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Keyway Curb Construction Report

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Construction Report
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Prepared in cooperation with the
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16. Abstract

This report describes the procedures, problems, and costs of installation of a keyway type curb. Cost effectiveness of keyway curbs will be evaluated during this study by tracking the performance, durability, and cost of maintaining a section of curb that was installed on US 24 in Colorado Springs.

Implementation:

Based on the findings of this study, recommendations for uses of keyway curbs will be made.

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KEYWAY CURB

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I. Background

Key Way Curbs are slip formed concrete installed on the surface of asphalt pavement. The curb is locked to the pavement in a keyway about one inch deep by three inches wide that is milled into the surface of the pavement. The concrete curb is slip formed over the keyway and tied to the asphalt pavement by the key that is formed. The concrete curb, which is reinforced with fibers, is 10" wide at the bottom and 6" high. There is no fill behind the curb. That means the curb must rely completely on the strength of the concrete and the keyway joint for its strength and support.

In a brochure from Key Way Curb Co. claims are made for installation of up to 4000′ per day, cost savings of 30% to 50% over conventional curb and gutter, and elimination of the vertical seam where the asphalt meets the concrete of a conventional curb and gutter (Appendix 1).

In February of 1992 a proposal to study key way curb was approved but various problems delayed the project. In 1993 project NH-FC-STE(CX) 024-3(32) was constructed. It included 1316′ of key way curb on US 24 east of I 25 in Colorado Springs. The curb, which was installed by the Key Way Curb Company of Colorado Springs is located in the median just east of the interchange with Circle Dr.

II. Construction

A. Milling the Keyway

After several delays, mostly weather related, Bill Harger of Key Way Curb Company started milling the keyway on US 24 on Tuesday, November 16, at about 9:00 AM. The plans called for 800′ of curb with about 350′ in the westbound lane and about 450′ in the east bound lane, both on the median. The total was later increased to 1316′.

There are no CDOT specs for key way curb. Figure 1 is a detail from CDOT plans. It was taken from a drawing in the contractor's brochure (see appendix 1).

The first cut with the milling machine did not look good. As Figure 2 shows, the keyway was less than 1/2"deep, about 2 - 1/2" wide, and had a rounded bottom and sides. The CDOT engineers were concerned about both the depth and shape of the keyway. It did not match the drawing in the plans in size or shape, and with no square sides would not provide any support for the concrete key to prevent the curb being pushed out of position.

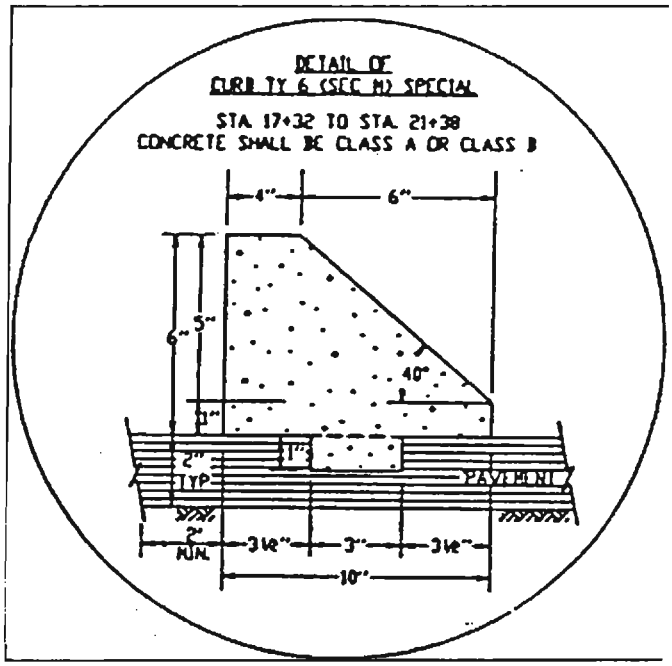


Figure 1

After looking at the keyway and talking to the contractor, the Resident Engineer decided that the keyway would be acceptable with a minimum depth of 3/4". The contractor agreed and

