 ARE FEASIBLE, THE VALUE ENGINEERING TEAM EVALUATED THE PAVEMENT DESIGNS FROM EACH OF THE CASES 1-4 USING THE FOLLOWING ASSUMPTIONS:

CASE COMPARISONS BASED ON 10,000,000 ESAL's FOR THE WIDENING IN THE MEDIAN, 50,000,000 ESAL's FOR THE OVERLAY, SUBGRADE CBR 7, AND A REQUIRED SN OF 6.94 FOR THE OVERLAY AND 5.04 FOR THE WIDENING

DETAIL 1A

VALUE ENGINEERING ALTERNATIVE

OVERLAY - No Change

WIDENING - USE 6" DGA, 10" DB, 4" CK, 4"CI, 1 ½"AK/A

Advantages
- meets the required SN...based on reductions in ESAL's calculated by applying lane distribution
- greatly increases the drainability of the pavement structure
- conservative design for $10x10^6$ EASL's due to constraints of matching the depth of the existing pavement
- substitutes lower cost materials for higher cost materials

Disadvantages
- constructability - requires more attention when laying DB layers

Conclusion
Carry forward for further consideration

DETAIL 2A

VALUE ENGINEERING ALTERNATIVE

OVERLAY - mill 1 ½ " asphalt, overlay with 4" CI, 1 ½" AK/A

Advantages
- milling allows for removal of dense graded surface course from pavement structure and replaces it with larger stone mix
- allows for compliance of base layer with KY specs for layer thickness
- milling allows for correcting the cross slope without use of an asphalt wedge

Disadvantages

- overlay treatment cost more than proposed design

WIDENING - Match existing depth of DGA, use 8 ½ - 9 ¾" drainage blanket, 4" CI and 1 ½" AK/A

Advantages

- reduces total depth of widening
- eliminates DGA table
- matches existing subgrade elevation
- meets required SN
- provides additional pavement drainage
- substitutes lower price material in pavement structure
- conservative design for $10x10^6$ ESAL's

Disadvantages

- increases cost of overlay section
- constructability - requires more attention when laying DB layers

Conclusion

Carry forward for further consideration

DETAIL 3A

Value Engineering Alternative

OVERLAY - Mill 3", overlay with a 4" CI and 1 ½"AK

Advantages

- allows for 1 ½ " reduction in profile grade
- milling allows for removal of top layers of existing pavement & replaces with larger stone mix
- allows for compliance with KY specs for layer thickness
- milling allows for correcting the cross slope without use of a asphalt wedge

Disadvantages

- constructability - use of untreated drainage blanket more difficult to construct than treated sections

WIDENING - Use 6"DGA, 9"DB, 2" Crushed Stone Base (choker), 3 ½"CK, 4"CI, 1 ½" AK

Advantages
- meets SN required
- increases drainability
- conservative design for $10x10^6$ ESAL's

Conclusion
Carry Forward for Further Consideration

DETAIL 4A

Value Engineering Alternative

OVERLAY - mill off the existing 4" of asphalt, break and seat the 10" PCC and overlay with 4"CK, 4"CI, 1 ½ " AK/A

Advantages
- increases the long term performance of pavement section
- milling allows for correcting the X-slope without using a asphalt wedge
- reduces maintenance effort expected from reflective cracking
- consistent with treatment of other PCC in Ky

Disadvantages
- requires additional 5" of more asphalt mix
- requires additional cost and time for break and seating operations
- requires additional milling
- obvious increase in first cost

WIDENING- USE 6" DGA, 10" DB, 4" CK, 4"CI, 1 ½"AK/A

Advantages
- meets the required SN...based on reductions in ESAL's calculated by applying lane distribution
- greatly increases the drainability of the pavement structure
- conservative design for $10x10^6$ EASL's due to constraints of matching the depth of the existing pavement
- substitutes lower cost materials for higher cost materials

Disadvantages
- constructability - requires more attention when laying DB layers

Conclusion
Carry forward for further consideration

DETAIL 1B

Value Engineering Alternative

OVERLAY - No Change

WIDENING - Use 6"DGA, 10"DB(type 2), 1 ½" Bond Breaker, 8" PCC overlay

Advantages
- increased drainability
- allows for lower cost material to be substituted for higher cost material

Disadvantages
- constructability...treated drainage blanket requires more attention to lay than higher type asphalt layers

Conclusion
Carry Forward for Further consideration

DETAIL 2B

Value Engineering Alternative

OVERLAY - No Change

WIDENING - Use 15" DGA, 10" DB(type 2), 8" PCC overlay

Advantages
- increased drainability
- allows for lower cost material to be substituted for higher cost material

Disadvantages
- constructability...treated drainage blanket requires more attention to lay than higher type asphalt layers

Conclusion
Carry Forward for Further consideration

DETAIL 3B

Value Engineering Alternative

OVERLAY - mill 3 ½" and overlay with 8" PCC

Advantages
- lowers profile grade by 3 ½"
- lowers thickness of matched widened section
- milling allows for correcting the cross slope without using a asphalt wedge.

Disadvantages
- additional cost of milling
- constructability of drainage blanket requires additional attention

WIDENING - Use 6" DGA, 10" DB(type 2), 4" CI, 8" PCC overlay

Advantages
- increased drainability
- substitution of lower cost materials for higher cost materials
- less thickness - due to thickness - due to thickness required to match existing

Disadvantages
- constructability of drainage blanket requires additional attention

Conclusion
Carry Forward for Further consideration

DETAIL 4B

Value Engineering Alternative

OVERLAY - No change

WIDENING - Use 6" DGA, 10" DB, 4" CI, 8" PCC

Advantages
- increased drainability
- substitution of lower cost materials

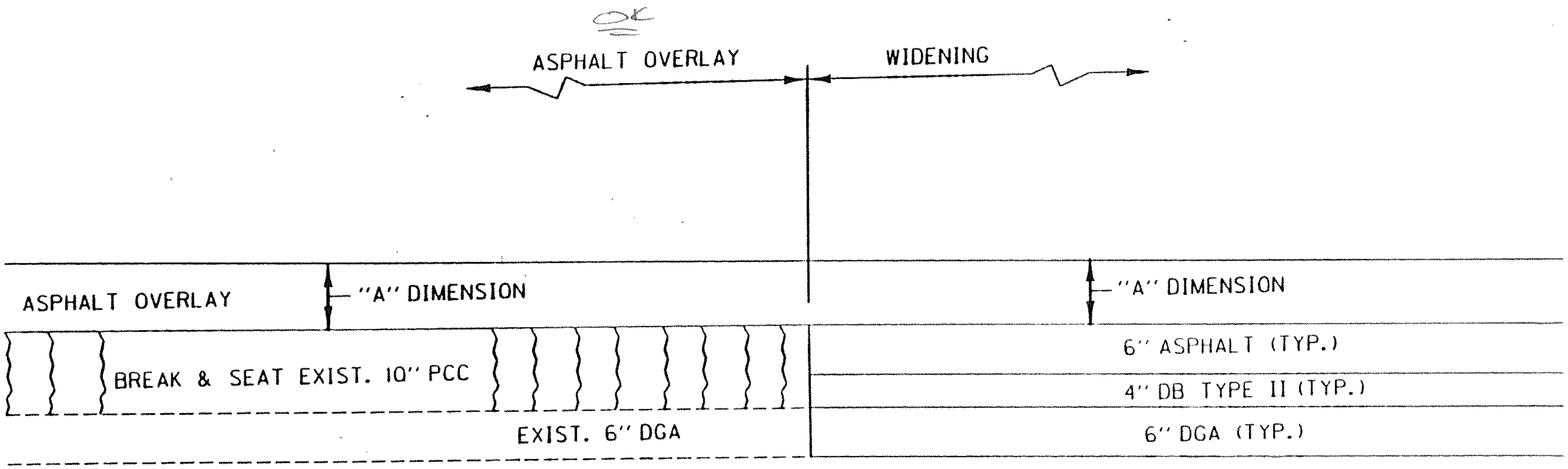
Disadvantages
- construction of drainage blanket requires more attention when applying thick layers

Conclusion
Carry Forward for Further consideration

VII. DEVELOPMENT PHASE

VII.(A) PAVEMENT SELECTION CATALOG

VII.(A)(1) AS PROPOSED

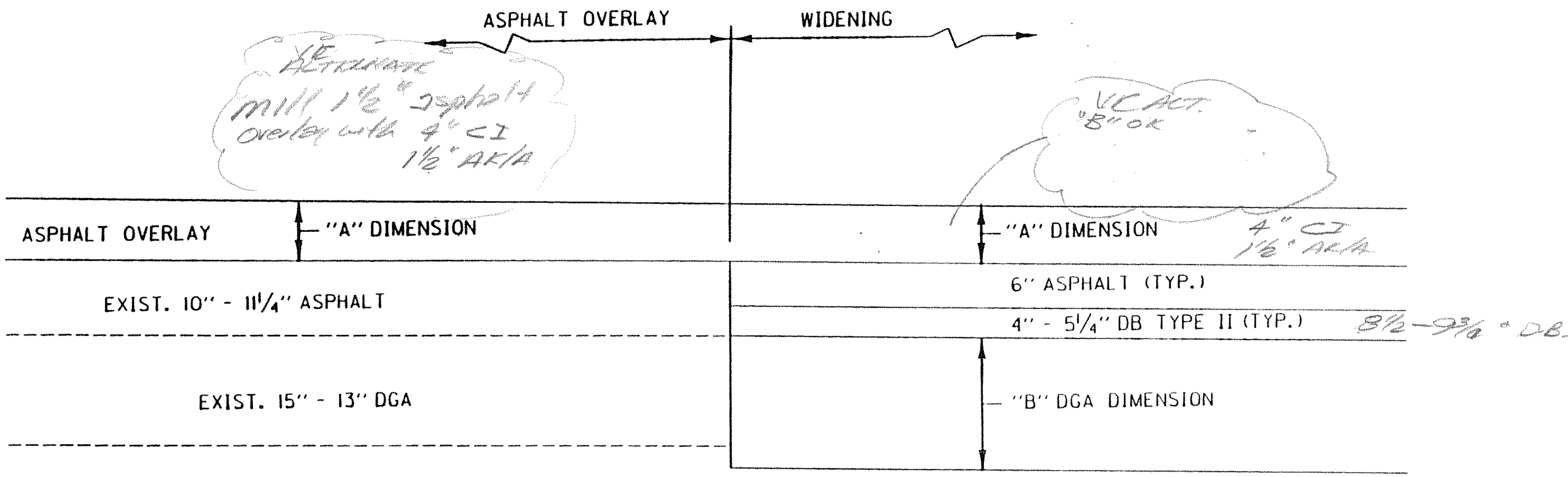


REQUIRED OVERLAY THICKNESS

CBR	2	4	7	11
ESAL'S	"A" DIMENSIONS			
30×10^6	12"	11"	8.5"	7"
50×10^6	13"	12"	9.5"	8"
70×10^6	14"	13"	10.5"	9"

TYPICAL ASPHALT OVERLAY DIMENSIONS
DETAIL "1A"

AS PROPOSED



REQUIRED OVERLAY THICKNESS

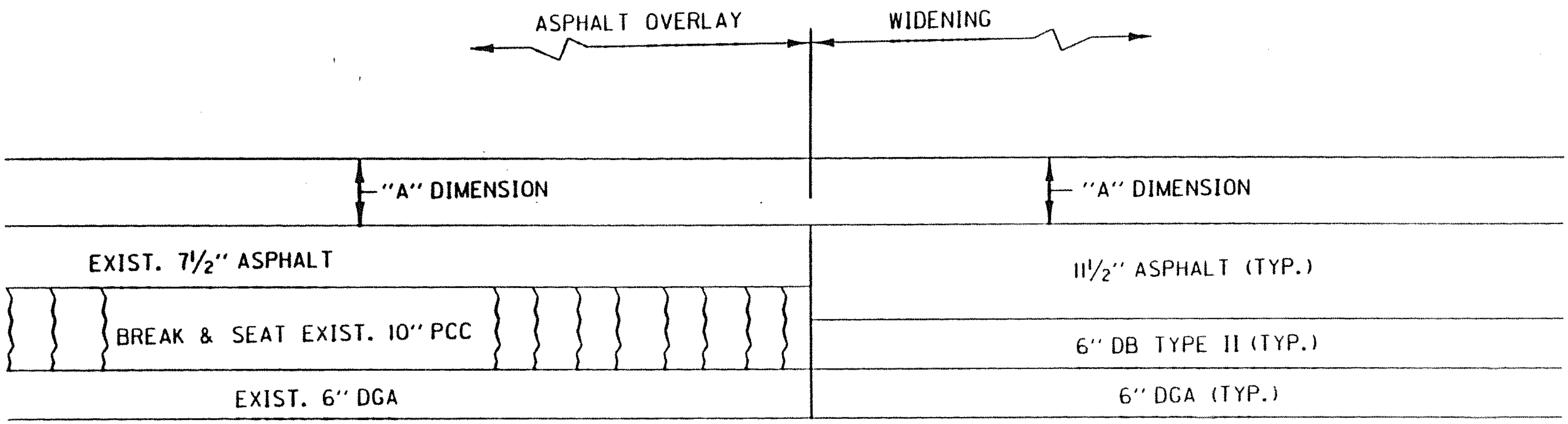
CBR	2	4	7	11
ESAL'S	"A" DIMENSIONS			
30x10⁶	5.5"	4"	2"	1.5"
50x10⁶	6.5"	5"	4"	1.5"
70x10⁶	7.5"	6"	5"	4"

REQUIRED DGA THICKNESS

CBR	2	4	7	11
ESAL'S	"B" DIMENSIONS			
30x10⁶	~~16"~~ 17"		~~17"~~ 16"	
50x10⁶	~~17"~~ 18"		~~18"~~ 17"	
70x10⁶	18"			

TYPICAL ASPHALT OVERLAY DIMENSIONS DETAIL "2A"

AS PROPOSED



REQUIRED OVERLAY THICKNESS

CBR	2	4	7	11
ESAL'S	"A" DIMENSIONS			
30×10^6	6.0"	4.5"	3.0"	1.5"
50×10^6	6.5"	5.5"	3.5"	2.0"
70×10^6	7.5"	6.5"	4.5"	3.0"

TYPICAL ASPHALT OVERLAY DIMENSIONS
DETAIL "3A"

AS PROPOSED

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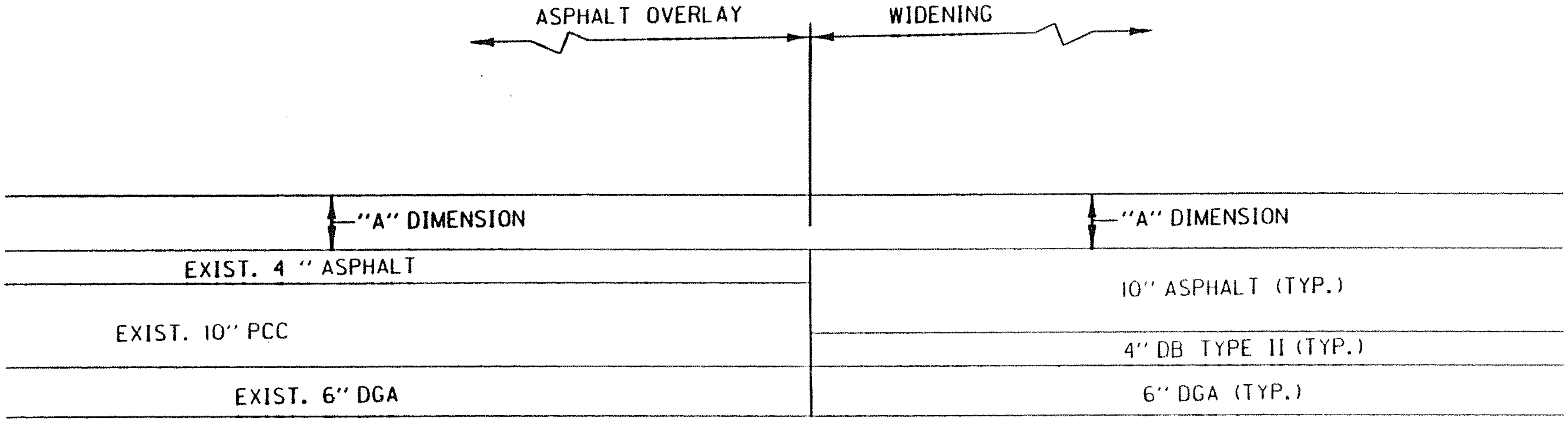

REQUIRED OVERLAY THICKNESS

CBR	2	4	7	11
ESAL'S	"A" DIMENSIONS			
30×10^6	6.0"	4.5"	3.0"	3.0"
50×10^6	7"	5.5"	4.0"	4.0"
70×10^6	8"	6.5"	5.0"	5.0"

TYPICAL ASPHALT OVERLAY DIMENSIONS DETAIL "4A"

AS PROPOSED

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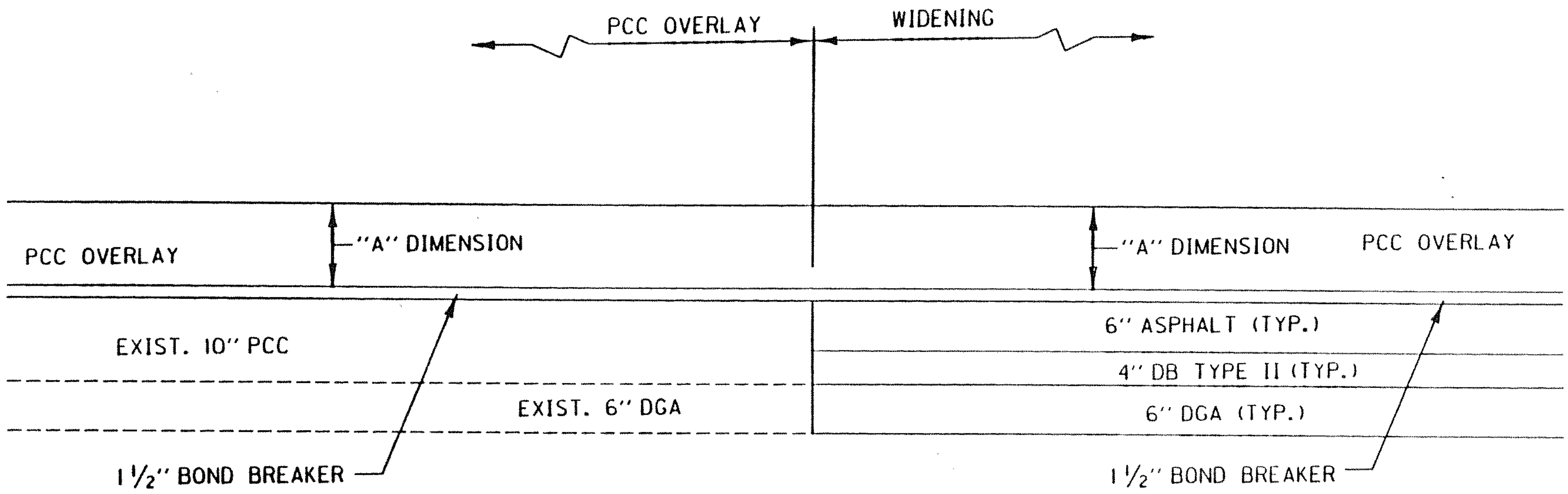

