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## **DURAFLEX CURB**

**William (Skip) Outcalt**

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**COLORADO DEPARTMENT OF TRANSPORTATION**  
**RESEARCH BRANCH**

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16. Abstract <p>DuraFlex Curb, an erosion control alternate for timber, concrete, or bituminous curbing placed with guardrail, has been submitted for consideration for the CDOT Approved Products List (APL).</p> <p>DuraFlex Curb is made of HDPE in an "L-shape." The vertical arm of the "L" provides a six-inch high vertical section placed at the face of the guardrail posts. The eighteen-inch wide horizontal arm sits flat on the existing pavement and is overlaid with hot mix asphalt.</p> <p>Projects on US-24 in Region 2 and on US-50 in Region 5 were selected for evaluation. On US-24 approximately one thousand feet of the DuraFlex Curb were placed in two 500' test sections. On US-50 approximately two thousand feet of DuraFlex Curb were installed. On the US-50 project approximately seven thousand feet of composite lumber curb were installed for evaluation also.</p> <p>This report evaluates the performance of the two products in comparison to lumber curb.</p> <p>Implementation: In rural locations, where curb is needed along the edge of the pavement to control erosion, DuraFlex Curb or composite lumber curb may provide a weather resistant replacement for lumber curb. However, evaluation for expected water flow and geometry is recommended for each site. The site on US-50 was not suitable for DuraFlex, composite lumber, or lumber curb.</p>					
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# DuraFlex Curb

by

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## **EXECUTIVE SUMMARY**

This study evaluates the use of two innovative products to replace lumber curb at the edge of the pavement in rural locations where water runoff control is needed. The first, DuraFlex Curb, is an “L-shape” made of HDPE. The second is composite lumber – a man-made substitute for redwood or pressure treated lumber used in decks and patios.

On US-24 approximately one thousand feet of the DuraFlex Curb were placed in two 500’ test sections. On US-50 approximately two thousand feet of DuraFlex Curb were installed, and approximately seven thousand feet of composite lumber curb were installed for evaluation.

DuraFlex Curb is an L shape made from high density polyethylene. The six-inch high vertical arm of the “L” is placed at the face of the guardrail posts; the eighteen-inch wide horizontal arm rests flat on the existing pavement and is over-laid with hot mix asphalt. The top lift of asphalt bonds through holes in the horizontal leg of the curb material to the pavement below, essentially making the curb a part of the pavement when it is properly installed.

Composite lumber is made from recycled plastics combined with wood chips. The product used on US-50 was hollow in cross section.

## **IMPLEMENTATION STATEMENT**

In rural locations, where curb is needed along the edge of the pavement to control erosion, DuraFlex Curb or composite lumber curb may provide a weather resistant replacement for lumber curb. However, evaluation for expected water flow and site geometry is recommended for each site.

The site on US-50 was not suitable for DuraFlex, composite lumber or lumber curb for the following reasons.

- Because steep embankments begin at the edge of the highway, often inside the guardrail posts, proper construction of the base for the curb materials was not possible in many places.
- In many places the guardrail was very close to the traveled lanes. Trucks and snowplows often rubbed against it, causing the curb, which is mounted to the guardrail posts, to move and separate from the pavement.
- Steep terrain, combined with periods of heavy runoff, generates water quantities and velocities that are beyond the capabilities of four inch high curbs. When the runoff is not controlled, erosion of the steep embankments can very quickly lead to collapse of the edge of the pavement.

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## 1.0 BACKGROUND

Along rural highways water from rain or melting snow has the potential to do severe damage to the roadway structure in a surprisingly short amount of time. Erosion in mountain areas is often exacerbated by very steep terrain, sparse ground cover, severe weather and the fact that the pavement serves as a collector for runoff. In some locations CDOT uses curbs of various



**Figure 1. Dangerous erosion on US-50.**

designs to keep the water on the pavement surface until it can be directed into prepared drains that route it into natural drainage channels. This report evaluates two new curbs; DuraFlex Curb (DFC) – A new product designed and manufactured specifically as a curb; and composite lumber – a new use for a product common in home building.