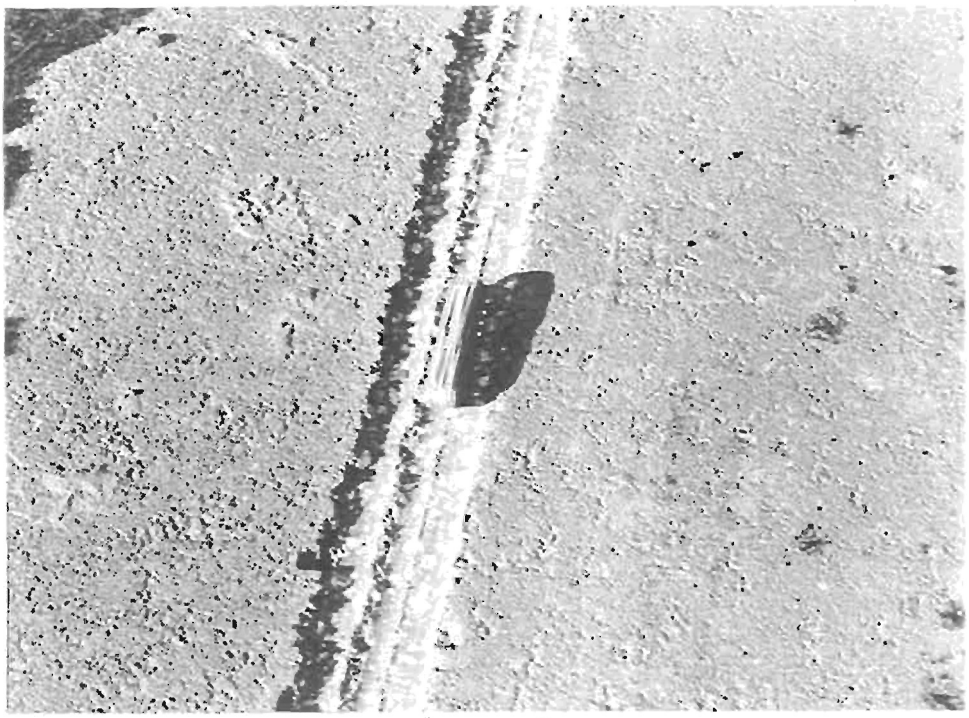


Figure 2

made additional passes with the milling machine.

Figure 3 shows the keyway after two passes. It was 3/4" deep only in spots. Part of the problem may have been due to the asphalt being cold. The contractor tried feeding the machine slower and putting diesel fuel on the pavement to soften it, but still had considerable difficulty getting the keyway to proper depth. In places where the forward movement stopped with the cutter still turning the keyway was deep enough; however, when the machine was moving the cutter rode up over the surface rather than cutting into it. The deep spot in Figure 4 is a place where the machine stopped moving.