REQUIRED OVERLAY THICKNESS

CBR	2	4	7	11
ESAL'S	"A" DIMENSIONS			
30×10^6	10"	9"	8"	
50×10^6	11"	10"		
70×10^6	12"	11"	10"	

TYPICAL PCC OVERLAY DIMENSIONS DETAIL "1B"

AS PROPOSED

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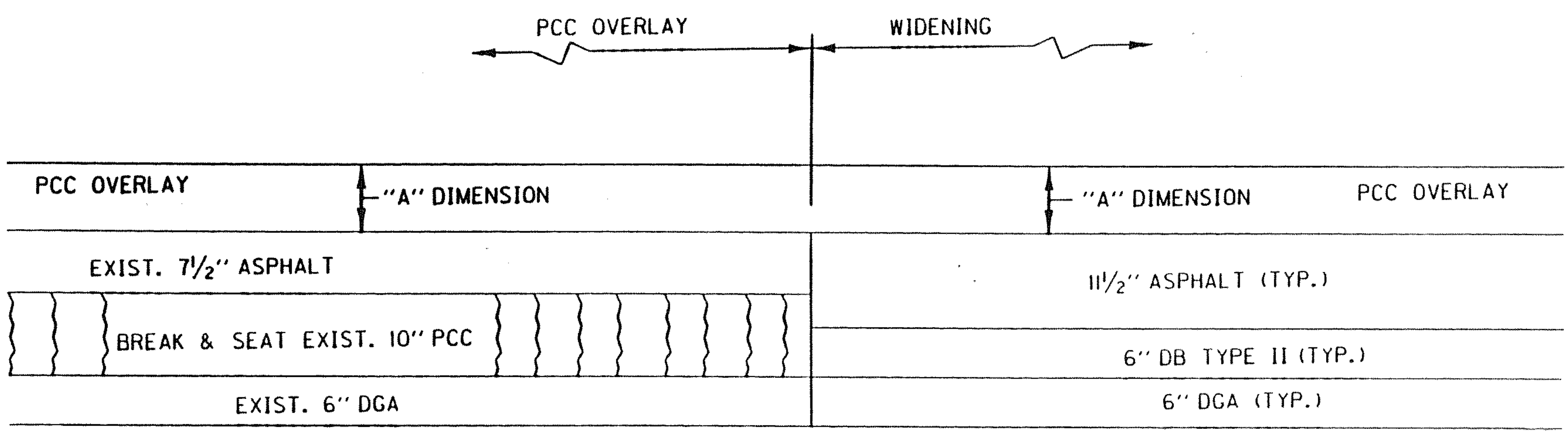

REQUIRED OVERLAY THICKNESS

CBR	2	4	7	11
ESAL'S	"A" DIMENSIONS			
30×10^6	8"		8"	
50×10^6	9"			
70×10^6	10"			

TYPICAL PCC OVERLAY DIMENSIONS DETAIL "3B"

AS PROPOSED

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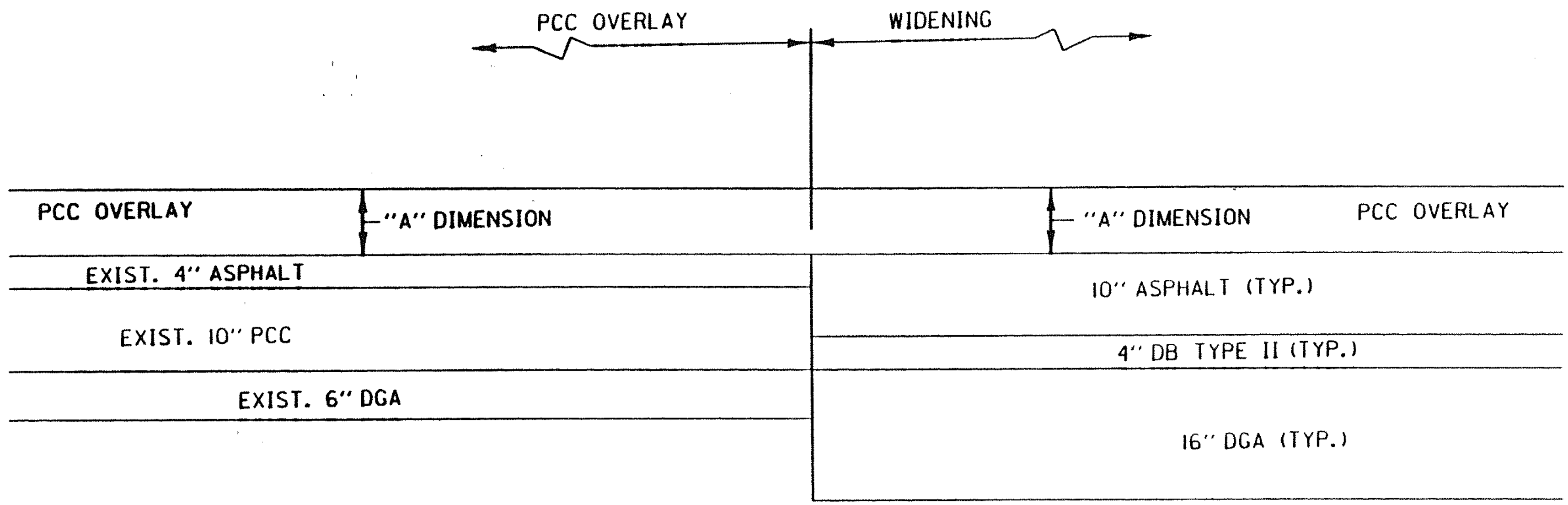

REQUIRED OVERLAY THICKNESS

CBR	2	4	7	11
ESAL'S	"A" DIMENSIONS			
30×10^6	8"		8"	
50×10^6	9"			
70×10^6	10"			

TYPICAL PCC OVERLAY DIMENSIONS DETAIL "4B"

AS PROPOSED

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SN Required

ESAL's	CBR=2	CBR=4	CBR=7	CBR=11
30	7.7	7.1	6.46	5.9
50	8.26	7.58	6.94	6.38
70	8.62	7.94	7.3	6.74

Alt "1A"

SN Provided (Widening Portion)

ESAL's	CBR=2	CBR=4	CBR=7	CBR=11
30	8.94	8.54	7.54	6.94
50	9.34	8.94	7.94	7.34
70	9.74	9.34	8.34	7.74

Alt "2A"

SN Provided (Widening Portion)

ESAL's	CBR=2	CBR=4	CBR=7	CBR=11
30	7.74	7.14	6.48	6.28
50	8.28	7.68	7.42	6.42
70	8.82	8.22	7.82	7.42

Alt "3A"

SN Provided (Widening Portion)

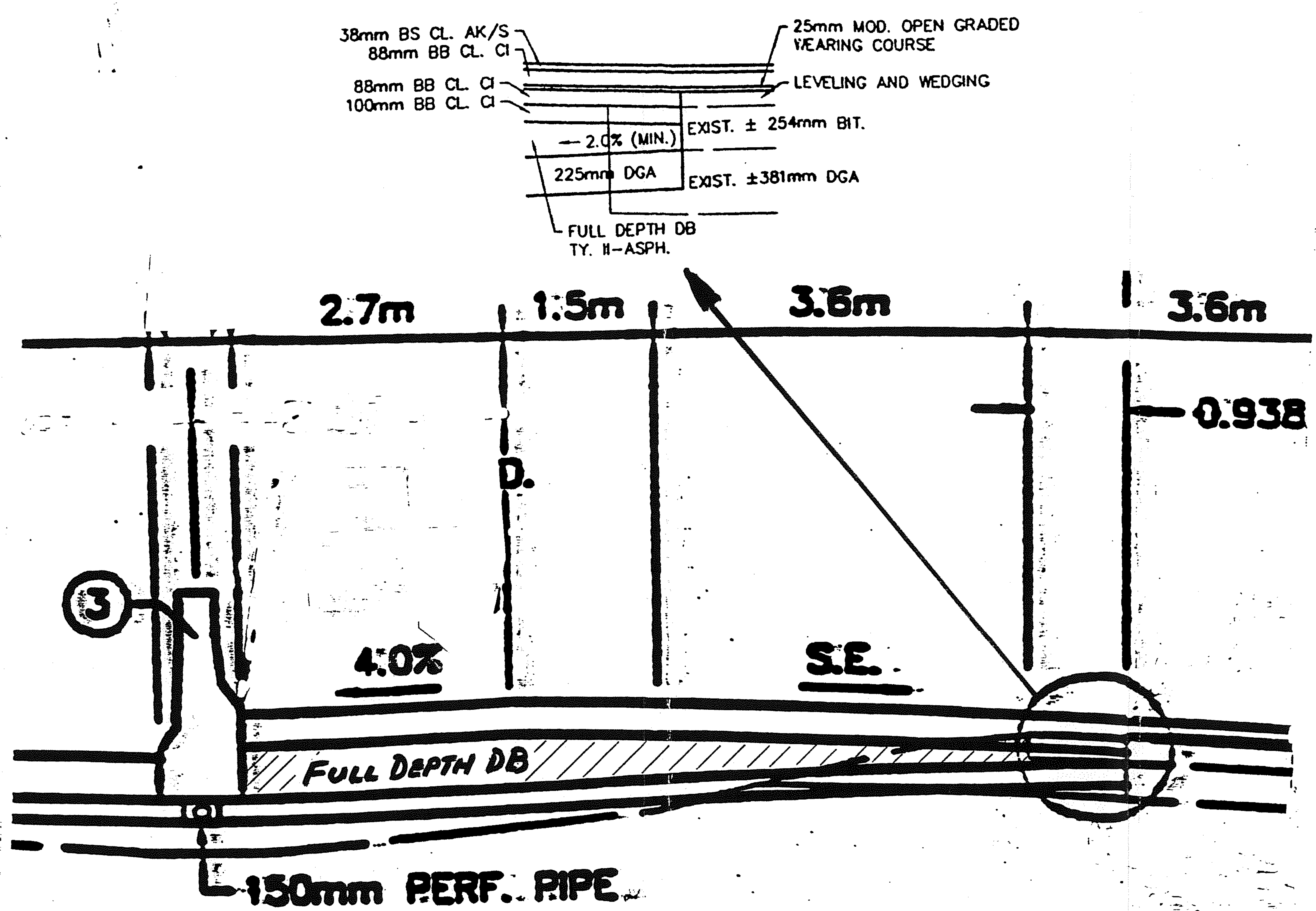
ESAL's	CBR=2	CBR=4	CBR=7	CBR=11
30	9.16	8.56	7.96	7.36
50	9.36	8.96	8.16	7.56
70	9.76	9.36	8.56	7.96

Alt "4A"

SN Provided (Widening Portion)

ESAL's	CBR=2	CBR=4	CBR=7	CBR=11
30	8.14	7.54	6.94	6.94
50	8.54	7.94	7.34	7.34
70	8.94	8.34	7.74	7.74

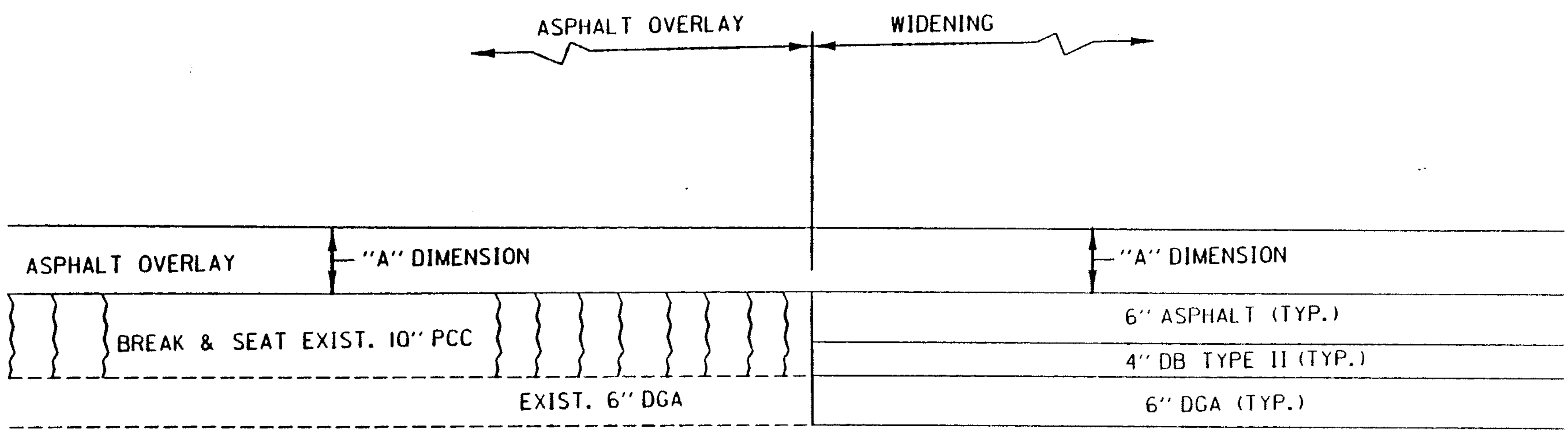
AS PROPOSED



Superelevated Section

AS PROPOSED

VII.(A)(2) V.E. ALTERNATIVES



Note: Check Table thickness, original design. Table Values appear high.

REQUIRED OVERLAY THICKNESS

CBR	2	4	7	11
ESAL'S	"A" DIMENSIONS			
30×10^6	12"	11"	8.5"	7"
50×10^6	13"	12"	9.5"	8"
70×10^6	14"	13"	10.5"	9"

VE Alternative — widening
"A"
10" Type II DB
6" DGA

Suggestion for High side of SE. Substitute DGA for DB.

TYPICAL ASPHALT OVERLAY DIMENSIONS
DETAIL "1A"

VALUE ENGINEERING ALTERNATIVE

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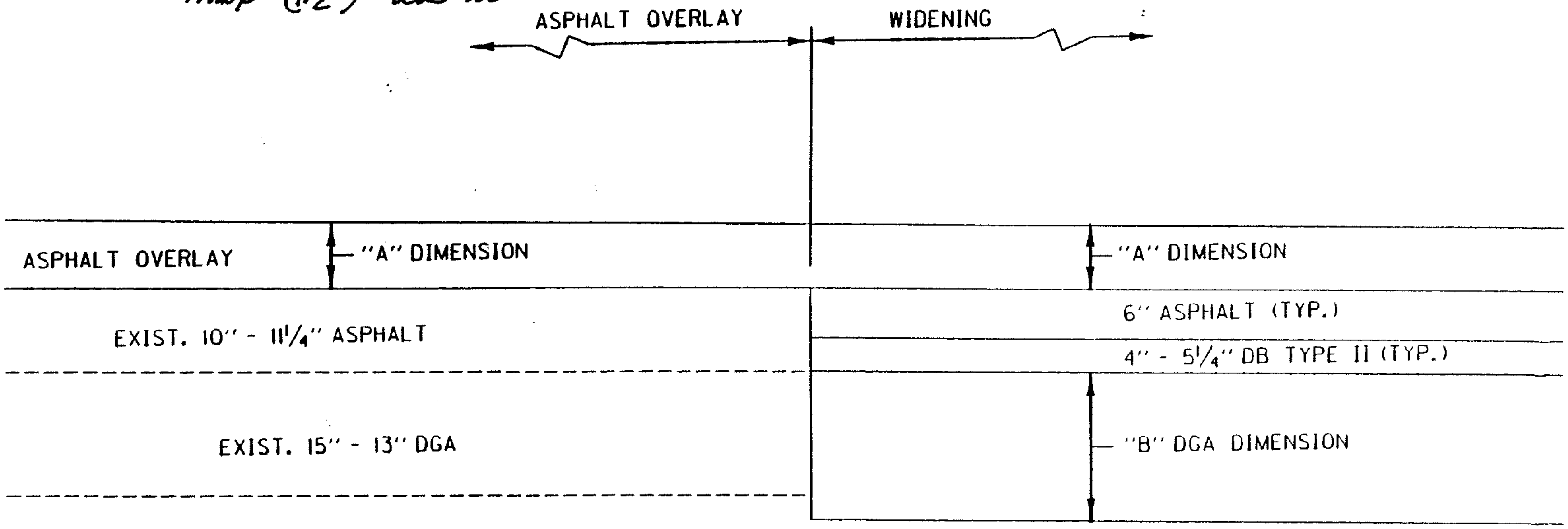
Note: Check ORIGINAL table overlay thickness. Appears too low. Appears that surface max (1½") was not taken into CONSIDERATION.

** SEE NEXT SHEET FOR VE Alternative



REQUIRED OVERLAY THICKNESS

CBR	2	4	7	11
ESAL'S	"A" DIMENSIONS			
30×10^6	5.5"	4"	2"	1.5"
50×10^6	6.5"	5"	4"	1.5"
70×10^6	7.5"	6"	5"	4"

REQUIRED DGA THICKNESS

CBR	2	4	7	11
ESAL'S	"B" DIMENSIONS			
30×10^6	16"		17"	
50×10^6	17"		18"	
70×10^6	18"			

TYPICAL ASPHALT OVERLAY DIMENSIONS
DETAIL "2A"

VALUE ENGINEERING ALTERNATIVE

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Detail "2A" Value Engineering Alternative

Asphalt Overlay

Mill 1½" Existing Asphalt

Overlay w/ "A" Dimensions Asphalt

Widening

"A"

8½" to 9¾" Asphalt Treated Drainage Blanket (Type II)

15" to 13" Dense Graded Aggregate (match existing) (eliminates need for DGA table)

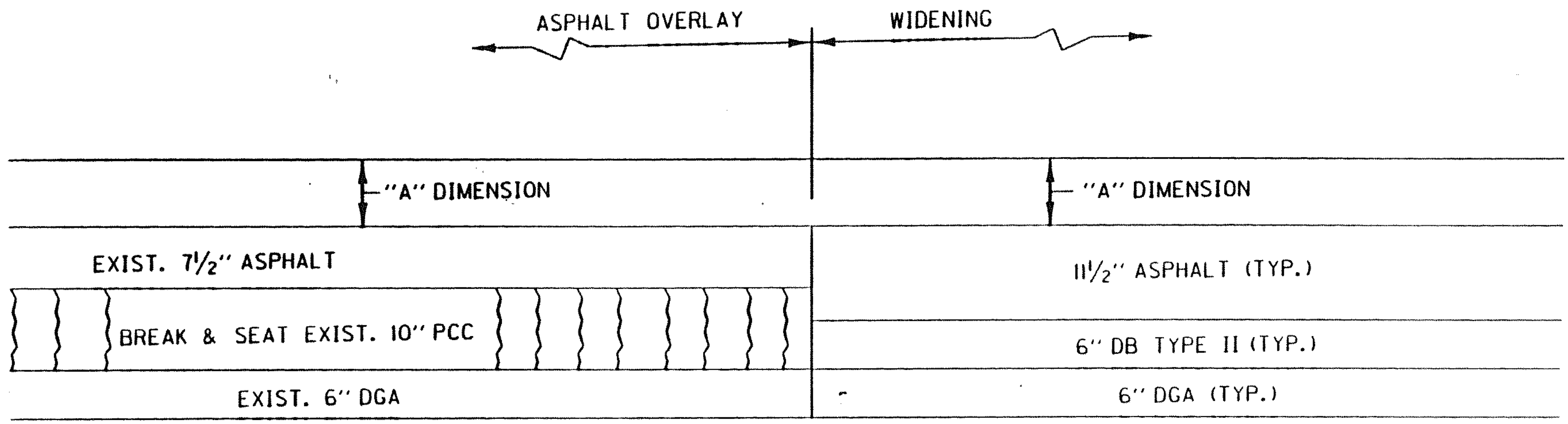
Suggestion for High side of SE - (widening)

SUBSTITUTE DGA FOR DRAINAGE BLANKET IN VE Alternative for widening. Subgrade treatment required for CBR < 4. (SE section only)

CBR	2	4	7	11
ESAL'S	"A" DIMENSIONS			
$30X10^6$	7.5	6.0	4.5	3.0*
$50X10^6$	9.0	7.5	5.5	4.5
$70X10^6$	10.0	8.0	6.5	5.0

* 4.5 unless a binder course is added.