In the past, most of Colorado’s rural highway curbs were either extruded from pavement material or pressure treated lumber. Extruded curbs can be made by passing concrete or asphalt through specially designed slip form machines. Extruded curbs (**Figure 2**) are very



**Figure 2. Extruded curb - concrete in this case.**

effective, and are not easily damaged by traffic or normal maintenance operations such as snow removal. However, they are expensive. Repairs are difficult and installation of new extruded curb as part of an overlay project is very difficult if guardrail is already in place, because the machinery cannot operate below existing guardrail.

Pressure treated lumber is an inexpensive curb material that is readily available and easy to install and repair without any special equipment. However, it has a tendency to warp and crack reducing its effectiveness as a curb, and the chemicals used to treat the lumber are hazardous. To make the wood resistant to decay and insects, it is treated with chromated copper arsenate (CCA), or alkaline copper quat (ACQ). The chemicals are hazardous to workers installing the curb and, if they

leach out and into the soil or water, to the environment. Additionally the treatment provides little protection from the effects of the sun and moisture which cause most of the damage to wood curbs.

Highway curb is subjected to periods of complete dryness interspersed with heavy soaking. As wood curb absorbs and gives off moisture, it expands and contracts aggravating its tendency to

split, crack, twist and warp (**Figure 3**). That tendency is what led CDOT to try new curb materials.



In 2005, approximately six miles of lumber curbing was replaced as part of project number NH 05020-055 on US-50 over 11,312 foot high Monarch Pass. In an effort to reduce problems and costs associated with the initial construction and with the maintenance of the highway curb, the CDOT design team selected two innovative products for testing on the project: DuraFlex Curb (DFC) and composite lumber.

**Figure 3. Wood curb can twist and warp.**

## 2.0 TEST SITES

### 2.1 US-24

CDOT's first installations of DuraFlex Curb were on US-24 west of Colorado Springs between Divide and Flourissant. Two locations about three miles apart were chosen for the evaluation of the product, and about 200 feet of DFC was installed at each. One site, at mp 271, is shaded by a mountain during most of the winter; the other site, at mp 274, gets full sun all year long. Both are on the right shoulder eastbound.

US-24 on the west side of 9,200 foot Ute pass, is a two-lane highway with 12 foot lanes, no median and 3 foot shoulders. Center crowned in most places and gently sloping, the winding highway speed limit varies from 35 to 45 mph in the areas of the test sections. Annual average daily traffic is 5,700 with 7.4% trucks.

### 2.2 US-50

Project NH 0502-055, on 11,300 foot Monarch Pass in south-central Colorado, was the second site where CDOT installed DuraFlex Curb and the first use of composite lumber as curbing material. US-50 on the west side of the pass is steep with two through lanes and a passing lane in most places. The speed limit is 45 mph.



**Figure 4. US-50 has steep slopes to both sides.**

Much of the highway is cut into the side of the mountain with steep slopes above and below (**Figure 4**). About 2,000 feet of DFC and nearly 7,000 feet of composite curb was installed on the project. Annual average daily traffic is 2,300 with 20.1% trucks.



**Figure 5. Severe erosion can occur very rapidly.**

Most of eastbound US-50 at the site has guardrail on the right shoulder protecting high, steep embankments. In some areas the guardrail sits just outside the highway shoulder stripe. The area experiences heavy snowfall in the winter and sudden, intense rain storms in the summer. Both melting snow and heavy rain contribute to periods of heavy, fast-moving runoff that, if not controlled, can do extensive damage in a very short time. To make matters worse, the sparsely-vegetated and very steep sandy-gravel embankments (**Figure 5**) are highly susceptible to very rapid erosion. And in many places, they begin right at the edge of the pavement.



### 3.0 CURB INSTALLATION

Normal procedure for installing DFC or lumber curb is to position the curb against the bottom of guardrail posts and tight against the old pavement surface, then power nail it in place before the top lift of asphalt is laid. A close fit between the bottom of the curb and the pavement, together with the edge containment given by the curb during compaction of the top lift, provides a tight mechanical joint between the asphalt and curb. A tight mechanical seal is very important to the long term function of the curb since there is very little or no adhesion between the asphalt and the curb material.