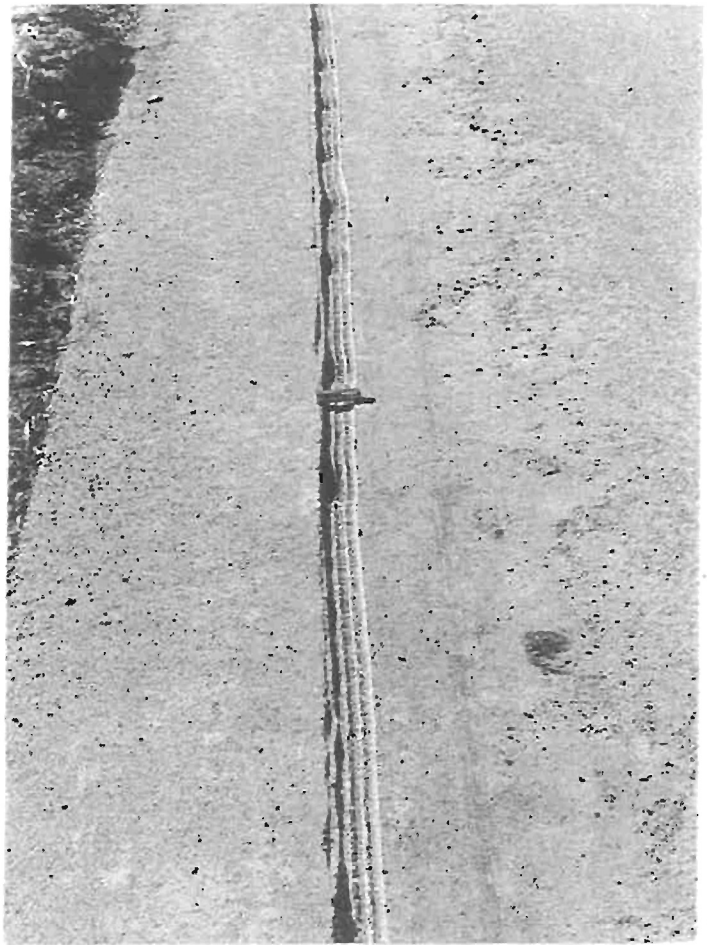


Figure 3

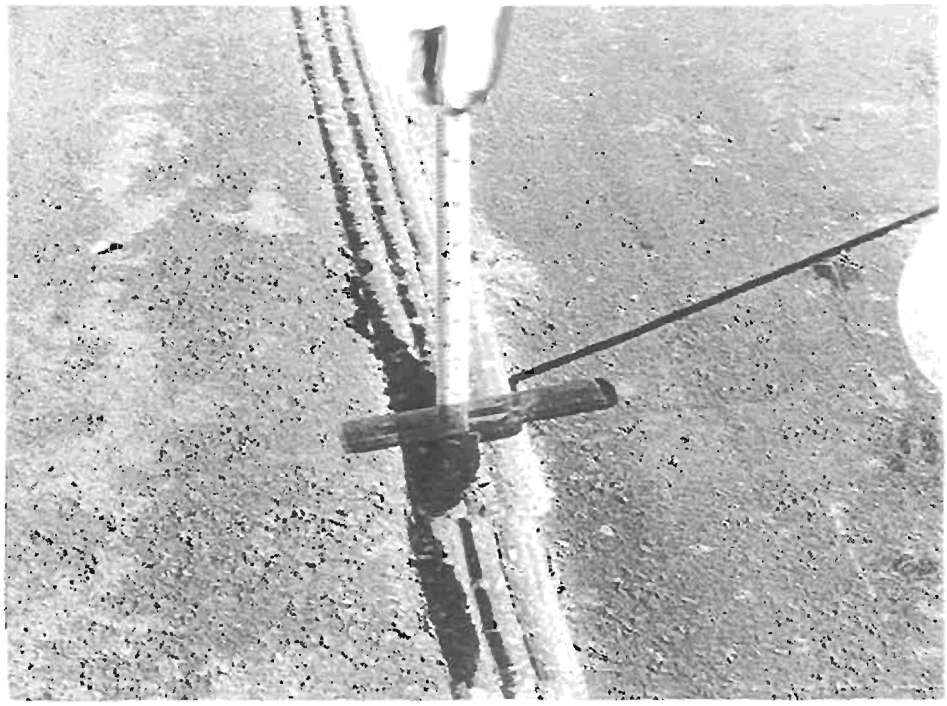


Figure 4

After making several passes with the milling machine the contractor was still not able to achieve a consistent 3/4" depth. The contractor met with the Resident Engineer and was able to convince him that the curb would work with a minimum keyway depth of 1/2" so the curb was poured over a keyway that varied from 1/2" to 1" deep.

B. Pouring the Curb

The machine that formed the concrete curb has a hopper to receive the concrete from the mixer truck, an auger which pushes the concrete from the hopper into the form, a small gasoline engine to drive the auger, and a slipform which rides on the surface of the pavement and shapes the curb. By pushing the concrete through the slipform, the auger pushes the machine forward. This method insures a good curb because the machine cannot move unless there is sufficient mix in the hopper for the auger to be able to completely fill the form. The reader can see the slipform at the back of the machine near the wrench lying on the pavement in Figure 5. The tube just in front of the slipform contains the auger which is chain driven by a small engine hidden under the cover in front of the hopper

Steering the slipform machine was like guiding a toy wagon with a handle that turned the front

Figure 5

wheels. There was no provision for an automatic guide. The operator followed a line that was laid out from the shoulder stripe and marked on the pavement. On the curve the line was made up of chords about 12' long. Figure 6 shows the smooth curve of the finished curb. The straight sections at the west end of the project were smooth and straight.

Figure 6

Near the middle of the curved part of the job in the eastbound lane, the curb height increased to 8". A man had climbed on the right side of the machine to pull the concrete mix down the chute from the mixer truck. His weight on the rear of the machine made it lean to the right which raised the left side of the slip form off the surface of the pavement. This made the height of the back of the curb increase. The contractor noticed the problem and adjusted the machine to compensate for the extra weight. The only effect this had on the curb was added height and a slight tilt of the top of the curb.