** SEE Next sheet for VE Alternate.



Note:
Did not check orig. SN; for this table. Good idea to check.

REQUIRED OVERLAY THICKNESS

CBR	2	4	7	11
ESAL'S	"A" DIMENSIONS			
30×10^6	6.0"	4.5"	3.0"	1.5"
50×10^6	6.5"	5.5"	3.5"	2.0"
70×10^6	7.5"	6.5"	4.5"	3.0"

TYPICAL ASPHALT OVERLAY DIMENSIONS DETAIL "3A"

VALUE ENGINEERING ALTERNATIVE

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Detail "3A" Value Engineering Alternative

Asphalt Overlay

Mill 3" Existing Asphalt
overlay w/ "A"

Widening

A"
3½" CK Mix (Base)
2" Crushed Stone Base (choker)
9" Type I Drainage Base
6" DGA

Suggestion for High Side of SE - Widening

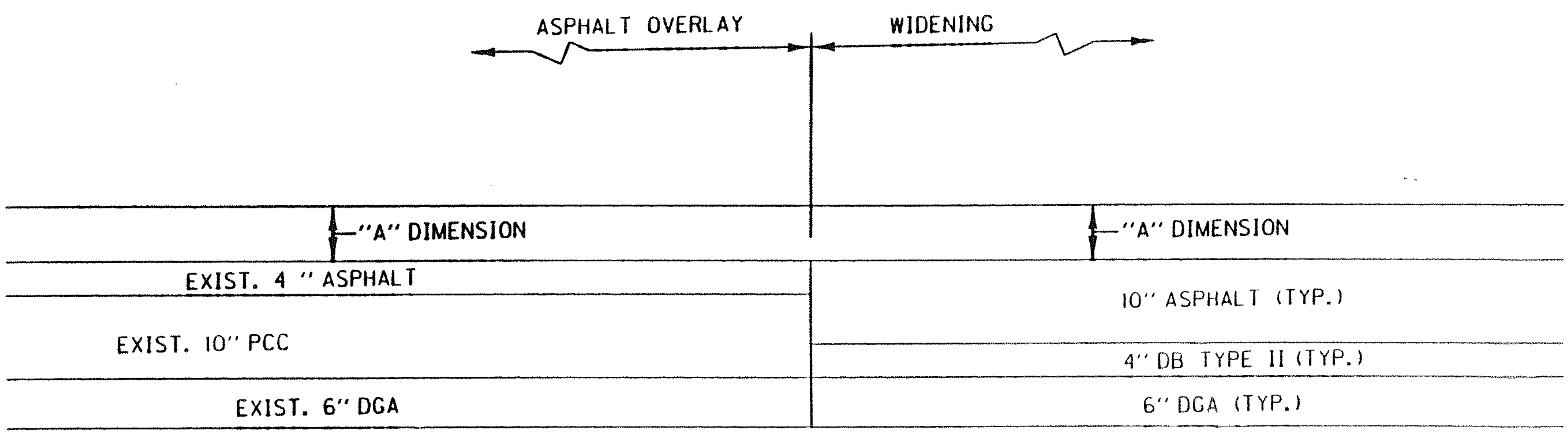
Substitute DGA for DB and CSB (Crushed stone base)

CBR	2	4	7	11
ESAL'S	"A" DIMENSIONS			
$30X10^6$	7.5"	6.0"	4.5"	3.0*
$50X10^6$	9.0"	7.0"	5.5"	4.5"
$70X10^6$	10.0"	8.0"	6.5"	5.0"

* 4.5" unless Binder Course is used.

Note: Very similar to table for Detail 1A VE Alt.

VALUE ENGINEERING ALTERNATIVE



V.E. Alternative:
Remove Exist. 4" Asphalt
and treat as Detail 1A.

REQUIRED OVERLAY THICKNESS

CBR	2	4	7	11
ESAL'S	"A" DIMENSIONS			
30×10^6	6.0"	4.5"	3.0"	3.0"
50×10^6	7"	5.5"	4.0"	4.0"
70×10^6	8"	6.5"	5.0"	5.0"

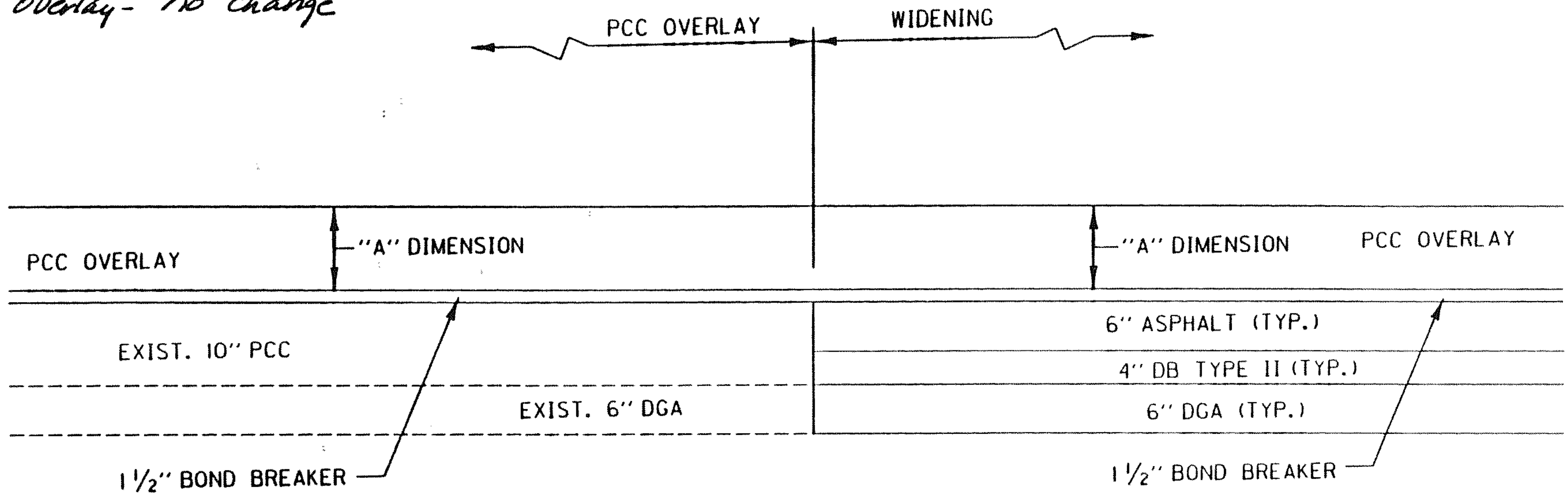
TYPICAL ASPHALT OVERLAY DIMENSIONS
DETAIL "4A"

VALUE ENGINEERING
ALTERNATIVE

c:\u\cstout\state175.dgn

c:\u\cstout\state175.dgn

overlay - no change



56

VE Alternative: (widening)
Use 10" DB rather
than 4" DB w/ 6" Asphalt.

High side of SE -
Use DGA (16")
1½" Bond Breaker
"A"

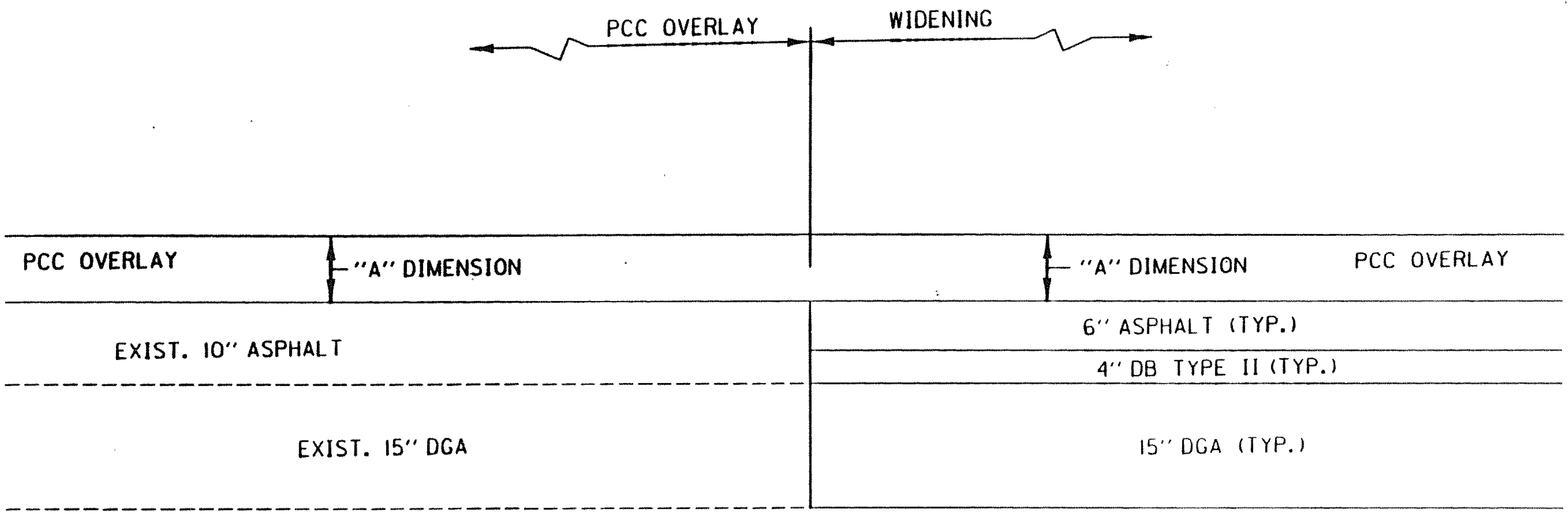
REQUIRED OVERLAY THICKNESS

CBR	2	4	7	11
ESAL'S	"A" DIMENSIONS			
30×10^6	10''	9''	8''	
50×10^6	11''	10''		
70×10^6	12''	11''	10''	

TYPICAL PCC OVERLAY DIMENSIONS
DETAIL "1B"

VALUE ENGINEERING
ALTERNATIVE

overlay - no change



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VE Alternative:
"A"
10" DB
15" DGA

Recommendations for High side of SE.
Use 21 DGA, 4" CI, "A" Dimension

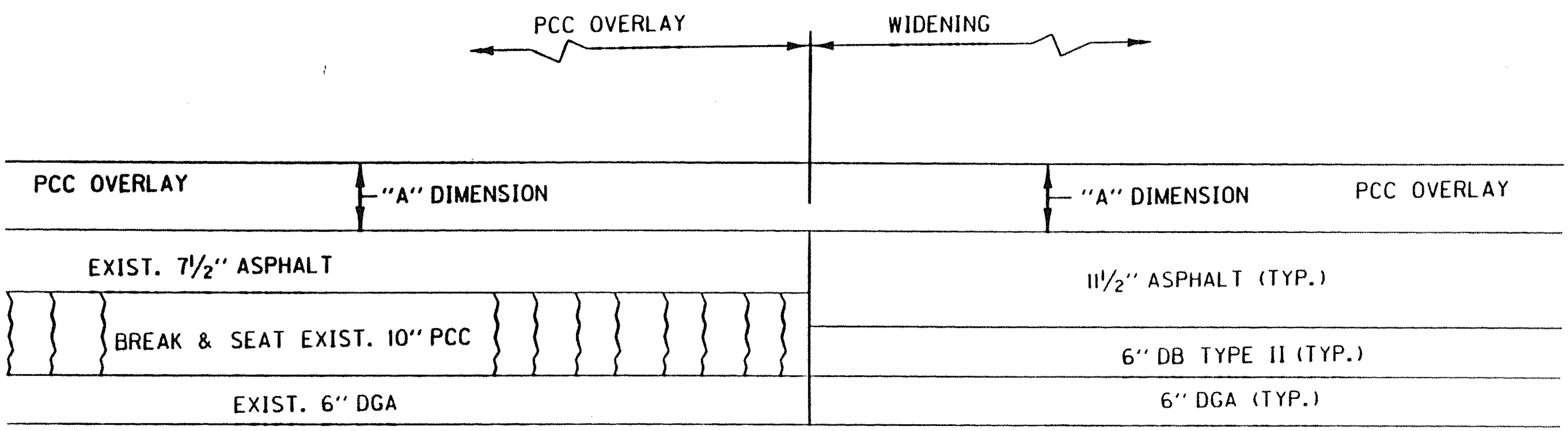
REQUIRED OVERLAY THICKNESS

CBR	2	4	7	11
ESAL'S	"A" DIMENSIONS			
30×10^6	8"		8"	
50×10^6	9"			
70×10^6	10"			

Value Engineering Alternative.

TYPICAL PCC OVERLAY DIMENSIONS DETAIL "2B"

VALUE ENGINEERING ALTERNATIVE



VE Alternative - Overlay

Mill 3½" Existing Asphalt

"A" (PCC)

VE Alternative - Widening

"A"
4" CI (Base)
10" Type II DB
6" DGA

(Suggestion)
High side of SE. -
"A"
4" CI
16" DGA

REQUIRED OVERLAY THICKNESS

CBR	2	4	7	11
ESAL'S	"A" DIMENSIONS			
30×10^6	8"		8"	
50×10^6	9"			
70×10^6	10"			

TYPICAL PCC OVERLAY DIMENSIONS DETAIL "3B"

VALUE ENGINEERING ALTERNATIVE

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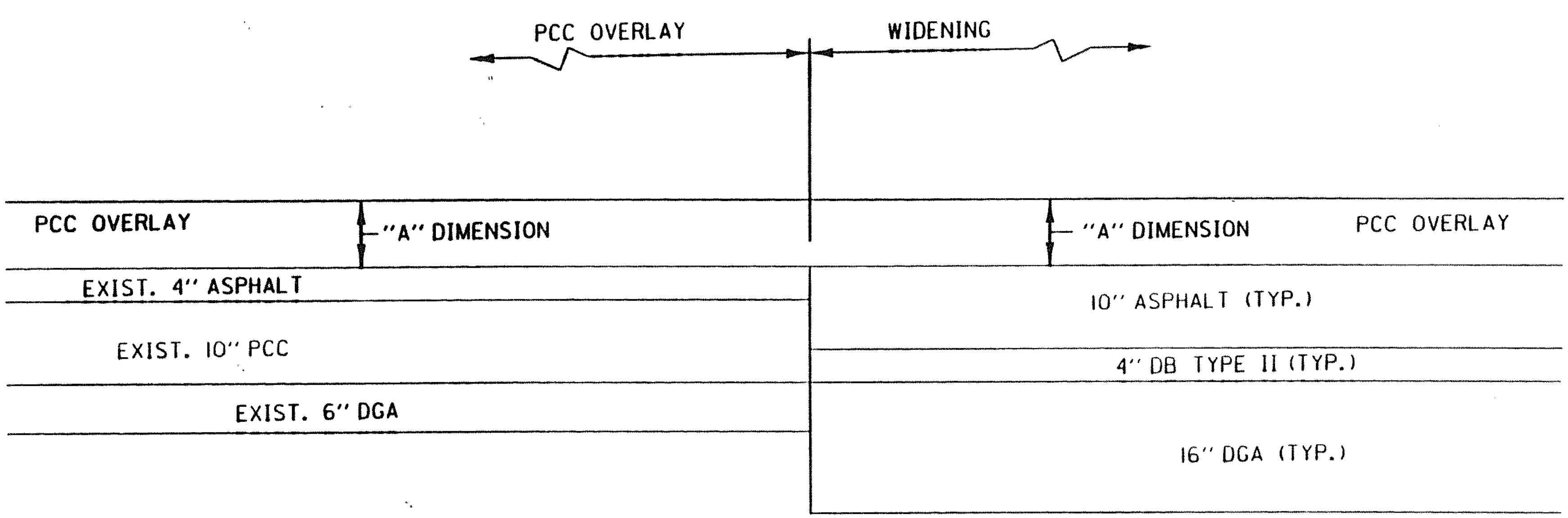
OVERLAY - SAME



VE Alternative - Widening

"A"
4" CI (BASE)
10" Type II DB
6" DGA *

* Match Existing DGA

REQUIRED OVERLAY THICKNESS

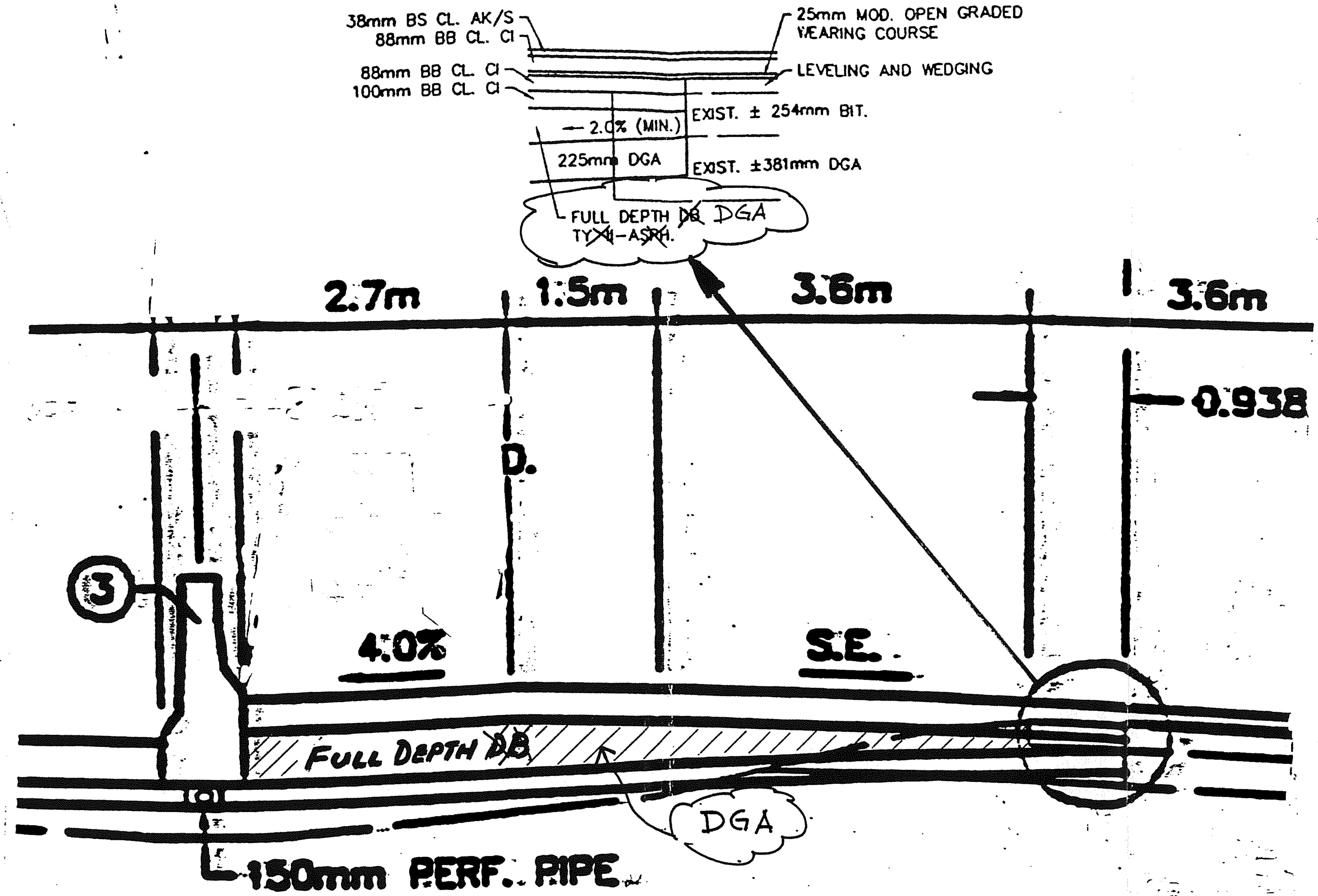
CBR	2	4	7	11
ESAL'S	"A" DIMENSIONS			
30×10^6	8"		8"	
50×10^6	9"			
70×10^6	10"			