With lumber curbs, the top lift of asphalt presses against the face of the curb providing a tight fit, but any movement opens gaps in the curb. When the top lift of asphalt is laid with DFC, it is placed on top of the horizontal leg of the curb and binds through the holes in the leg to the pavement below. Because the bottom leg of the DFC is contained in the pavement slight movement of the vertical face will not break the bond with the asphalt.



**Figure 6. The edge of the pavement was placed and compacted by hand.**



**Figure 7. Slight movement of the guardrail can render the curb completely ineffective.**

At both sites, most of the new guardrail was installed before the final mat was laid; as the old guardrail was removed new guardrail was placed immediately so that all areas were protected at all times.

Unfortunately, having the block-outs and guardrail already in place prevented the paver and rollers from operating close to the guardrail posts, so the asphalt for about two feet out in front of the curb had to be placed and compacted by hand (**Figure 6**). This resulted in lower density, hence, lower strength in the mat next to the curb.

If a watertight condition can be maintained at the pavement/curb joint, any curb can be effective. However, it is virtually impossible to maintain a watertight joint over long periods with curbing material that relies on the guardrail posts for support. Any impact on the guardrail is likely to move one or more posts, and with them the curb, breaking the seal between the curb and the pavement surface.

US-50 is a winding mountain highway with guardrail very close to the driving lane; it is not unusual for a truck driver to misjudge a corner and rub against the guardrail moving the posts slightly (**Figure 7**). Snow plows sometimes “ride the rail” in an effort to clear as much of the pavement surface as possible. Even the weight of the snow and

ice that a plow throws can be enough to move the guardrail enough to open a gap between the curb and the pavement. A small gap between the curb and the pavement surface is all that is necessary to allow water to escape and begin to erode the shoulder.

#### 4.0 DURAFLEX CURB

DuraFlex Curb is a proprietary product manufactured and sold by Keyway Curb Company of



**Figure 8. Holes in the horizontal leg of the DFC help the layers of asphalt bond together to strengthen the curb.**

Colorado Springs, Colorado. It is made of High Density Polyethylene plastic (HDPE) – the plastic used to make milk and laundry detergent jugs. The original DFC installed on USW-24 was HDPE sheets formed into L-shaped sections with a row of holes punched along one leg (**Figure 8**). The curb was extensively re-designed between the two projects to address some issues encountered on US-24.

The DFC sections on US-24 were cold formed into V-shapes by bending 78 inch by 12 inch sheets of 1/8 inch thick HDPE. A row of three-inch diameter holes punched along one leg were designed to anchor the curb to the pavement by having the asphalt bond through the holes with the asphalt

below the curb.

Integration of the curb into the pavement and the relative flexibility of the material, give the DFC some benefits over wood and composite curb materials. It is relatively impervious to small movements of the guardrail. With the horizontal leg embedded in the asphalt mat, the vertical curb is flexible enough to follow small movements of the guardrail posts without damage. If the guardrail movement is large enough, the nails will pull through the curb material leaving only a



**Figure 9. Without the support of the DFC, the edge of the pavement would have collapsed.**

hole the diameter of the nail head. Unless the event that moved the guardrail also damages the curb, it will remain in place and functional.

By virtue of its L-shape and overlap of the sections, DFC provides a continuous water-flow channel. In fact, the curb can even serve as reinforcement and support the edge of the pavement under some circumstances. **Figure 9** shows an area washed out behind the DFC. Apparently a high volume of water during a very heavy rain overflowed the curb and cut the base out from under the edge of the pavement.

DFC's overlapping design contains water extremely well. However, it also traps



water between the HDPE and the pavement. DFC's strength shown in **Figure 9** is also a potential weakness: Where the curb is embedded in the pavement it may provide a weakened plane and an access path for moisture to get into the pavement. Its efficiency practically guarantees the presence of some moisture all along the curb. In cold mountain locations, freeze-thaw cycles will almost certainly lead to failure if any moisture penetrates the pavement.