III. Costs

The tabulation of bids listed the price of type 2 II-M curb and gutter at $8.50 per linear foot from Lawrence Construction. For the Keyway curb Lawrence Construction bid $18.00 for the original 812 feet. An additional 504 feet cost $5.28 per foot.

A possible reason for the high bid price is the fact that

the general contractor had no experience with the keyway curb and felt that it was necessary to price it high to cover possible problems. At $18.00 per foot keyway curb would not be cost effective for the CDOT.

A direct comparison of $8.50 per foot for type 2 II-M curb and gutter to $5.28 per foot for Keyway curb is misleading. To match the type 2 II-M curb and gutter on this job with a keyway curb requires widening the asphalt surface by 36" to get the same surface width and allow for the placement of the keyway curb. Assuming a thickness of 6" for the asphalt, the extra asphalt costs 2.75_1$ per linear foot of curb. Adding the cost of the extra asphalt to the cost of the keyway curb gives a cost of $8.03 per linear foot. At the prices bid the Key Way Curb saves the CDOT $.47 per linear foot - $618.52 for 1316' of curb. By replacing the 4765 feet of type 2 II-M curb and gutter on the job with Key Way Curb the CDOT could have saved an additional $2239.55 assuming the Key Way Curb performs as stated. However, if the asphalt is thicker than six inches or the cost of asphalt goes up the cost of using Key Way Curb gets higher.

IV. Questions

There are questions to be answered during the evaluation over the next three years:

1. Will the curb break and/or be pushed out of position by snow plows and being hit by traffic?

2. During the winter will water get under the curb and freeze causing it to lift out of the keyway? (Melting snow in the median will drain against the back of the keyway curb along its entire length.)

3. Will the shape of the keyway have an effect on the durability of the curb?

Questions number 1 and number 2 will be answered by observing the curb for a period of three years; number 3 will only be answerable if the curb breaks and the shape of the keyway in the area of the break can be evaluated.

V. Endnotes

This cost for asphalt was figured by: 1. assuming asphalt is two tons per cubic yard. 2. using the contractor's bid prices of $21.90/ton and $30.40/ton for HBP GR C and GR CX respectively 3. using a ratio of 2:1 for the quantities of HBP GR C and GR CX since the Tabulation of bids shows that ratio for total quantities. 4. assuming that the asphalt to replace the pan part of a type 2 II-M curb and gutter would be 6" thick and 36" wide or 1.5 cubic feet.

($21.90 x 2 + $30.40)/3 x 2 = $49.47/cu. yd. = $1.83/cu. ft. cost of asphalt

(36" x 6" x 12")/1728 = 1.5 cu. ft. of asphalt to replace the bottom part of the curb and gutter.

1.5 cu. ft. @ $1.83/cu ft = $2.75/linear ft of asphalt

$2.75 for asphalt + $5.28 for Keyway curb = $8.03 cost per foot to replace type 2 II-M curb and gutter with Keyway curb.

APPENDIX 1

ADVANTAGES OF

KEY WAY CURB COMPANY

Over
Conventional types
of curbs

1. **Quick** installation of up to 4,000 feet per day.

2. **Saves** 30 - 50 % when compared to curb and gutter or vertical curb installation cost.

3. **Eliminates** vertical seams between asphalt paving and the concrete of other curb types. (Very important from an engineering standpoint).

4. **Solves** scheduling problems between paving and concrete companies. ***Key Way Curb*** is installed after paving is completed - giving the completed job a fresh new look.

5. **Automatic** 3 year warranty on a ***Key Way Curb.*** (Unheard of in the industry!)

6. **Conserves** natural resources.