SUGGESTION
High side SE

"A"
4" CI
16" DGA

TYPICAL PCC OVERLAY DIMENSIONS
DETAIL "4B"

VALUE ENGINEERING ALTERNATIVE



Superelevated Section

VALUE ENGINEERING ALTERNATIVE

VII.(A)(3) COST COMPARISON

DESIGN AND INITIAL COST COMPARISON OF "AS PROPOSED" AND VALUE ENGINEERING ALTERNATIVES

					ASSUME CBR 7								50,000,000 EAL'S							
					DETAIL 1A		DETAIL 2A		DETAIL 3A		DETAIL 4A		DETAIL 1B		DETAIL 2B		DETAIL 3B		DETAIL 4B	
ITEM	SN	$/SY/IN.	FUNCTION	B/S	OVER	WIDE	OVER	WIDE	OVER	WIDE	OVER	WIDE	OVER	WIDE	OVER	WIDE	OVER	WIDE	OVER	WIDE
AK/A Surface CS	.44	2.51	Support loadings Maintain friction	S B	1 ½" (1 ½")	1 ½" (1 ½")	1 ½" (1 ½")	1 ½" (1 ½")	1 ½" (1 ½")	1 ½" (1 ½")	1 ½" (1 ½")	1 ½"								
CI Base (25mm)	.40	2.11 PG 76 1.66 PG 64	Support loading (Top)	B	4" (4")	4" (4")	2 ½"* (4")	2 ½"* (4")	2"* (4")	2"* (4")	2 ½"* (4")	2 ½"* (4")								
CK Base (37mm)	.40	1.56	Support loadings (Bottom)	B	4" (4")	10" (4")		6"		11 ½" (3 ½")	(4")	10"		6"		6"		11 ½"		10"
DB (#57 Treat. Type II)	.21	1.17	Convey water Support loadings	B S		4" (10")		4" (8½-9¾")		6" (9")**		4" (10")		4"		4"		6"		4"
DG Agg.	.14	0.74	Separate fines Support loadings	B S	6" (6")	6" (6")		18" (13-15")		6" (6")		6" (6")		6" (6")		15"		6"		16"
BR. & Seat. PCC	.24	1.00 SY	Min. reflect. cracks Support loadings	B B	10" (10")						(10")									
Exist. Asph. Overlay	.30	N/A	Support loadings	B																
PCC 8"	-	25.18 SY	Support loadings	B									8"	8" (8")	8"	8"	8"	8"	8"	8"
Bond Breaker	N/A	1.67	Prevent bonding	B									1 ½"	1 ½" (1 ½")	-	-				
Milling	N/A	0.93	Remove damage Correct x-slope Recycle mat'l	B S B			(1 ½")		(3")		(4")									
Crushed Stone Base	.14	0.60	Support loads Convey water	B S						(2")***										
		Cost x $000			$388 ($388)	$563 ($528)	$180 ($271)	$555 ($534)	$159 ($299)	$570 ($428)	$180 ($462)	$515 ($528)	$552 ($522)	$704 ($669)	$502 ($502)	$768 ($732)	$502 ($567)	$833 ($759)	$502 ($502)	$874 ($759)
		Initial Cost:	Total "As Proposed" Total VE Alt.	$/mi $/mi	$951 ($916)		$736 ($805)		$729 ($728)		$695 ($990)		$1,257 ($1,221)		$1,270 ($1,234)		$1,335 ($1,326)		$1,376 ($1,261)	
		V.E.	Superelevation Alt.	$/mi	- $66		- $68		+ $33		- $66		- $66		+ $18		- $26		- $66	

* NOTE: Layer thicknesses less than 3" do not meet KY specs.
** NOTE: Type I untreated
*** NOTE: Between 9" DB & 3 ½" CK
(#) = Value Engineering Alternative layer thickness & cost per mile

directional mile?

Initial Cost Comparison

Using the average unit bid prices provided by KYTC, the cost/sy/in was calculated for all materials utilized in the proposed catalog and the Value Engineering Alternatives. Each of these prices was used to compute the cost per one direction mile for each detail and alternative. In determining these initial cost, the shoulder treatment and the level and wedge items were not considered in this cost comparison. A CBR-7 and 50x10^6 EASL's were used for each proposed detail and Value Engineering Alternative calculation.

Average Unit Bid Prices

Item #	Item	$/SY/in
243	AK/A surf	$ 2.51
246	AK/S surf	$ 1.65
139	CI Base (PG76-22)	$ 2.11
137	CI Base (PG 64-22)	$ 1.66
134	CK Base	$ 1.56
18	DB (#57 Treated)	$ 1.17
1	DG Agg	$ 0.74
2084	PCC (8")	$25.18 SY
2107	B&S PCC	$ 1.00 SY
15	Untreated DB (Type 1)	$ 0.53
3	Crushed Stone Base	$ 0.60
9173	Bond Breaker	$ 1.67

Overlay = 19946 SY/Mile
Widening = 15253 SY/Mile

*Used 1 direction mile
*Used CBR=7 and 50x10^6 ESAL's

Initial Cost/Mile - Proposed Catalog

Details	Overlay	Widening
1A	$387,969.15	$563,293.29
2A	$180,320.88	$555,209.20
3A	$159,177.06	$570,309.67
4A	$180,320.88	$514,941.28
1B	$552,332.43	$704,231.01
2B	$502,265.46	$767,530.96
3B	$502,265.46	$832,508.74
4B	$502,265.46	$873,996.90

Initial Cost/Mile - Value Engineering Alternatives

Details	Overlay	Widening
1A	$387,969.15	$527,601.27
2A	$271,279.20	$534,007.53
3A	$299,205.00	$428,304.24
4A	$462,171.99	$527,601.27
1B	$552,332.43	$668,538.99
2B	$502,265.46	$731,838.94
3B	$567,292.68	$758,989.28
4B	$502,265.46	$758,989.28

Initial Total Cost/Mile 1 Direction

Proposed Catalog			V.E. Alternatives
1A	$951,262.44	↓	$915,570.42
2A	$735,530.08	↑	$805,286.70
3A	$729,486.73	≈	$727,509.24
4A	$695,262.16	↑	$989,773.26
1B	$1,256,563.44	↓	$1,220,871.42
2B	$1,269,796.42	↓	$1,234,104.40
3B	$1,334,774.20	↓	$1,326,281.96
4B	$1,376,262.36	↓	$1,261,254.74
	$8,348,937.83	≈	$8,480,652.14

Notes

- These numbers are based on a one direction mile.
- Alternatives were compared using a CBR=7 and $50x10^6$ ESAL's using average unit bid prices.
- Shoulder treatments were not considered. Used higher priced materials for full width widening and overlay.
- Level and wedge quantities were not considered due to design observations which do not recommend the exclusive use of level and wedge as proposed for the difference in cross slope elevations and super elevated sections.
- Used $1.00/sy for breaking and seating pavement in initial cost/mile analysis, however 1997 average unit bid price analysis indicates Bond S= $0.25/sy.

Cost/Mile Reductions for Super Elevated Sections Using Value Engineering Alternatives

1A and 4A Widening Section
Tangent Section Cost = $527,601.27/mile
Super Elevated Section Cost:
16" (0.74) + 4"($1.56) + 4"($2.11) + 1.5"($2.51) = $30.29/sy (15253 sy/mile) = $462,013.37/mile

Cost Reduction/1 direction mile
(-) $527,601.27 - $462,013.37 = $65,587.90

2 A Widening Section
Tangent Section Cost = $534,007.53
Super Elevated Section Cost:
15" (0.74) + 9.75"(0.74) + 4:($2.11) + 1.5"($2.51) = $30.52/sy (15253 sy/mile) = $465,521.56/mile

Cost Reduction/1 direction mile
(-) $534,007.53 - $465,521.56 = $68,485.97

3A Widening Section
Tangent Section Cost = $428,304.24
Super Elevated Section Cost:
17" (0.74) + 3.5"($1.56) + 4"($2.11) + 1.5"($2.51) = #30.25/sy (15253 sy/mile) = $461,403.25

Cost Reduction/1 direction mile
(+) $461,403.25 - $428,304.24 = $33,099.01

1B Widening Section
Tangent Section Cost = $668,538.99
Super Elevated Section Cost:
16" (0.74) + 1.5"($1.67) + $25.18 = $39.53/sy (15253 sy/mile) = $602,951.09

Cost Reduction/1 direction mile
(-) $668,538.99 - $602,951.09 = $65,587.90

2B Widening Section
Tangent Section Cost = $731,838.94
Super Elevated Section Cost:
21" (0.74) + 4"($2.11) + $25.18 = $49.16/sy (15253 sy/mile) = $749,847.48

Cost Addition/1 direction mile
(+) $749,837.48 + $731,838.94 = $17,998.54

3B Widening Section

Tangent Section Cost = $758,989.28

Super Elevated Section Cost:

19.5" (0.74) + 4"($2.11) + $25.18 = $48.05/sy (15253 sy/mile) = $732,906.65

Cost Reduction/1 direction mile

(-) $758,989.28 - $693,401.38 = $65,587.90

Total Cost Reduction/1 direction mile = $240,234.75

Total Cost Reduction/1 mile = $480,469.50

VII.(A)(4) LIFE CYCLE COST ANALYSIS

VII.(A)(4)(a) AS PROPOSED LCC

Interstate Widening, Life Cycle Cost Analysis
Summary

Life cycle cost analysis has been performed on a total of four Hot Mix Asphalt alternatives and four Portland Cement Concrete alternatives as follows:

Hot Mix Asphalt

1A - Asphalt Overlay of New Broken and Seated Pavement
2A - Asphalt Overlay of Existing Asphalt Pavement
3A - Asphalt Overlay of Existing Broken and Seated Pavement
4A - Asphalt Overlay of Existing Composite Pavement (AC over PCC)

Portland Cement Concrete

1B - Unbonded PCC Overlay of Existing PCC Pavement
2B - PCC Overlay of Existing AC Pavement
3B - PCC Overlay of Existing Broken and Seated pavement
4B - PCC Overlay of Existing Composite Pavement (AC over PCC)

The rehabilitation schedule utilized for each pavement type is as follows:

Hot Mix Ashalt

Year 10 — Mill 1.5" and 1.5" Overlay
Year 20 — Mill 1.5" and 4.0" Overlay
Year 30 — Mill 1.5" and 1.5" Overlay

Portland Cement Concrete

Year 15 — Clean and Reseal Joints
Year 30 — Clean and Reseal Joints

Structural sections have been analyzed for traffic levels of 30,000,000, 50,000,00, and 70,000,000 ESAL's and subgrade CBR's of 2, 4, 7, and 11 for a total of 12 structural cross section scenarios. In addition, present worth analysis was performed for discount rates of 0, 2, 4, 6, 8, and 10.

AS PROPOSED

This analysis was conducted utilizing the current Excel spreadsheet utilized by the Kentucky Transportation Cabinet Division of Design.

The following assumptions were utilized in the analysis:

inside shoulder work included in widening section,

outside shoulder work included in rehabilitation of existing pavement,

installation of pavement edgedrains was not included in the analysis for any alternate,

installation of the median barrier was not included in the analysis for any alternate,

traffic control costs were assumed as follows:
initial construction, $325,000 (included in the cost of rehabilitation),
subsequent rehabilitations, $100,000,

delay costs $5,000/day;
initial construction 120 days @ $5,000/day --- $600,000 (included in cost of rehabilitation),
rehabilitation 30 days @ $5,000/day---$150,000,

centerline and cross slope adjustment made as follows:
centerline adjustment, 2.67' (to the left),
cross slope adjustment from 1.5% to 2.0%,

all pavement materials both existing and those added during the rehabilitation and widening were utilized to calculate the salvage value of the pavement, this total quantity of materials was considered as dense-graded-aggregate (DGA) and the associated unit cost for DGA was used to determine the total salvage value,

for the bituminous alternate, guardrail adjustment was made over 50% of the project in year 20,

an analysis period of 40 years was utilized,

BIT SURF CL AK/A PG76-22/50%ER was utilized for all mainline surfaces,

BIT CONC SURF CL AK/S PG64-22 was utilized for all shoulders,

AS PROPOSED

TABLE 1. Alternate 1A/Alternate 1B, Existing PCC Pavement

ESAL'S	Project Cost Ratio	Recommended Alternate CBR 2	4	7	11
30,000,000		Alt. 1A or Alt. 1B	Alt. 1A or Alt. 1B	Alt. 1A or Alt. 1B	Alt. 1A
	Alt. 1A mean/Alt. 1B mean	0.97	0.97	0.96	0.94
	Alt. 1A +1SD/Alt. 1B -1SD	1.19	1.18	1.16	1.13
50,000,000		Alt. 1B	Alt. 1A or Alt. 1B	Alt. 1A or Alt. 1B	Alt. 1A
	Alt. 1A mean/Alt. 1B mean	0.99	0.97	0.98	0.94
	Alt. 1A +1SD/Alt. 1B -1SD	1.21	1.19	1.19	1.14
70,000,000		Alt. 1B	Alt. 1B	Alt. 1A	Alt. 1A
	Alt. 1A mean/Alt. 1B mean	0.99	0.99	0.94	0.90
	Alt. 1A +1SD/Alt. 1B -1SD	1.21	1.21	1.15	1.09

Alt. 1A, Asphaltic Concrete Overlay
Alt. 1B, Portland Cement Overlay

AS PROPOSED

Table 1B.

DRAFT 3/9/98	Alternate Comparison, Discount Rate 4.0 Percent							DRAFT
		Alternate 1A				Alternate 1B		
	Mean - 1SDV Unit Costs Alt 1A	Mean Unit Costs Alt 1A	Mean + 1SD Unit Costs Alt 1A	mean/mean	+1sd/-1sd	Mean - 1SDV Unit Costs Alt 1B	Mean Unit Costs Alt 1B	Mean + 1SD Unit Costs Alt 1B
	4	4	4			4	4	4
30,000,000 CBR =2	3,827,373	4,302,977	4,778,582	0.97	1.19	4,024,318	4,428,996	4,833,675
30,000,000 CBR =4	3,736,283	4,194,114	4,651,944	0.97	1.18	3,949,846	4,342,972	4,736,098
30,000,000 CBR =7	3,508,353	3,921,713	4,335,072	0.96	1.16	3,741,081	4,100,793	4,460,505
30,000,000 CBR =11	3,439,120	3,841,418	4,243,716	0.94	1.13	3,741,081	4,100,793	4,460,505
50,000,000 CBR =2	3,918,522	4,411,910	4,905,298	0.99	1.21	4,063,515	4,474,003	4,884,492
50,000,000 CBR =4	3,827,315	4,302,908	4,778,502	0.97	1.19	4,024,318	4,428,996	4,833,675
50,000,000 CBR =7	3,599,037	4,030,093	4,461,149	0.98	1.19	3,741,081	4,100,793	4,460,505
CBR =11	3,463,012	3,867,522	4,272,033	0.94	1.14	3,741,081	4,100,793	4,460,505
70,000,000 CBR =2	4,009,670	4,520,843	5,032,015	0.99	1.21	4,155,316	4,580,177	5,005,038
70,000,000 CBR =4	3,918,522	4,411,910	4,905,298	0.99	1.21	4,063,515	4,474,003	4,884,492
70,000,000 CBR =7	3,718,744	4,165,309	4,611,873	0.94	1.15	4,024,318	4,428,996	4,833,675
70,000,000 CBR =11	3,553,695	3,975,903	4,398,111	0.90	1.09	4,024,318	4,428,996	4,833,675

AS PROPOSED

TABLE 4. Alternate 4A/Alternate 4B, Existing Composite Pavement

ESAL'S	Project Cost Ratio	Recommended Alternate			
		CBR			
		2	4	7	11
30,000,000		Alt. 4A	Alt. 4A	Alt. 4A	Alt. 4A
	Alt. 4A mean/Alt. 4B mean	0.87	0.82	0.78	0.78
	Alt. 4A +1SD/Alt. 4B -1SD	1.05	1.00	0.95	0.95
50,000,000		Alt. 4A	Alt. 4A	Alt. 4A	Alt. 4A
	Alt. 4A mean/Alt. 4B mean	0.84	0.81	0.81	0.81
	Alt. 4A +1SD/Alt. 4B -1SD	1.03	0.98	0.98	0.98
70,000,000		Alt. 4A	Alt. 4A	Alt. 4A	Alt. 4A
	Alt. 4A mean/Alt. 4B mean	0.85	0.82	0.84	0.84
	Alt. 4A +1SD/Alt. 4B -1SD	1.03	1.00	1.02	1.02

Alt. 4A, Asphaltic Concrete Overlay

Alt. 4B, Portland Cement Overlay

AS PROPOSED

Table 4B.