#### 4.1 US-24 West of Divide



**Figure 10. Holding DFC tight against the post base and the pavement with a shovel.**

the curb continued to try to flatten out, it actually pulled many of the four-inch nails out of the asphalt. As **Figure 11** shows, the base of the curb was not tight against the pavement in many places. This was partly due to movement in the curb as described, and was partly due to the



**Figure 11. Air gaps between the curb material and the pavement surface.**

uneven surface below the curb. In any case, the gap causes a weak place in the pavement, and provides a path for water penetration.

As **Figure 8** shows on the previous page, the HDPE had a memory; it tried to return to its original flat shape rather than maintain a 90° bend. Because the curb material had partially flattened out, it was difficult for the installers to push it tight against both the bottoms of the guardrail posts and the surface of the asphalt at the same time. They used shovels to hold the curb in place while it was nailed to the pavement along the edge of the horizontal leg (**Figure 10**). (The DFC was not nailed to the guardrail posts on US-24.)

Another problem caused by the curb's memory resulted in bows in the vertical curb face between the guardrail posts. Heat and pressure from the final lift of asphalt on the face of the curb aggravated the effect. This condition, shown in **Figure 12**, was primarily a cosmetic problem. However, if it became too extreme, it would effectively lower the curb's height and reduce its water carrying capacity.

To provide support for the DFC between posts the installers nailed a continuous one-inch steel band to the posts behind the top of the curb



**Figure 12. Wavy curb face between guardrail posts is mainly a cosmetic problem.**



**Figure 13. Steel band was installed to provide support for the DFC between posts.**

as shown in **Figure 13**. While the band was not completely successful in eliminating the bows, it did provide some support for the vertical face of the curb.

In addition to bonding of the two pavement lifts through the holes in the curb material, the



**Figure 14. Cracks along the edge of the HDPE on US-24.**



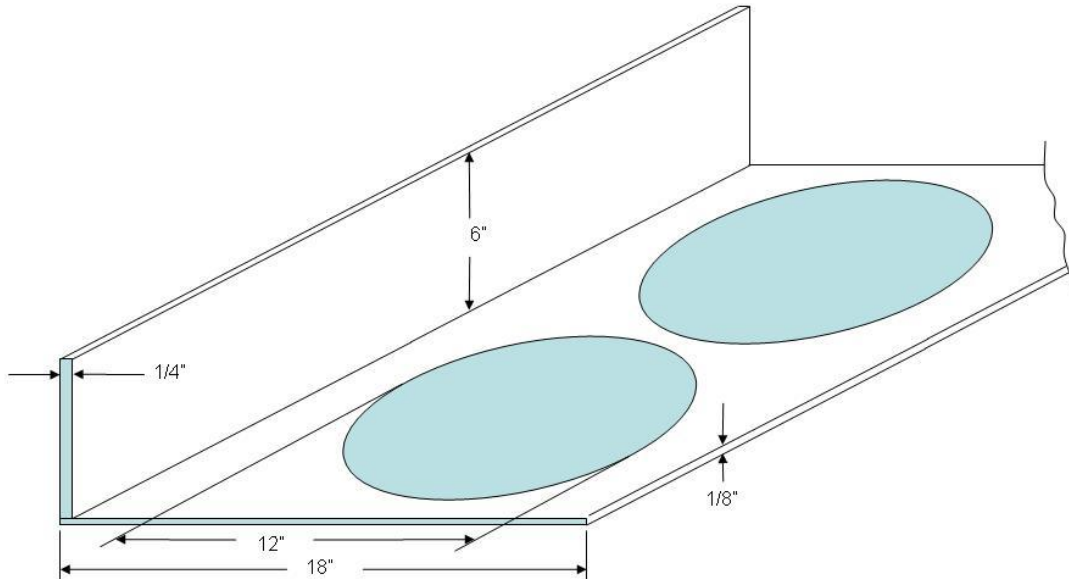
**Figure 15. Cracks are developing at the end and along the edge of the DFC on US-50.**

manufacturer thought the high temperature of the hot mix would soften the HDPE and allow the asphalt to bond to it, effectively making the curb a part of the pavement. However, a short time after construction, evidence of cracking along the edge of the embedded curb seemed to indicate that the bond between the curb and the asphalt did not develop. **Figure 14** shows a developing crack on US-24, **Figure 15** shows similar cracks at the end of a DFC section on US-50.