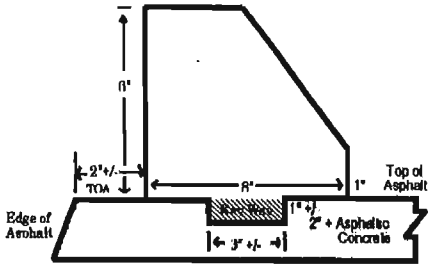
DOT Approved

BILL HARGER
(719) 531-7999

KEY WAY CURB COMPANY

2110 Vickers Dr.
Colorado Springs, CO 80918

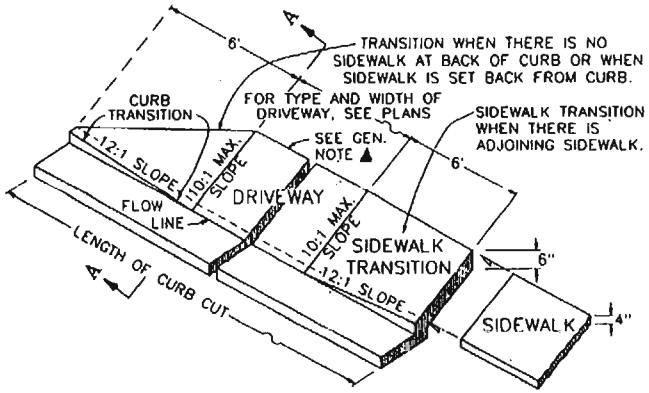
The key way is cut into the pre-existing or freshly paved parking lot and/or street with a custom milling machine as shown above



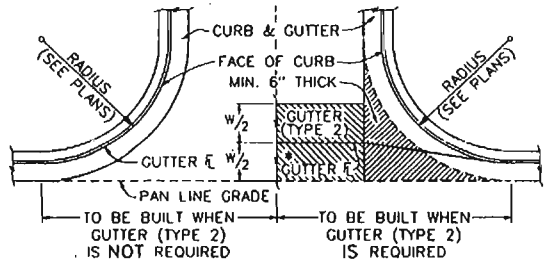
Other Molds are Available

This type of curb construction has been approved by both the State of Colorado and the State of Florida Departments of Transportation.

Engineering and test reports available upon request.



CURB CUT FOR DRIVEWAYS



THIS AREA SHALL BE POURED MONOLITHICALLY WITH CURB AND GUTTER AND PAID FOR AS "CONCRETE PAVEMENT."

* FLOW LINE LOCATION WILL BE ESTABLISHED BY W/2 SHOWN ON PLANS.

CONSTRUCTION OF CONCRETE GUTTERS AT INTERSECTION

LEGEND FOR RADII
A = 1/8" TO 1/4"
B = 1"
C = 1 1/2"
D = 1 1/2" TO 2"

GENERAL

ON CURVES 3 DEGREES AND SHARPER, CURE
ON THE ARC OF THE CURVE UNLESS OTHERW
LENGTH OF 10 FEET MAY BE USED WHEN TH
DEGREES.

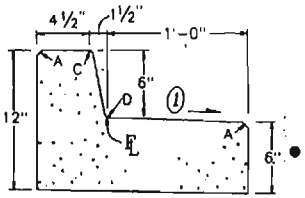
▲ — EXPANSION JOINTS SHALL BE INSTALLED WHE
FIXED STRUCTURE. EXPANSION JOINT MATER
EXTEND THE FULL DEPTH OF CONTACT SURF.

CONCRETE SHALL BE CLASS A OR B.

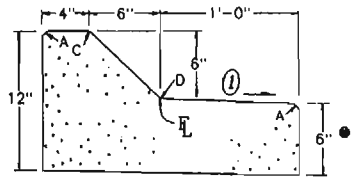
(1) — GUTTER CROSS SLOPES SHALL BE 1/2"/FT.
1"/FT. WHEN DRAINING TOWARD CURB.

PROFILE GRADE OF CURBS AND GUTTERS SH

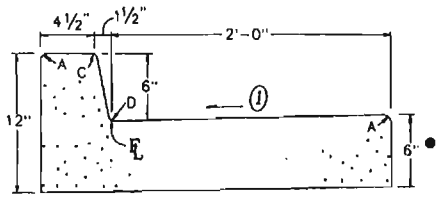
● — WHEN TIE BARS ARE REQUIRED, THE GUTTER
THE PAVEMENT THICKNESS T. BARS SHALL E
AASHTO M 284 AND SPACED 2'-6". THEY S
LENGTH INTO THE GUTTER.