DRAFT	3/9/98	Alternate Comparison, Discount Rate 4.0 Percent						DRAFT
	Alterante 4A					Alternate 4B		
	Mean - 1SDV Unit Costs Alt 4A	Mean Unit Costs Alt 4A	Mean + 1SD Unit Costs Alt 4A	mean/mean	+1sd/-1sd	Mean - 1SDV Unit Costs Alt 4B	Mean Unit Costs Alt 4B	Mean + 1SD Unit Costs Alt 4B
	4	4	4			4	4	4
30,000,000 CBR =2	3,454,797	3,837,169	4,219,541	0.87	1.05	4,005,040	4,411,339	4,817,639
30,000,000 CBR =4	3,276,108	3,635,381	3,994,655	0.82	1.00	4,005,040	4,411,339	4,817,639
30,000,000 CBR =7	3,100,637	3,458,693	3,816,750	0.78	0.95	4,005,040	4,411,339	4,817,639
30,000,000 CBR =11	3,100,637	3,458,693	3,816,750	0.78	0.95	4,005,040	4,411,339	4,817,639
50,000,000 CBR =2	3,520,754	3,929,925	4,339,095	0.84	1.03	4,213,805	4,653,518	5,093,231
50,000,000 CBR =4	3,395,234	3,769,906	4,144,579	0.81	0.98	4,213,805	4,653,518	5,093,231
50,000,000 CBR =7	3,216,545	3,568,119	3,919,692	0.81	0.98	4,005,040	4,411,339	4,817,639
50,000,000 CBR =11	3,216,545	3,568,119	3,919,692	0.81	0.98	4,005,040	4,411,339	4,817,639
70,000,000 CBR =2	3,593,501	4,014,713	4,435,925	0.85	1.03	4,288,277	4,739,543	5,190,808
70,000,000 CBR =4	3,514,359	3,904,431	4,294,504	0.82	1.00	4,288,277	4,739,543	5,190,808
70,000,000 CBR =7	3,335,671	3,702,644	4,069,617	0.84	1.02	4,005,040	4,411,339	4,817,639
70,000,000 CBR =11	3,335,671	3,702,644	4,069,617	0.84	1.02	4,005,040	4,411,339	4,817,639

AS PROPOSED

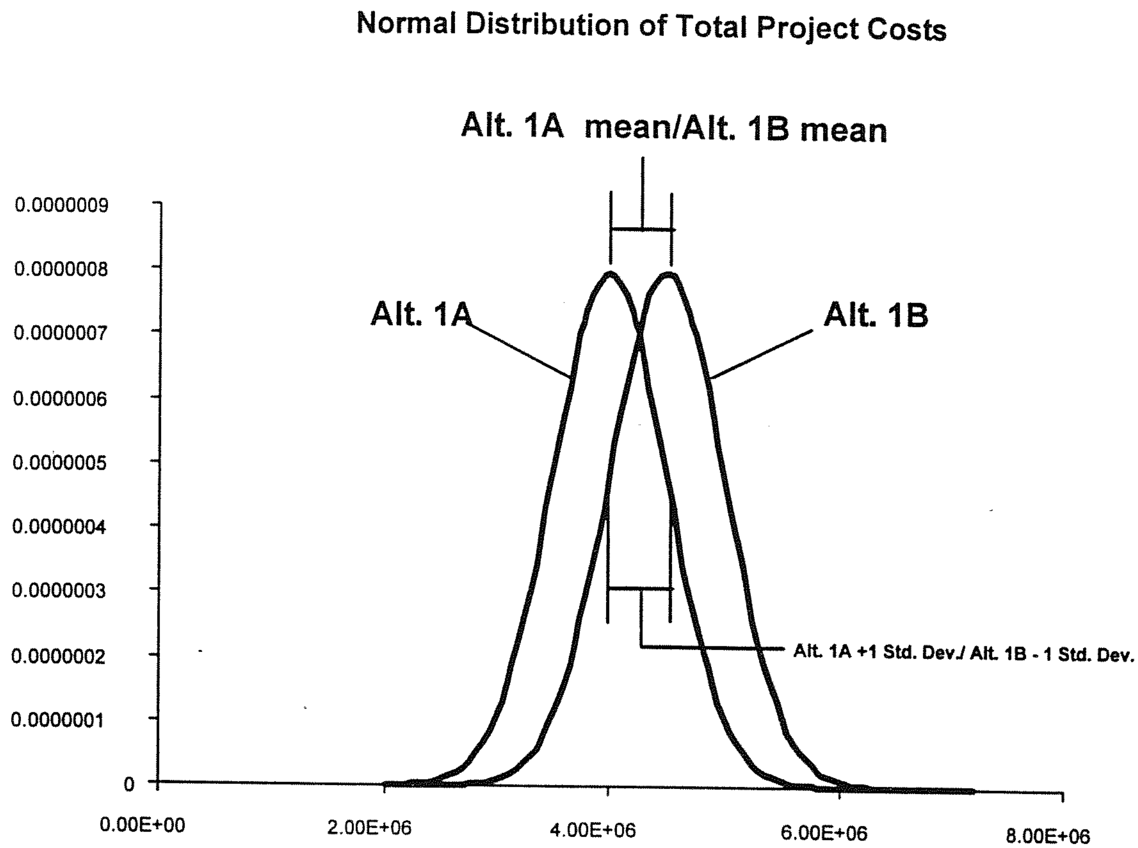


Figure 1.

AS PROPOSED

VII.(A)(4)(b) V.E. ALTERNATIVE LCC

The Value Engineering Team determined the initial cost for the Value Engineering proposals. These costs were developed for all the existing pavement cases with a 50,000,000 ESAL's design traffic load and a 7 CBR. The life cycle rehabilitation schedule used in the Value Engineering Analysis was the same as the treatments used in the development of the Pavement Catalog, namely:

Hot Mix asphalt - Year 10-Mill 1.5" and 1.5" Overlay
Year 20-Mill 1.5" and 4.0" Overlay
Year 30-Mill 1.5" and 1.5" Overlay
Portland Cement Concrete - Year 15 - Clean and Reseal Joints
Year 30 - Clean and Reseal Joints

The Value Engineering team used the same assumptions as the pavement Catalog LCCA, namely:

Inside shoulder work included in widening section.
Outside shoulder work included in rehabilitation of existing pavement.
Installation of pavement edgedrains was not included in the analysis for any alternative.
Installation of the median barrier was not included in the analysis for any alternative.
Traffic control costs were assumed as follows: Initial construction, $325,000 (included in the cost of rehabilitation). Subsequent rehabilitations, $100,000, Delay costs $5,000/day: Initial construction 120 days @ $5,000/day - $600,000 (included in cost of rehabilitation). Rehabilitation 30 days @ $5,000/day - $150,000. Centerline and cross slope adjustment made as follows: Centerline adjustment, 2,6.67' (to the left), Cross slope adjustment from 1.5% to 2.0%.

Value Engineering Alternatives 1A and 1B Life Cycle Cost Analysis (LCCA)

Alternative	1A	1B
Overlay	$ 388,000	$ 552,000
Widening	$ 527,000	$ 668,000
Per Direction	$ 915,000	$1,220,000
Initial Cost	$1,830,000	$2,440,000
MOT & Delay	$ 925,000	$ 925,000
Drainage Wedge	$ 131,000	$ 115,000
Total Initial Cost	$2,886,000	$3,480,000
Year Rehabilitation		
2008 - 1A	$ 556,000	
2013 - 1B		$ 441,000
2018 - 1A	$ 600,000	
2928 - 1A & 1B	$ 259,000	$ 244,000
2038 - Salvage	-$360,000	-$325,000
Total 40 year LCC	$3,951,000	$3,840,000

KY

VE: TABLE 1. Alternate nA/Alternate nB, Existing PCC Pavement

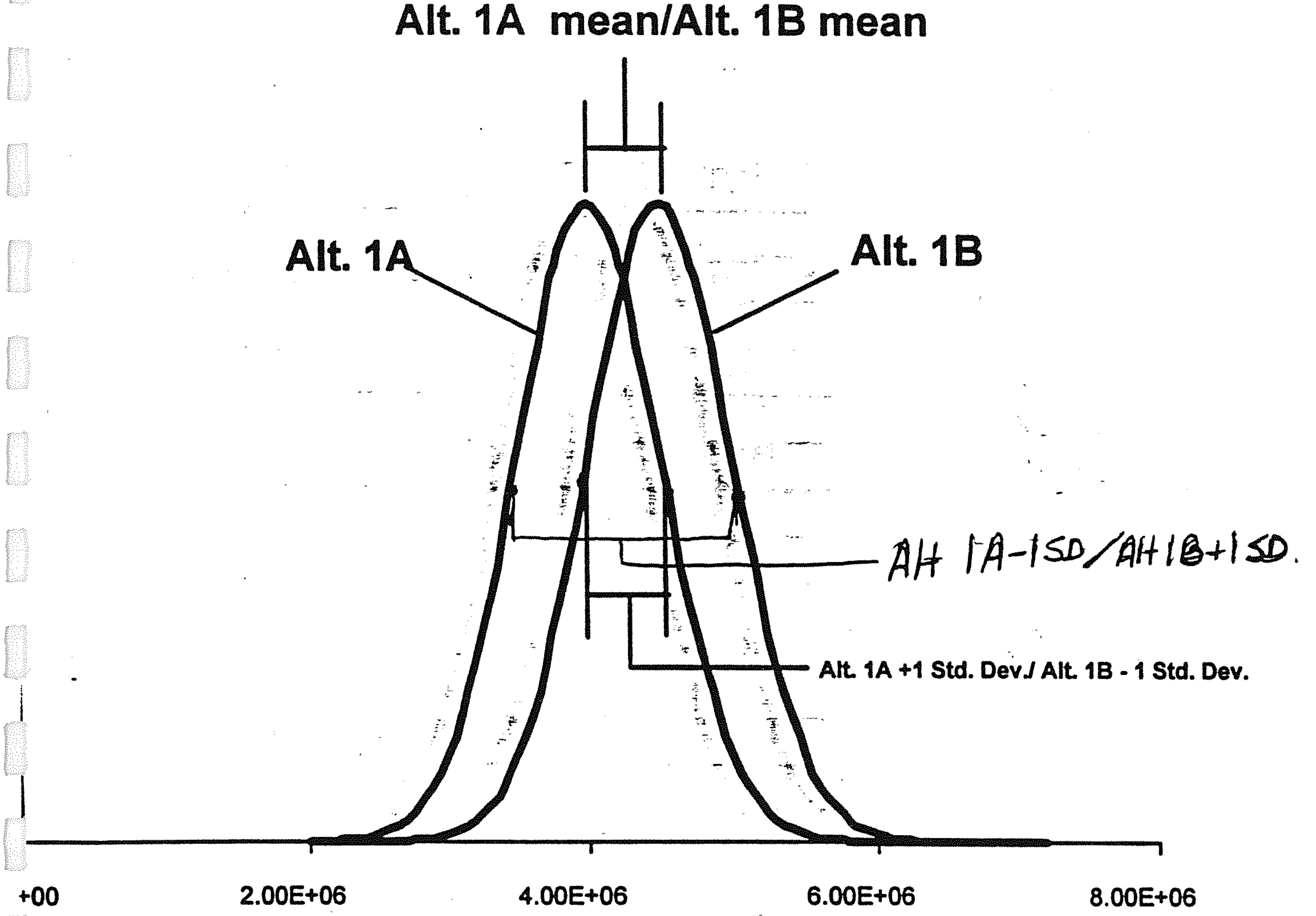
	ESAL's	Project Cost Ratio	Recommended Alternate CBR 2	4	7	11
CASE 1	30,000,000	1A/1B	0.97	0.97	0.96	0.94
		PVT TYPE	1A - 1B	1A - 1B	1A - 1B	1A
	50,000,000	1A/1B	0.99	0.97	0.98	0.94
		VE: 1A/1B			1.03	
		PVT TYPE	1B	1A - 1B	1A - 1B	1A
	70,000,000	1A/1B	0.99	0.99	0.94	0.90
		PVT TYPE	1B	1B	1A	1A

Alt. 1A, Asphaltic Concrete Overlay
Alt. 1B, Portland Cement Overlay

	ESAL's	Project Cost Ratio	Recommended Alternate CBR 2	4	7	11
CASE 2	50,000,000	2A/2B	0.89	0.84	0.86	0.78
		VE:2A/2B			0.96	
		PVT TYPE	2A	2A	2A 2B	2A
CASE 3	50,000,000	3A/3B	0.88	0.85	0.84	0.79
		VE:3A/3B			0.88	
		PVT TYPE	3A	3A	3A	3A
CASE 4	50,000,000	4A/4B	0.84	0.81	0.81	0.81
		VE:4A/4B			1.04	
		PVT TYPE	4A	4A	4A 4B	4A

NY

Normal Distribution of Total Project Costs



VALUE ENGINEERING
ALTERNATIVE

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VII.(B) DESIGN COMMENTS

DESIGN COMMENTS

1. Lime Treated Subgrade

During the initial briefing the team was told that KYTC now lime treats their fine grained subgrade on new construction. We understood that KYTC did not use lime treatments on widening projects because of concerns with timing issues (seven days typical cure times), introduction of specialized equipment and staging in the more constrained working areas. It was the teams' strong feeling that the KYTC should consider lime treating all of the fine-grained subgrade soils. The team looked at the monitory benefits of lime treating the subgrade in the pavement widening sections. There was a need to use lime treatment in a few cases but it was not required in most cases to make the sections work.

However though the team could not justify lime treatment based on reducing the required pavement sections, we still feel strongly that it should be used in the widening projects. Lime stabilizing the fine-grained subgrade soils will provide a more uniformly stiff subgrade support, which is highly desirable. It will reduce the occurrence of the weaker areas along the grade, which will provide more consistent pavement performance. The pavement will fatigue more uniformly along the project rather than fatiguing early in areas of wetter, weaker subgrade soils. It will also reduce or eliminate the problem of the localized areas of very weak subgrade that has to be dug up and repaired before the surfacing is placed. On some projects the costs for repairing wet, weak subgrade locations can easily exceed the costs for lime treating the subgrade. The stiffer lime treated subgrade also provides a more sound base on which to compact the surfacing layers thus providing better long term performance. Therefore we strongly encourage KYTC consider using lime treatment on all their widening over fine grained soils.

ASKED UNIVERSITY TO RE-EVALUATE WHOLE CONCEPT. VALIDATE BY DOING A AASHTO ~~SYSTEM~~ DESIGN TO SYSTEM. TO TREAT THINGS EQUAL.

2. Staged Design for LCCA

There is a basic inconsistency in the way the treatments in the A and B treatment tables were developed. In the LCCA the AC treatments were all given an additional 2.5 inch overlay at 20 years, which effectively doubles the ESAL's that the treatments were develop for. This added ACP provides a staged design for twice the ESAL's shown in the tables

As an example in case 1-A for a CBR of 2 and 30 million ESAL's a 12 inch overlay is shown. However, with the 2.5 inch of ACP added by the LCCA the actual section is a 14.5 inch overlay. This overlay thickness satisfies a 60 million ESAL design over 40 years. The same matrix in 1-B shows a 10-inch PCCP overlay that provides for 30 million ESAL's but not 60 million ESAL's which was provided for in the comparable A cell and 20 year added ACP.

The comparisons are not equal. This difference needs to be rectified to provide comparative sections in the LCCA.

When the pavement selection tables are completed, a 40 year accumulated ESAL's recognizing the expected lane distribution should be used for the input to be consistent with the LCCA used to develop the tables. Provided that the tables shows a reduction of 2.5 inches in the overlay selections then it should also note that an additional 2.5 inches is required to complete the staged design.

3. Drainage of Layers in Superelevated Pavement Sections

In applications where a drainable base layer is used in the widening a complication develops when the pavement is superelevated. In the superelevated sections the base layer would normally drain water back into the pavement. To drain the water away from the pavement the subgrade is sloped back toward the median as is the dense graded base and the bottom of the drainable base. The resulting wedge is filled with treated drainable base which then allows drainage away from the pavement section, but it cost a lot of money and provides difficulty paving on the somewhat unstable material.

The Value Engineering Team recommends that the KYTC do a more detailed drainage analysis of this section. The intent of the drainable base layer in the widening is to help drain water away from the PCC Pavement where the left lane is sloped toward the median. Where the existing left lane is sloped away from the median there is no water to drain out from under or within the PCC Pavement. With this in mind, is there really a problem placing KYDC's non-draining dense graded base in the wedge created in the superelevated pavement? Because the dense graded aggregate base is relatively non-draining then there really is not much water brought into the PCC Pavement by the base in the superelevated pavement section. In those sections where a PCC Pavement overlay is used then a four inch layer of AC Pavement needs to be placed on the dense graded aggregate base to prevent pumping of the PCC Pavement. For a new pavement section there would not be any question about using drainable base across the full pavement section. However, with widening next to a pavement section that is not drained and what water that does occur is found at the contact of the old PCC Pavement and the dense base the use of dense graded aggregate base on the high side of the PCC Pavement would introduce very little additional water into the pavement section.

4. Drainage Layers in AC Widened Pavements

A layer of drainable base was included in all pavement sections included in this study. In many cases the use of the drainable base layer complicated the layer configuration and any modifications. It also contributed to higher costs and particularly deep sections on the high side of a superelevated pavement section.

The use of a drainage layer next to or underneath a PCC Pavement slab is recommended by the FHWA Pavements Section and considered good practice in all most all States. Most States have found that PCC Pavements are particularly susceptible to increased damage and reduced service lives when water is present at the base of the slabs. Dense graded granular bases and cement treated bases are particularly prone to pumping, faulting and cracking when the bases are wet. The general comments about reducing the effects of water in the base are to either stop the water from entering the pavement section or to make the base insensitive to the presence of excess water. The general experience by most States is that you can not really stop the water from entering the PCC Pavement so you have to use base material that is relative insensitive to the effects of water or can help move the water out of the base quickly. To do this most States use a treated or untreated drainable base that is both insensitive to the presence of water and helps move the water out from under the pavement quickly.

The need for the use of a drainable base in AC Pavements has not met with the same strong consensus by the FHWA and most States. Most states have not experienced the same clear damage relationship in their AC Pavements as they have in their PCC Pavements. The Value Engineering Team members from other States indicated that they did not include a drainage layer in their AC Pavements because of the difficulty in quantifying the cost advantages of using drainage layers in their AC Pavements. The FHWA Pavements Section conducted a series of meetings with a working group of State and FHWA pavement engineers on the drainage of pavements. That working group made a clear recommendation for the use of drainage layers in PCC Pavements, however, they did not reach a consensus on the use of drainage layers in AC Pavements. In fact the general consensus was to not recommend the use of drainage layers in AC Pavement rather than to make no recommendations one way or the other.

The Value Engineering Team recommends that the KYTC look again at their desire to drain the AC Pavement Sections using their drainable base. They particularly should look at the use of a drainable base in the widening where no drainable base was used in the existing pavement. This could significantly reduce the cost of sections like 2-A where placing a drainable base at the bottom of the existing pavement increases the cost and complexity of the widening section considerably. It also increases the risk of bringing water back into the system when the pavement is in a curve and the pavement is superelevated up and the base could drain back towards the existing pavement.

5. <u>Test Pavement Sections of AC Pavement over C&S PCC Pavement to Confirm Design Curves.</u>

The KYTC design criteria, for AC Pavement overlays over cracked and seated PCC Pavement, was used to develop the pavement selection tables. KYTC has had very good experience using AC Pavement over crack and seated PCC Pavements. Most of this good experience is based on 7.5 inches of AC Pavement over the crack and seated PCC Pavements. However, most of the pavement selection tables call for 10 inches to 14 inches of AC Pavement over the cracked and seated PCC Pavement. Because this thickness looked very conservative compared to the overlay thickness that had served KYTC the Value Engineering Team looked at the design curves using different design procedures. The result of this review confirmed that the design thickness matched those obtained from other design procedures. The reason that the thickness looked so thick was that most of the design procedures call for very thick pavements at high ESAL designs. These designs are all based on limited pavement failures that were monitored at relative low ESAL's compared to those now used in design for high volume freeways. For example most of those failures were experienced on thinner pavements with only at best 1 to 10 million ESAL's. These damage relationships are now being extended to pavements that are two to three times as thick and easily 10 to 20 times more ESAL's.

These designs which call for much thicker pavements bring with it high additional costs. One inch of added overlay thickness costs KYTC over $80,000 per mile for every mile of six lane pavement they are planning to build. There is mounting evidence that the extension of these damage trends does not require relatively thicker pavements. Unfortunately there has not been a concerted program to confirm these damage trends at higher ESAL levels because of the time and effort that it would take. KYTC plans to invest close to one billion dollars in widening over 200 miles of Interstate in the near future. A significant component of this cost will be due to the pavement damage trends measured for thinner more lightly loaded pavements.

With this investment in mind the Value Engineering Team recommends that the KYTC consider investing in limited accelerated testing of several of their existing or new pavements to confirm the need for these thickness at higher ESAL loadings. The FHWA has moved its ALF to some States for limited testing of their pavements several years ago. Since then a few more agencies have acquired heavy vehicle simulators which could possibly be used. With the larger number of accelerated pavement testing devices that are around KYTC may be able to borrow or rent one to test their pavements.

In the next few years AASHTO will develop a national M-E design procedure. This design procedure will need field validation of a range of pavement sections in the different environmental regions around the US. KYTC may be able to work with other States in the Southeast to set up a series of accelerated pavement tests to provide damage trends that are based more closely on the pavements and loads that the states are using. These accelerated pavement tests will serve the state now and in the future as new design methods evolve.

6. Stability of Drainable Base Layer

Some concern was noted about the relative stability of the material used in the drainable base. The material evidently is an AASHTO # 57 stone which may be either untreated or treated with 2 to 2.5% AC to tack the rock together to facilitate construction. The general concern was that the basic gap graded stone was not stable enough to pave to greater depths particularly on the high side of a superelevated pavement section. KYTC may consider using a material for the drainage layer that has a little less permeability and a little more stability. For an untreated drainage layer there are several gap graded drainage materials that provide more stability but also are a little slower draining such as that used in New Jersey, and Ohio. For treated material Oregon uses a gap-graded mix, which they use for a structural layer that might meet this need. It to is less permeable than the normal drainage layer made with #57 stone but it may be permeable enough to drain the sections when thicker layers are used.

VIII. SUMMARY OF RECOMMENDATIONS

SUMMARY OF RECOMMENDATIONS

It is the recommendation of the Value Engineering Team that the following Value Engineering Alternatives be carried into the Project Development process for further development.

NO Recommendation Number 1- CONSTRUCTIBILITY WITH WORKING IN MEDIAN. CANNOT DO EFFECTIVELY IN MEDIAN & DO NOT ACCEPT FROM CONSTRUCTIBILITY

The Value Engineering Team recommends that all subgrades having a CBR value of 6 or less be treated in areas when widening is planned.

NO Recommendation Number 2- NOT GOOD FOR TRAFFIC IN FUTURE

The Value Engineering Team recommends that the design for the widening be based on ESAL assignment recognizing the truck distribution across the 3 and 4 lanes in each direction, i.e. right lane 60% trucks, left lane (median) 5% trucks.

? Recommendation Number 3- STILL UNDER CONSIDERATION

The Value Engineering Team recommends that the catalog reflect fine tuning of the layer treatments to only provide the required SN using the most cost efficient materials (eg. thick Drainage Blanket in lieu of Asphalt Base).

NO Recommendation Number 4- NO DUE TO CONSTRUCTIBILITY

The Value Engineering Team recommends that Dense Graded Aggregate Base be substituted for Drainage Blanket (Type II) in the median of superelevated sections.

Recommendation Number 5- CUTTING SUBGRADE TO DRAIN BACK TO BASE. NO BENEFIT TO SUBSTITUTE AND NOT UNSTABLE. NO STABILITY PROBLEMS AT ALL

The Value Engineering Team recommends that the need to drain AC pavement widening sections using the drainable base be re-evaluated. WE DO GET BENEFIT FROM DRAINING ASPHALT PAVEMENT.

? Recommendation Number 6-

STILL UNDER CONSIDERATION

The Value Engineering Team recommends that accelerated testing be conducted in areas with cracked and seated PCC pavement to determine actual support value appropriate for use in the design of the overlays. Proposed testing of sections to measure stress and strains. DO NOT USE ACCELERATED TESTING

Recommendation Number 7-

The Value Engineering Team recommends that KYTC consider using a material for the drainage layer that has less permeability and more stability and can be constructed in thicker layers. MATERIALS INVESTIGATED

INTERSTATE WIDENING PROJECTS PAVEMENT DESIGNS
V.E. STUDY PRESENTATION
MARCH 27, 1998

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IX. APPENDICES

Commonwealth of Kentucky
Transportation Cabinet
Frankfort, Kentucky 40622

James C. Codell, III
Secretary of Transportation

T. Kevin Flanery
Deputy Secretary

Paul E. Patton
Governor

January 2, 1998

Mr. Jesse Story
Division Administrator
Federal Highway Administration
330 West Broadway
Frankfort, Kentucky 40601

Attention: Tom Pilling

Dear Mr. Story:

SUBJECT: Phased Design Concept for Interstate Widening
Corridor Approach for Pavement Designs for Interstate Widening and Pavement Rehabilitation Projects

Attached are minutes for two meetings held in October 1997. These meetings held October 3, 1997 and October 23, 1997 involved representatives of the Transportation Cabinet and representatives of the Federal Highway Administration.

The first meeting held October 3, 1997 involved discussions regarding a "Phased Design Concept for Interstate Widening" projects. The attached "MINUTES OF MEETING, OCTOBER 3, 1997, Phased Design Concept for Interstate Widening" describe specific discussions from that meeting. The second meeting held October 23, 1997 involved discussions regarding a "Corridor Approach For Pavement Designs for Interstate Widening and Pavement Rehabilitation Projects." The attached "MINUTES OF MEETING, OCTOBER 23, 1997, Corridor Approach For Pavement Designs, Interstate Widening and Pavement Rehabilitation Projects" describe specific discussions for that meeting.

This correspondence is to request your review and concurrence for the minutes of these meetings as written or to provide comments for appropriate modifications to reflect Federal Highway Administration perspectives for the context of these meetings. Following these meetings, it was the understanding of staff of the Division of Highway Design that there was a generalized conceptual agreement for the concepts presented at these meetings but that a formal request for concurrence by the Federal Highway Administration was needed.

Mr. Jesse Story
Phased Design Concept for Interstate Widening
Corridor Approach For Pavement Design for Interstate Widening
and Pavement Rehabilitation Projects
January 2, 1998
Page Two

This correspondence is our formal request for your concurrence for the following:

1. **Phased Design Concept for Interstate Widening**

2. **Corridor Approach For Pavement Designs for Interstate Widening and Pavement Rehabilitation Projects**

We recognize that there still may be details remaining for clarification and refinement of the concepts presented herein. However, we think it appropriate to request your concurrence in the concepts presented at this time with the understanding that specific details may need additional attention as these projects evolve.

The Transportation Cabinet is excited at your willingness to work as partners in refining the concepts presented herein to a culmination as a "memorandum of agreement" which can be used as guidelines in the development of future projects for pavement rehabilitation and widening on the Interstate System. We understand from earlier discussions that Tom Pilling will be the program contact for Interstate pavement rehabilitation and widening projects with Bob Farley being the contact for traffic control issues, Dudley Brown being the contact for pavement issues, and Ray Greer being the contact for bridge issues. On a similar basis, the Transportation Cabinet has identified Gary Sharpe as the Project Coordinator/Manager for Interstate widening and pavement rehabilitation projects. Steve Goodpaster is the Transportation Cabinet contact for bridge design issues. Other Transportation Cabinet staff will be designated to address critical areas of concern such as drainage, geotechnical issues, etc.

We look forward to our working together toward the successful completion of projects for widening and pavement rehabilitation of the Interstate System and appreciate your earliest review and concurrence for this request.

Sincerely,

J. M. Yowell, P.E
State Highway Engineer

BY: Gary W. Sharpe for JBS
John B. Sacksteder, P.E.
Director, Division of Highway Design

GWS:gws

Attachments

MINUTES OF MEETING
OCTOBER 3, 1997

Phased Design Concept for Interstate Widening

This is to document discussions held on October 3, 1997 regarding the concept of Phased Design for Interstate Widening projects. A meeting was held at 1:00 PM on October 3, 1997 in the office of the Kentucky Division, Federal Highway Administration. Mike Hancock, John Sacksteder, and Gary Sharpe represented the Transportation Cabinet. Representatives of the Federal Highway Administration were Dennis Luhrs, Tom Pilling, Paul Doss, Ray Greer, Bob Farley, Ed Maki, and Gary Goff.

Mike Hancock began discussions with a brief overview of the Department's desire to advance design for widening of the I 65 corridor from Elizabethtown to the Tennessee State Line and I 75 from Berea to the Tennessee State Line. Mr. Hancock also indicated a desire to accelerate development of plans for widening of I 75 north of Lexington and south of Covington, Kentucky.

Mr. Hancock explained that from a programming perspective, it was desirable to develop plans for these projects on a "fast track" basis because of the need to have projects "on the shelf" and available for use should other federal projects fail to meet schedules or should discretionary funds become available. Development of plans from the "corridor perspective" also was desirable from the operational perspective by providing a consistent concept for roadway design for the corridor rather than development of designs with minor inconsistencies as the projects were developed across highway district boundaries. Similarly, development of plans on a corridor basis would enhance scheduling for construction projects by minimizing the potential for having "an improved section followed by an unimproved section followed by an improved section." Thus by development of plans on a fast track basis and on a corridor basis, and having plans "on the shelf", the greatest degree of programming flexibility can be achieved and the traveling public can best be served by providing a consistent design concept throughout the specific corridor.

The discussions next evolved to the details of the "phased approach for design of widening of Interstate routes. Gary Sharpe summarized the phased design concept in terms of the following:

> It was noted that pavement for the Interstate System had for the most part been in service for approximately 30 years. Traffic volumes, percentages of trucks, and the sizes and weights of vehicles had increased during the life of these pavement sections. All of these conditions have contributed to the need for both extensive rehabilitation of the pavement and also construction of additional lanes on the Interstate System to accommodate the need for increased capacity.

Typically, projects for pavement rehabilitation and projects for capacity improvements have evolved separately and their scheduling have not been correlated. The ever increasing traffic volumes on the Interstate System has further complicated the development of pavement rehabilitation projects because of long delays during construction when the number of lanes on the Interstate had been reduced to one lane in each direction. Interstate widening projects, on the other hand, typically have been developed so as to provide two lanes of traffic in each direction during construction.

With the above introductory comments, Mr. Sharpe introduced the concept of "phase development for plans." Mr. Sharpe first noted that it was recognized that there may be some sections where construction of an additional lane in each direction would provide only a minimum increase in level of service but emphasized that it was the Cabinet's desire to first provide a consistent six-lane section for I 75 and I 65 from state line to state line before initiating additional construction to provide additional lanes for other selected sections. The concept of "phase development of plans" was summarized in the following three phases:

Phase I: **Widening of Bridges**

All mainline bridges are proposed to be widened to a six lane typical section for Phase I. If capacity analyses indicate additional lanes are required during the line and grade phase of plan development, it is proposed that this work be addressed in Phase III with the concurrence of the project team. Where cross road bridges must be reconstructed to accommodate roadway widening, cross road bridges will be lengthened to accommodate future roadway widening (in excess of a six lane typical section as determined appropriate from capacity analyses). However, should reconstruction of cross road bridges not be required during construction of an initial six lane section, lengthening of cross road bridges to accommodate widening in excess of a six lane typical section will be done in Phase III.

Phase II: **Roadway Widening**

Roadway widening may be addressed from any of the following perspectives:

<u>Phase II a:</u> In those instances wherein pavement deterioration is such that immediate action is necessary but that capacity improvements may be deferred for a short time, this phase will involve widening the inside shoulders for maintenance of traffic during construction.

Under this scenario, mainline bridges will be widened to an ultimate six lane typical section. Inside shoulders will be constructed to a "structural pavement design" consistent with the structural requirements for ultimate widening. The additional width of widened inside shoulder will be only that required to maintain two lanes of traffic during construction. Under this scenario, ultimate construction of the six lane section will follow in a Phase III which will involve construction of median storm drainage systems, median barrier wall, flattening of embankment slopes and cut slopes to meet current design criteria, and if necessary, construction of truck climbing lanes or other lanes to meet future capacity requirements. Designs developed in this phase will be developed such that there will be no "throw away construction" for future construction in subsequent phases.

<u>Phase II b:</u> In those instances wherein the need for pavement rehabilitation and widening of the Interstate for capacity improvements coincide, or when pavement rehabilitation has been completed and capacity improvement is the primary concern, it is proposed to widen to the inside with a six lane typical section in this phase. This would include construction of median storm drainage systems, median barrier wall, flattening of embankment slopes and cut slopes to meet current design criteria, as well a pavement rehabilitation for long-term structural reinforcement of the pavement. Under this scenario, construction of truck climbing lanes or other lanes to meet future capacity requirements would be deferred to Phase III.

Phase III. All Other Work

The definition of Phase III work is variable dependent upon the specific conditions for a given project section. In all instances, mainline bridges will be widened to at least a six lane typical section in Phase I. Should capacity analyses indicate that additional lanes for both roadway and bridges may be required at a later date, the concept of phasing construction of this work will be studied during the "line and grade" phase of plan development and the specifics for Phase III work specifically defined by the project team. Similarly, the need for reconfiguration or reconstruction of interchanges will be studied during the line and grade phase of plan development with the specifics for phasing this work defined by the project team. In some instances, more difficult interchange development problems may be treated as separate projects.

The above briefly describes the concept of phase development of plans for pavement rehabilitation and widening of the Interstate System. **It should be noted that it is not the intent of the Phase III work to avoid construction of any necessary work on the Interstate System. To the contrary, it is the intent of the plan development Phases I and II to complete all work which can be done within the limits of the existing right-of-way or with minimum strip takings. All work deferred for Phase III will be completely defined during the line and grade phase of plan development but may be separated into additional phases for construction as necessary on the basis of project team recommendations or other constraints.** Use of this approach will afford the Cabinet more flexibility in the use available funding by allowing the expenditure of available funds on those sections of Interstate having the greatest need from both the pavement performance perspective and the capacity improvement perspective. Data from the Cabinet's Pavement Management database will be used to make relative comparisons of pavement conditions while capacity analyses conducted at the line and grade phase will identify capacity improvements needed beyond a six lane typical section.

Work done in Phase III also may be that work needed immediately (as a part of Phase I / Phase II) but of necessity deferred because of major right-of-way acquisitions (including relocations), or significant relocations of utilities (fiber optics lines, gas transmission lines, electric power transmission lines, etc.) which would have delayed other work otherwise not impacted. Also, while not anticipated, work potentially affected by major environmental actions would be deferred to the Phase III portion of project development. Again, as was emphasized earlier, the intent of the Phase III work is not the avoidance of any necessary construction, it is instead intended to provide a mechanism for plan development and scheduling of construction projects to minimize the delays of large overall improvement efforts because of conditions for isolated locations within a given corridor. The development of all phases of work through the line and grade phase and then using information available at that time will provide the opportunity for the best scoping of the overall project needs while at the same time providing a mechanism for scheduling needed pavement rehabilitation and capacity work on a given Interstate corridor to best utilize available funding.

Thus the proposal for phase development of plans (Phases I, I, and III) is proposed for implementation of Interstate Widening and Pavement Rehabilitation projects. It should be noted that the current draft Six Year Plan includes a mixture of pavement rehabilitation projects and widening projects on the Interstate System. With the approval of the phased approach presented above, as projects evolve through the line and grade phase of project development, information will be available for refining costs and project schedules to reflect specific project conditions. In some situations, the complete project (Phases I, II, and III) may be grouped as one construction project as has been our past practice. In other situations wherein specific project conditions or constraints of available funding may result in long delays for completion of the overall project, breaking the project into phases will allow for optimum use of available funds and will minimize the time of delivery for needed improvements on the Interstate System.

During the October 3, 1997 meeting, FHWA staff expressed concern that development of plans in phases would simply be a means of avoiding the Phase III work. Transportation Cabinet staff emphasized this was not the case. It is for that reason that development of the complete project (Phase I, II, and III) through the line and grade phase of project development has been emphasized. It also should be emphasized that only in those situations wherein the Phase III work will significantly delay the overall project or wherein the Phase III work may not be needed (truck climbing lane, auxiliary lane on a ramp, etc.) until a future date, or wherein funding constraints limit completion of the overall project will actual construction be separated into the phases of plan development described above. It is anticipated that the majority of projects will address all issues in a single construction project.

MINUTES OF MEETING
OCTOBER 23, 1997

Corridor Approach For Pavement Designs
Interstate Widening and Pavement Rehabilitation Projects

This is to document discussions held on October 23, 1997 regarding the concept of a "Corridor Approach For Pavement Designs for Interstate Widening and Pavement Rehabilitation Projects." The meeting was held at 8:00 AM on October 23, 1997 in the office of the Kentucky Division, Federal Highway Administration. Gary Sharpe represented the Transportation Cabinet. Representatives of the Federal Highway Administration were Jesse Story, Division Administrator, and the following representatives of FHWA Staff: Dennis Luhrs, Tom Pilling, and Dudley Brown.

The meeting was initiated by Gary Sharpe with an overview of the Phased Design Concept for Interstate Widening which had been discussed with Federal Highway Administration Staff on October 3, 1997. The details of this discussion were similar to those presented on October 3, 1997 and are referenced by the "MINUTES OF MEETING, OCTOBER 3, 1997, Phased Design Concept for Interstate Widening." Mr. Sharpe further advised that the focus of the October 23, 1997 meeting was to discuss a "Corridor Approach For Pavement Designs for Interstate Widening and Pavement Rehabilitation Projects" but also emphasized that this approach to pavement design was a parallel effort to the "Phased Design Concept for Interstate Widening" discussed on October 3, 1997. Mr. Sharpe further noted that when the Interstate System was initially constructed in Kentucky, the approach to pavement design was relatively simplistic. Initial pavement designs on the Interstate routes typically were 10 inches Portland Cement Concrete Pavement placed over 6 inches Dense Graded Aggregate Base or were 7.5 inches Asphalt Concrete Pavement over 15 inches Dense Graded Aggregate Base. As experience in pavement design methodology evolved in Kentucky, later Interstate routes involved minor variations in the flexible pavement design but for the most past these designs were the mainstay for pavement designs on the Interstate, regardless of the levels of traffic or geotechnical conditions. This approach to pavement design was used for pavement design on Interstate routes until the mid 1980's when a project specific approach to pavement design was implemented. Mr. Sharpe noted that the proposal for a corridor approach to pavement design was a variation of the earlier simplified approach but supplemented to involve a matrix of computed pavement designs for a range of conditions for traffic loading (Equivalent Single Axle Loads (ESALs) and subgrade bearing capacity (California Bearing Ratios (CBRs)).

With the brief introductory comments discussed above, the following proposal for a corridor approach to pavement design for Interstate Widening and Pavement Rehabilitation projects was presented:

Three Levels of ESALs for Pavement Design at 20 Years:

30,000,000 ESALs,
50,000,000 ESALs, and
70,000,000 ESALs.

Four Levels of Subgrade Strength:

CBR 2 for poor quality, low bearing capacity soil subgrades,
CBR 4 for moderate to high quality soil subgrades with moderate to high bearing capacity,
CBR 7 for poor quality rock roadbed subgrades (limestone interbedded with shale or clay), and
CBR 11 for high quality durable rock roadbed subgrades.