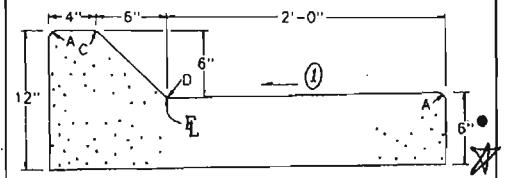
CURB AND GUTTER TYPE 2
(SECTION I B)
(6" BARRIER – 1' GUTTER) 6.25/8.00



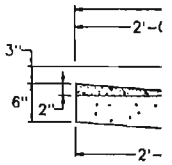
CURB AND GUTTER TYPE 2
(SECTION I M)
(6" MOUNTABLE – 1' GUTTER) 5.50/8.00



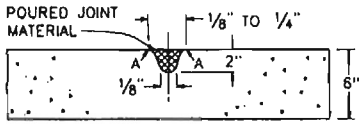
CURB AND GUTTER TYPE 2
(SECTION II B)
(6" BARRIER – 2' GUTTER) 6.00/8.00



CURB AND GUTTER TYPE 2
(SECTION II M)
(6" MOUNTABLE – 2' GUTTER) 6.00/8.50

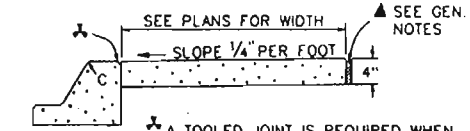


CURB
(4" M



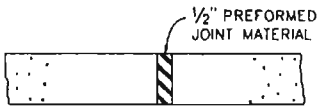
THIS JOINT REQUIRED WHERE LENGTH OF SLAB EXCEEDS 15 FEET.

TRANSVERSE CONTRACTION JOINT FOR CONCRETE PAVEMENT (DRIVEWAYS)



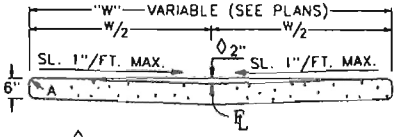
A TOOLED JOINT IS REQUIRED WHEN THE CURB & SIDEWALK ARE POURED SEPARATELY OR MONOLITHICALLY.

CONCRETE SIDEWALK



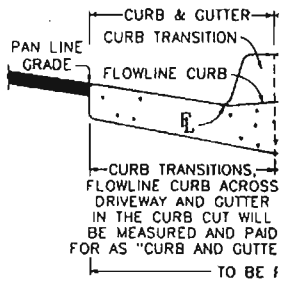
NOTE:
EXPANSION JOINTS SHALL BE PLACED IN THE SIDEWALK AT INTERVALS OF NOT MORE THAN 500 FT.

SIDEWALK EXPANSION JOINT

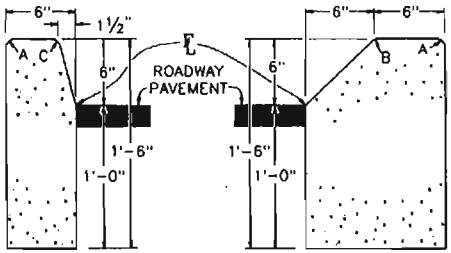


◊ 2" DEPTH WHEN USED AS A CROSSPAN IN AN INTERSECTION

GUTTER TYPE 2

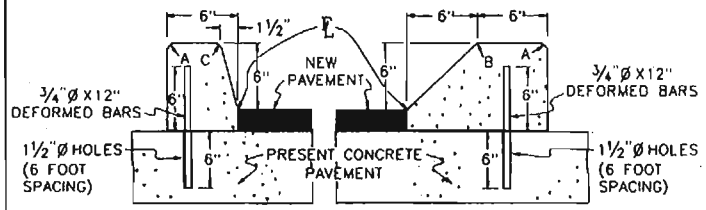


CONCRETE PA
SE



CURB TYPE 2
(6" BARRIER) (SECTION B)

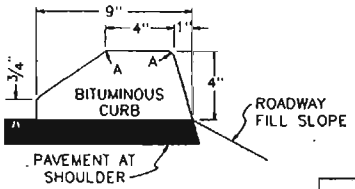
CURB TYPE 2
(6" MOUNTABLE) (SECTION M)



3/4"Ø X 12" DEFORMED REINFORCING BARS AT 6 FOOT SPACING. BARS TO BE GROUTED IN 1 1/2"Ø HOLES IN PRESENT CONCRETE. GROUT TO CONSIST OF 2 PARTS CLEAN SAND AND 1 PART CEMENT. COST OF INSTALLATION IS TO BE INCLUDED IN THE PRICE BID FOR CURB.

CURB TYPE 4
(6" BARRIER) (SECTION B)

CURB TYPE 4
(6" MOUNTABLE) (SECTION M)



CURB TYPE 6
(4" MOUNTABLE) (SECTION M)

DATE REVISED

DEPAR
CU
ISSI
STAFF DE
DATE: NO