Two Alternate Pavement Designs for Each Level of ESALs and CBR:

Asphalt Concrete Alternate, and
Portland Cement Concrete Alternate

Three Levels of Existing Pavement Designs:

Existing Portland Cement Concrete Pavement
Existing Asphalt Concrete Pavement
Existing Composite Pavement (2 thicknesses of existing overlay, one thick and another thin).

The above matrix of potential conditions involves 144 possible combinations of pavement designs which will be developed for Interstate Widening and Pavement Rehabilitation projects. Each of the 144 combinations of pavement designs will be evaluated for a 50-year analysis period of 100,000,000 ESALs whichever is least. **Life cycle cost analyses will be evaluated for the following conditions:**

Range of discount rates (0%, 2%, 4%, 6%, 8%, and 10%),

Zero Annual Maintenance Costs,

Periodic Rehabilitation Costs associated with Extending the Structural Life of the Pavement for 50 years or 100,000,000 ESALs (whichever is least),

Fixed User Delay Costs for Construction Delays (assumed for length of corridor),

Salvage Value of the Existing Pavement using Two Approaches:

Value of the remaining pavement as recycled aggregate, and
Value of the remaining pavement associated with the value of a new pavement constructed to satisfy structural requirements for the remaining structural life of the existing pavement.

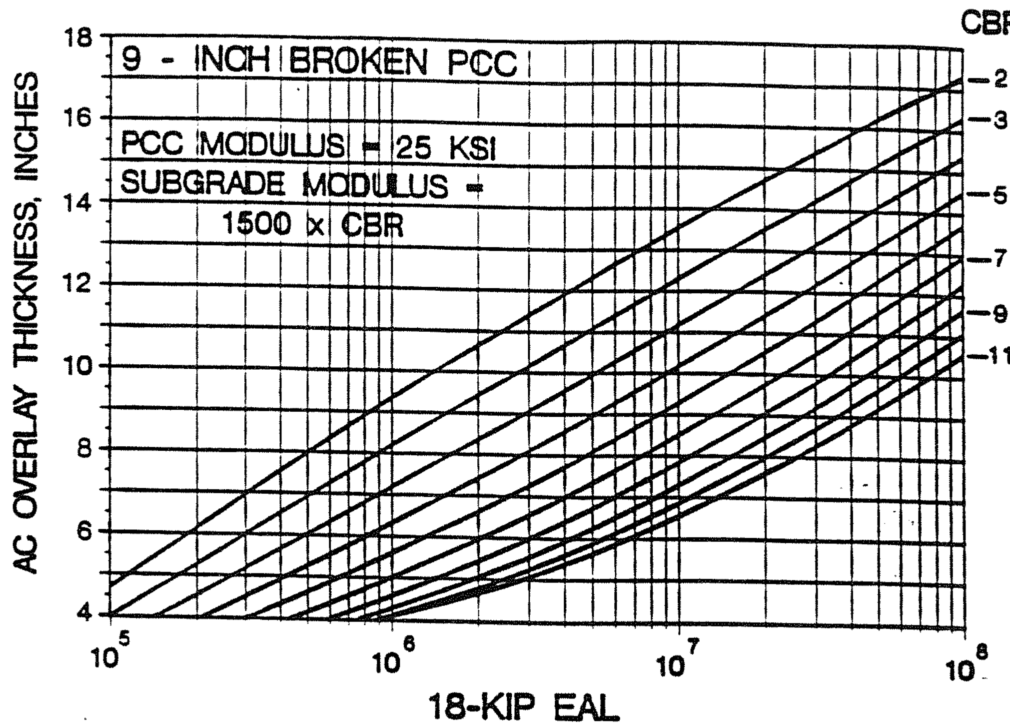
Two procedures were discussed for completion of life cycle cost analyses. These procedures will include the procedure currently used by the Cabinet which is generally consistent with the procedure detailed in the 1993 AASHTO Guide for Design of Pavement Structures, and also using a procedure developed by the University of Kentucky Transportation Center and currently being evaluated for implementation by the Transportation Cabinet.

The ultimate objective of this analysis is to develop a Catalog of Pavement Designs to be used for design of pavement for Interstate Widening and Pavement Rehabilitation projects.

The meeting concluded with a brief discussion involving consideration for bidding of alternate pavement types under certain situations. Generally, these discussions involved the following areas: stimulation of competition, and the use of warranties for pavements.

There also were discussions regarding innovative contracting practices: Specific topics of discussion included A+B contracts, Lane Rentals, and Performance Warranties.

6



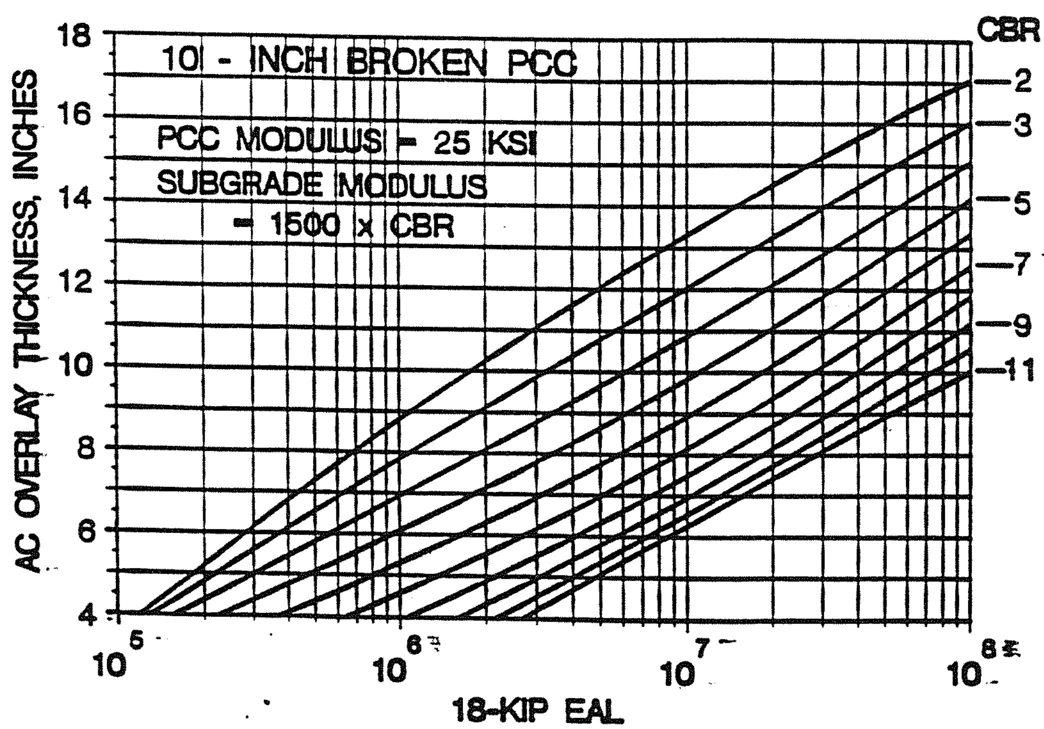
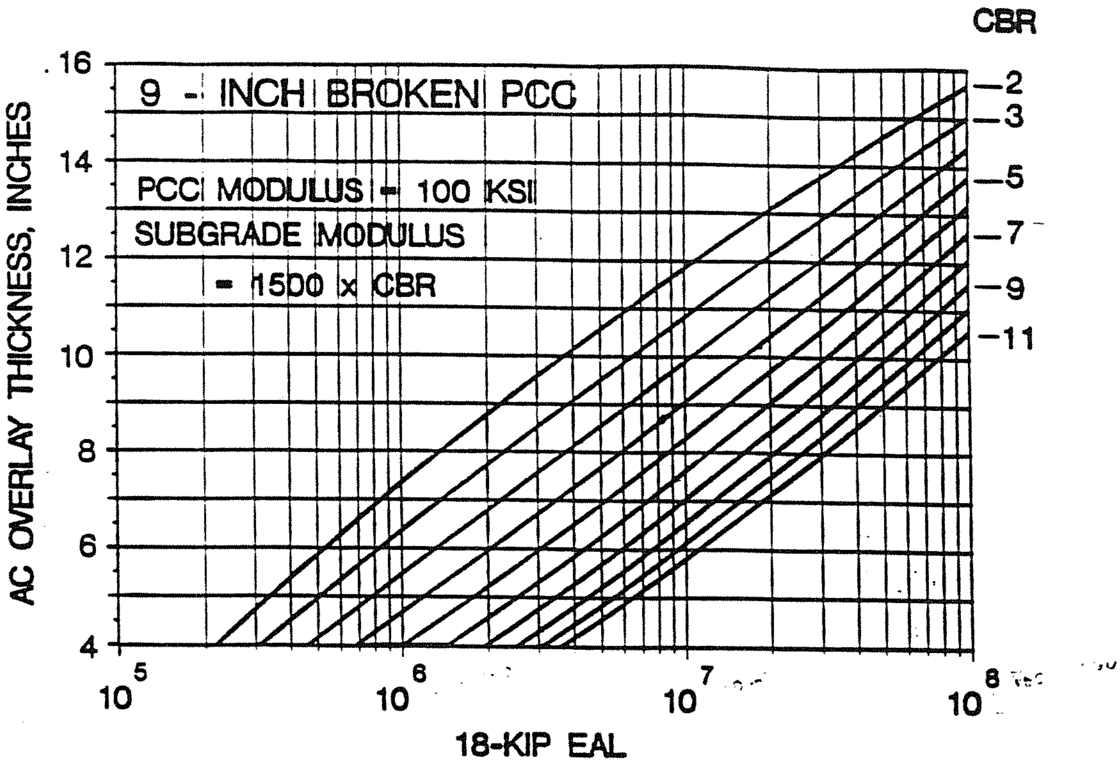


Figure 16. Thickness Design Curves for Asphaltic Concrete on Broken and Seated Portland Cement Concrete Having a Young's Modulus of 25 ksi.



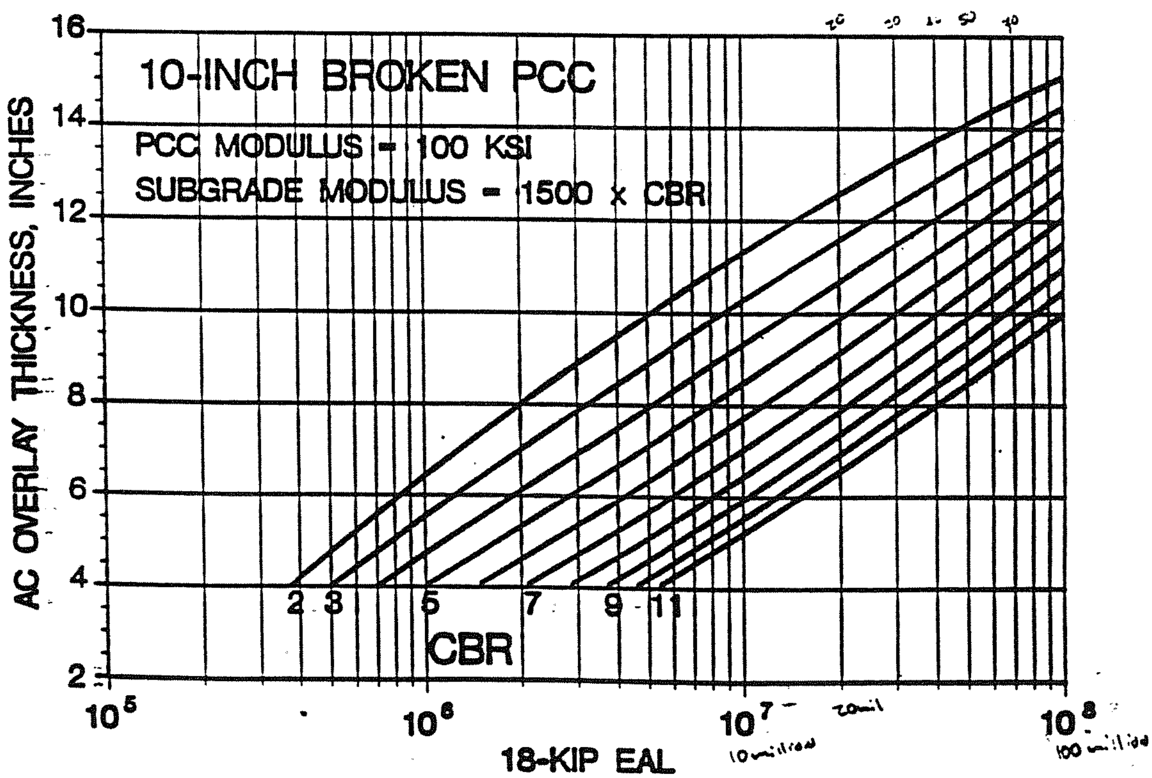
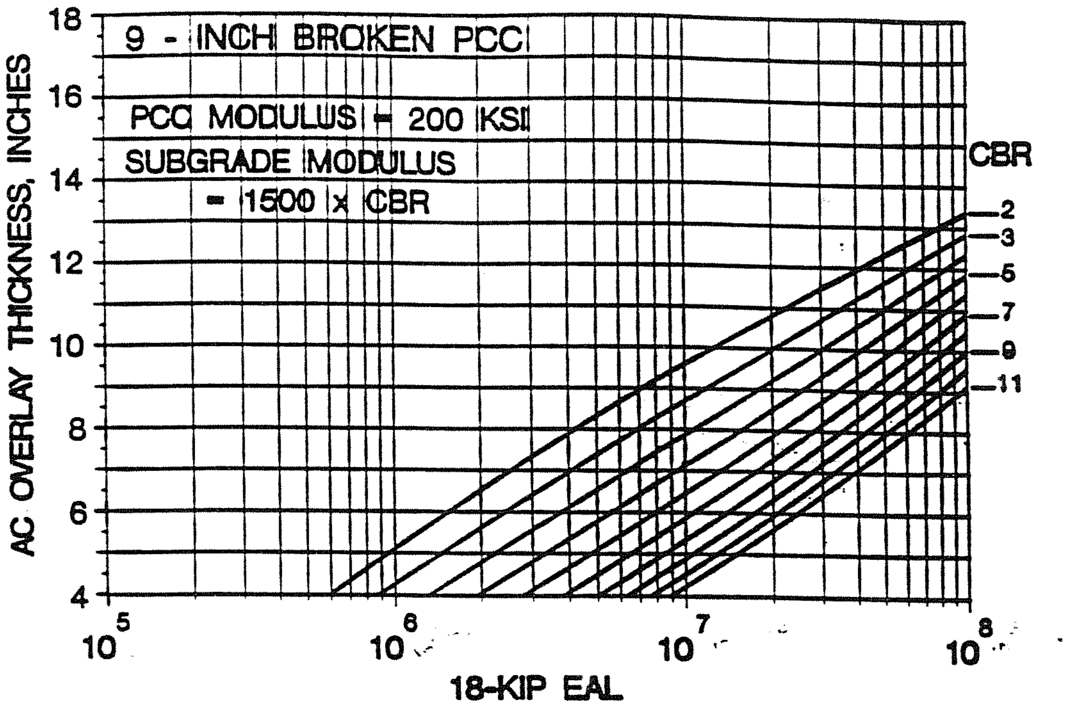


Figure 17. Thickness Design Curves for Asphaltic Concrete on Broken and Seated Portland Cement Concrete Having a Young's Modulus of 100 ksi.



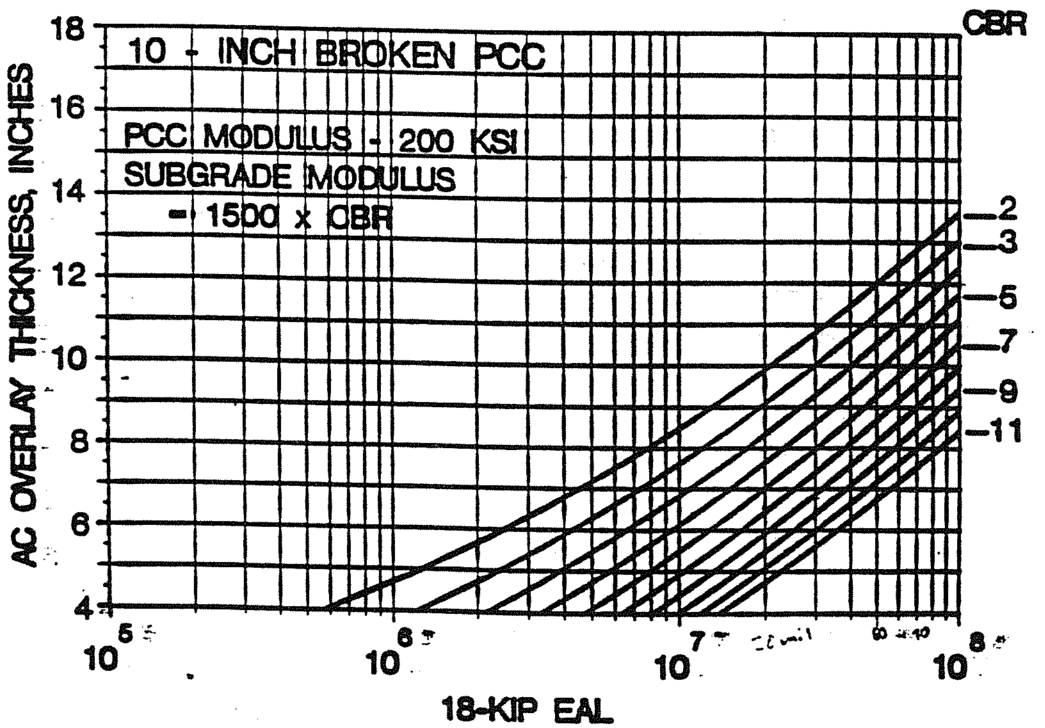


Figure 18. Thickness Design Curves for Asphaltic Concrete Broken and Seated Portland Cement Concrete Havir Young's Modulus of 200 ksi.

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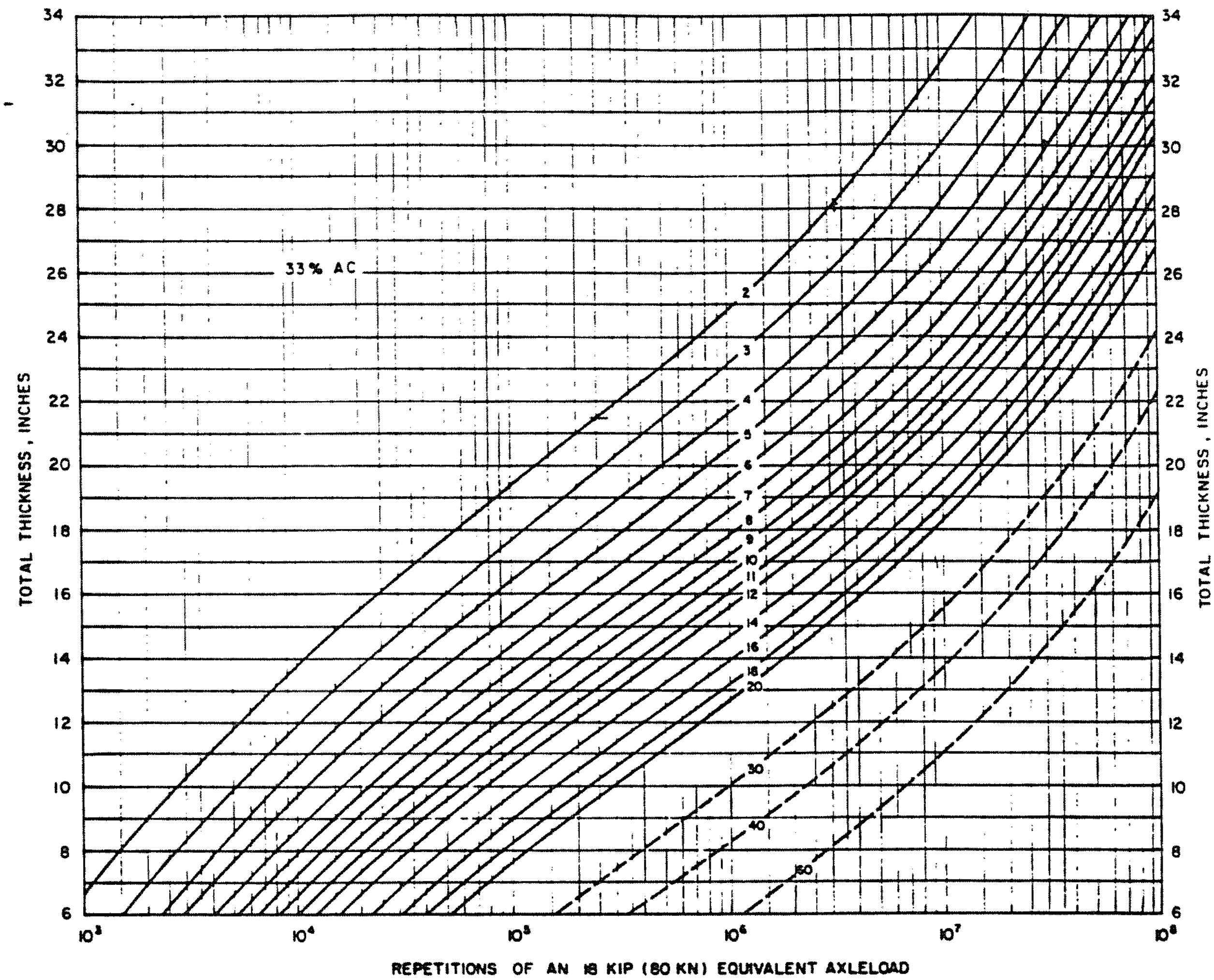
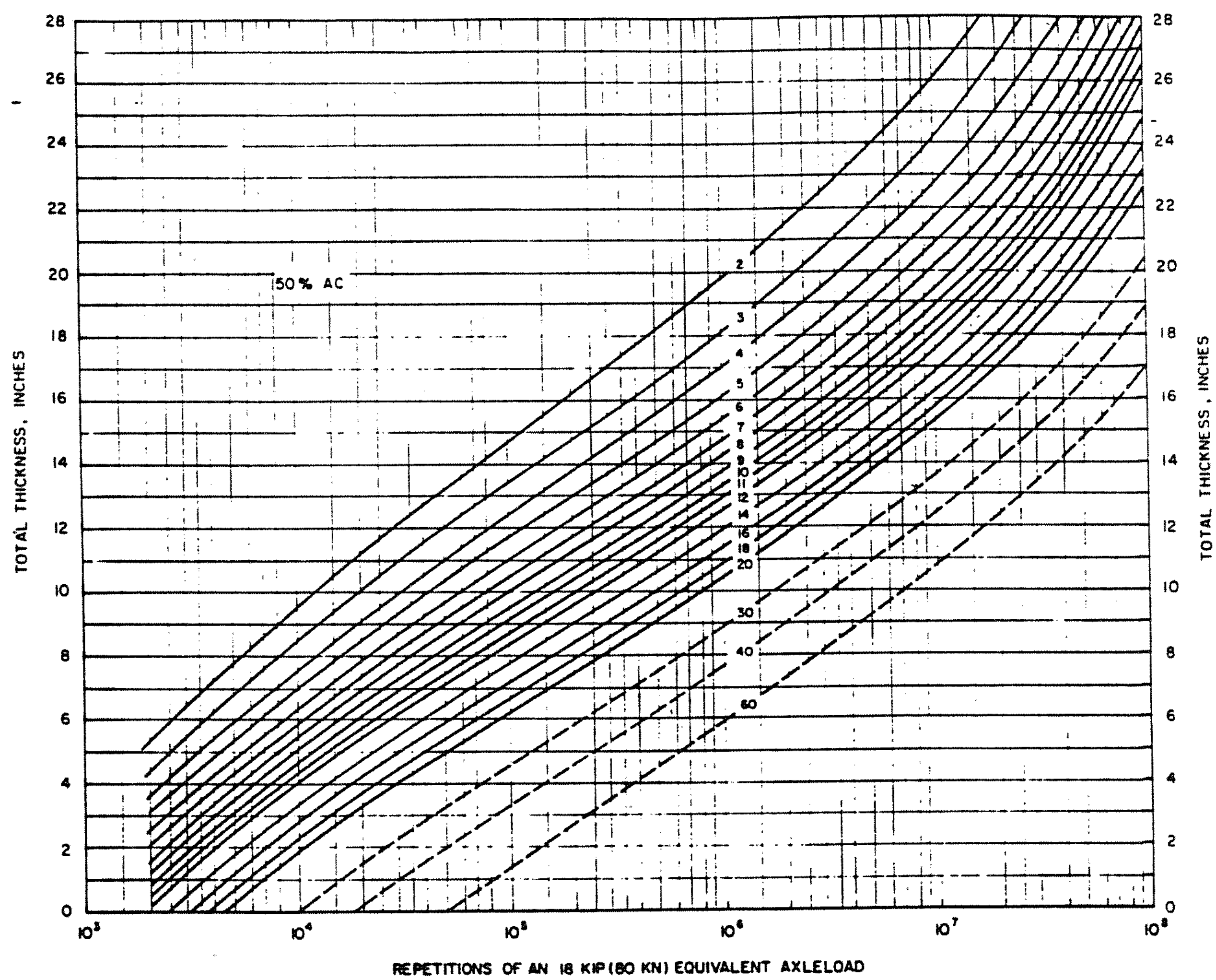
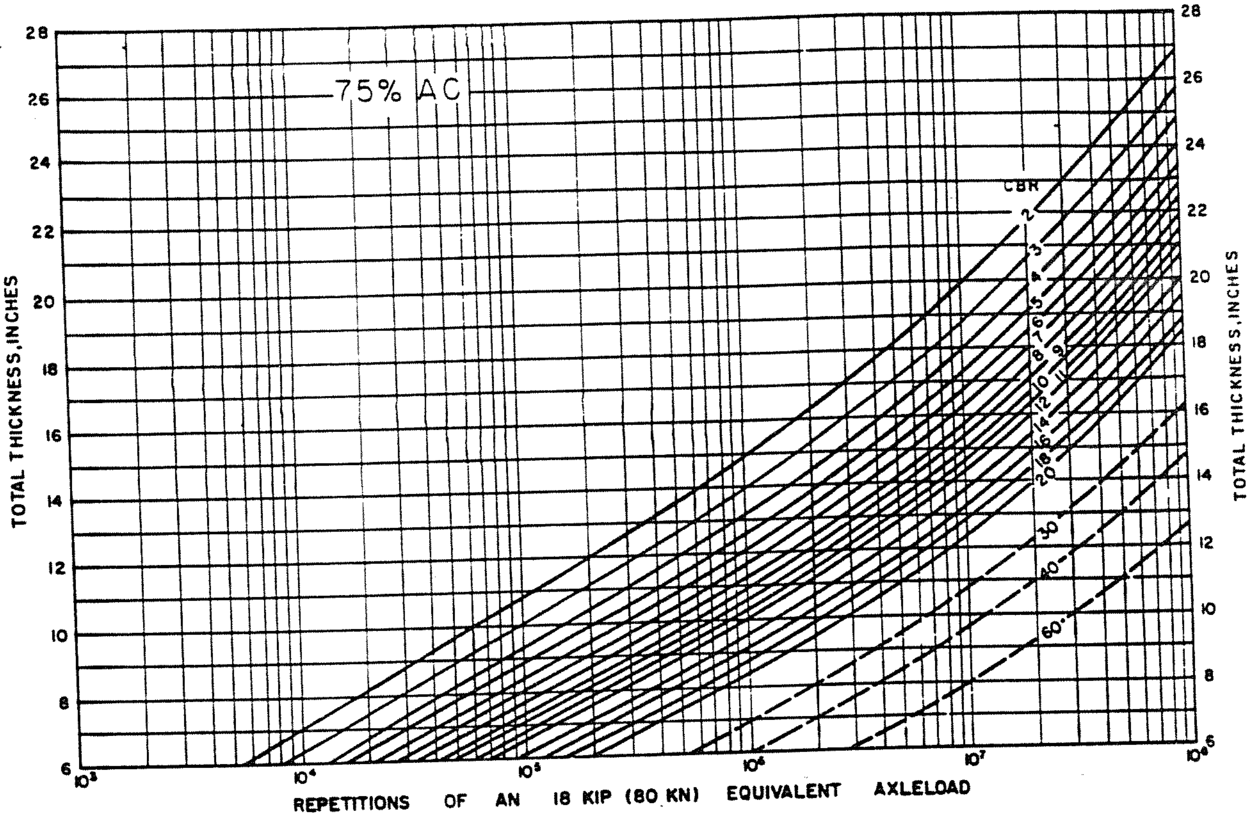


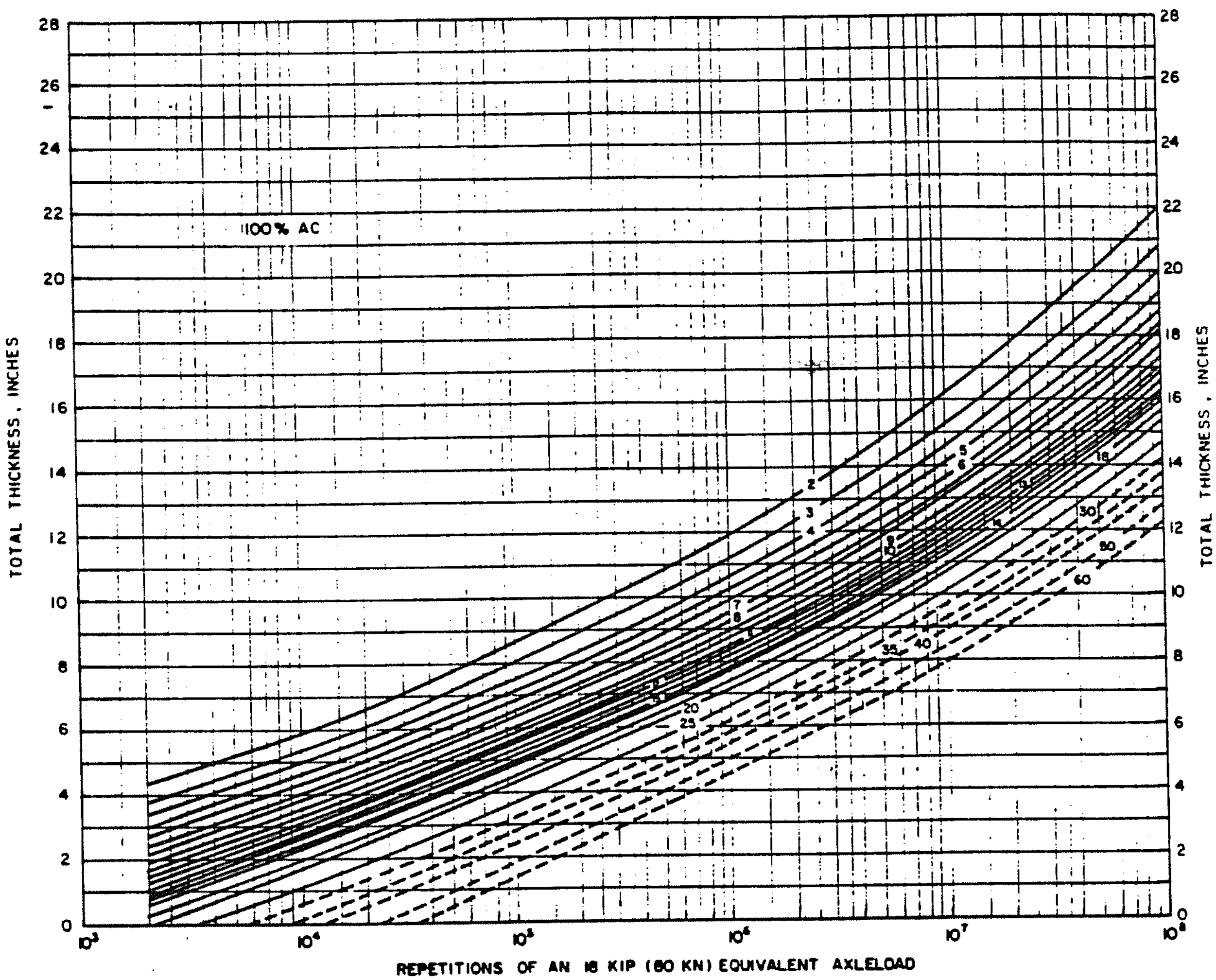
Thickness Design Curves for Pavement Structures Having 33 Percent Asphaltic Concrete Thickness of the Total Pavement Thickness.



Thickness Design Curves for Pavement Structures Having 50 Percent Asphaltic Concrete Thickness of the Total Pavement Thickness.

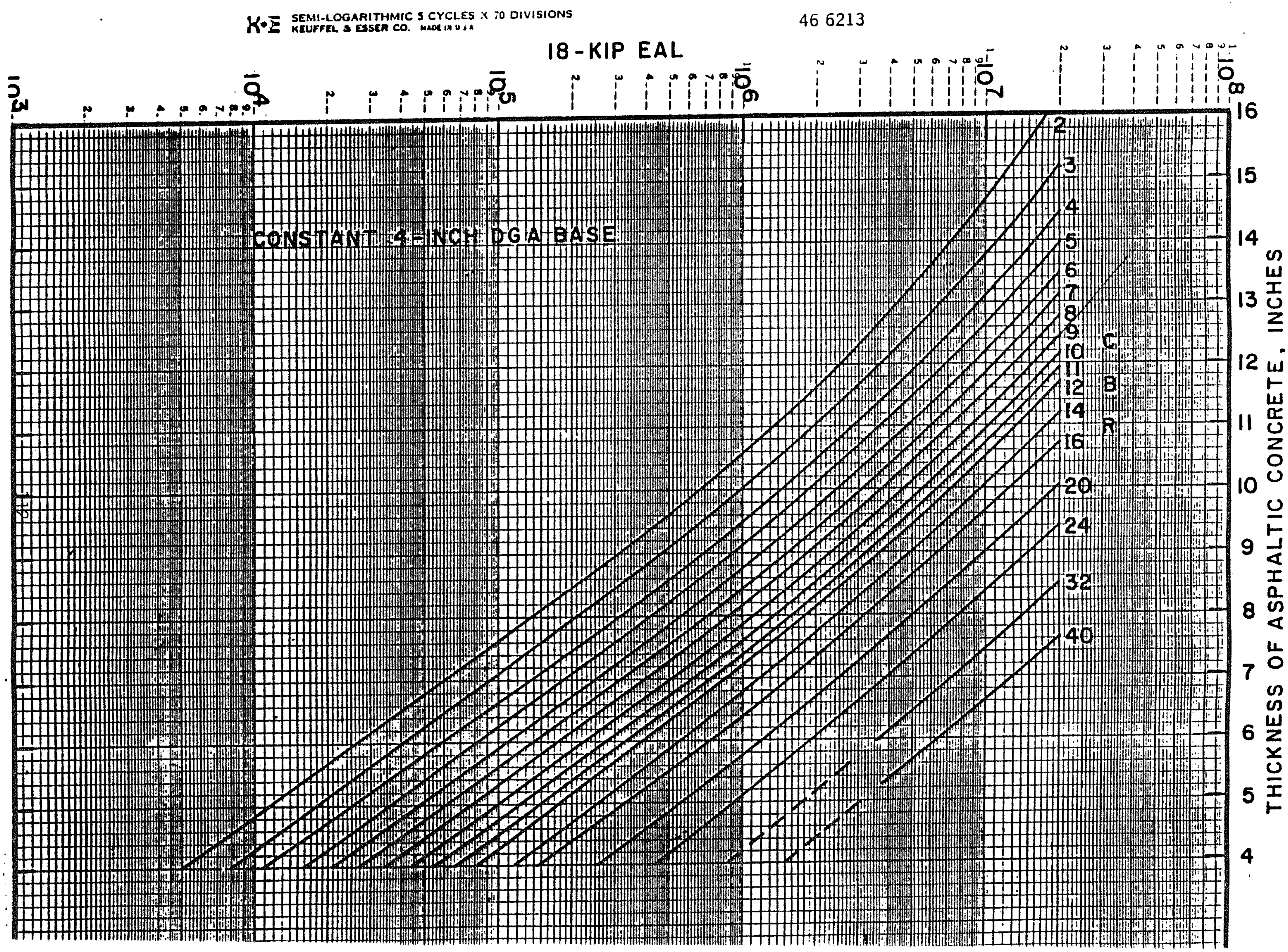


Thickness Design Curves for Pavement Structures Having 75 Percent Asphaltic Concrete Thickness of the Total Pavement Thickness.



Thickness Design Curves for Pavement Structures Having 100 Percent Asphaltic Concrete Thickness of the Total Pavement Thickness.

14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.0330 SOIL STABILIZATION - All subgrade soils having a CBR of 6 or less are recommended for stabilization. Subgrade modification typically is not used for small projects or projects with less than 50,000 ESALs per year. Consider subgrade modification for projects with more than 50,000 ESALs per year. The minimum thickness of subgrade modification is 200 mm and it is used over the full pavement width (edge of shoulder to edge of shoulder.) The stabilized subgrade soil layer typically is treated as an improved subgrade when greater than or equal to 600 mm in thickness. This increases the design CBR to somewhere between 7 and 11. When the stabilization is less than 600 mm in thickness, the CBR is considered unchanged and the stabilized subgrade soil layer instead is treated as a structural layer of the pavement structure using an AASHTO layer coefficient (usually a = 0.08). Methods for stabilization may be characterized into two broad categories: mechanical stabilization and chemical stabilization.

Methods for mechanical stabilization of subgrade soils include the following approaches:

a. controlling subgrade density-moisture,
b. undercutting poor materials and backfilling with granular materials,
c. proof rolling and re-rolling of the subgrade,
d. using granular layers, and
e. using granular layers reinforced with geotextile fabrics.

Blending aggregate with coarse grained granular soils may increase the strengths of the stabilized layers to strengths similar to that of aggregate bases. However, blending aggregate with fine grained soils with high clay contents may do nothing to increase the bearing capacity of the soil or at best will be minimally effective. Therefore, no structural credit is given to this procedure.

Chemical stabilization consists of mixing hydrated lime or cement to fine grained soils. Portland cement is more effective at stabilizing coarse grained or silty subgrades. Hydrated lime has been demonstrated to be more effective at stabilizing fine grained soils with high clay content. Typically, blending about 5-6 % of hydrated lime or portland cement by dry weight with the subgrade soil is sufficient.