## 4.2 US-50 on Monarch Pass

Before the Monarch Pass project, the DuraFlex Curb was extensively redesigned. The new curb is extruded with the 90° L-shape rather than a formed sheet. The curb has a 6-inch vertical leg – doubled in thickness to 1/4 inch, and is anchored into the asphalt by an 18-inch horizontal leg.



**Dura-Flex Curb**  
Not to scale

**Figure 16. Drawing of the modified DuraFlex Curb used on US-50.**



**Figure 17. DFC nailed to a guardrail post on US-50.**

The horizontal leg is 1/8 inch thick and has a row of 12 inch diameter holes spaced one inch apart along its length. When the asphalt is laid over the curb, the larger diameter the holes provide more area to improve the bond between the asphalt lifts and help make the curb become a part of the pavement. The curb sections are light and easy to transport and handle - the entire quantity of ±2000 feet for the project was delivered on a 15 foot goose neck trailer.

As on the US-24 project, before the curb was installed, a continuous one-inch-wide steel band was nailed to the posts at the height of the top of the curb to provide

support between posts. The sections of DFC were shingle-lapped with the uphill piece on top of



the downhill one. For the Monarch project, the curb was nailed to the guardrail posts near the top of the curb (**Figure 17**).

### 4.3 DuraFlex Curb Repairs

While neither DuraFlex Curb nor composite lumber curb require regular maintenance, when damage occurs prompt repair is essential. Any damage to the curb or separation between the curb and the pavement surface can lead to extreme erosion in a very short time.

From a maintenance viewpoint, one of the main drawbacks of DFC is difficulty of repair if a curb section must be replaced. Removal of a damaged section, without causing significant damage to the pavement and to the adjacent sections of curb, is difficult. Repairs that require replacement of a curb section will often be the result of damage to the pavement or severe damage to the base. At the location in **Figure 18**, a significant amount of the base material will require replacement. Without removing at least one section of curb there is no way to place and properly compact material to fill the void below the pavement. The fill must be well compacted; it is also very important that the new base be carefully graded so it can properly support the new section of DFC and asphalt.

This picture, **Figure 18**, is a close-up of the damage shown in **Figure 9** above. It shows a section of DFC supporting the edge of the pavement after runoff washed a large hole under it.



The wood post in **Figure 9** is at the right edge of this picture. When the shoulder eroded away, the asphalt from below the DFC also washed out, and took the top lift from above the hole with it. If the asphalt in this area had been properly compacted it would probably have been able to carry its own weight and would not have been carried away by the water.

**Figure 18. Close-up of the washout in Figure 9.**

## 5.0 COMPOSITE LUMBER CURB

Composite lumber, a man made product manufactured from recycled plastic and wood chips,



**Figure 19. A hollow section of composite lumber curb ends at a drain.**

was developed for applications like decks and patios where constant exposure to the elements causes wood to deteriorate rapidly. (Appendix A). The lumber is available in several sizes and colors in both solid and hollow configuration. Composite lumber does not rot, twist, warp and split the way wood curb does. Even though it is somewhat of a specialty item, it is not a proprietary product; there are several manufacturers and many suppliers and it is readily available in a variety of widths and can easily be cut to length using common hand tools.

Composite lumber curbs, like wood curbs, are nailed to the guardrail posts so the bottom of the curb is below the top of the final lift of asphalt or tight against its surface. When the top lift of pavement is placed after installation of the curb, the curb acts as an edge containment for the asphalt. During compaction the asphalt is forced against the curb forming a pressure seal. There is very little adhesion between the materials and no mechanical connection other than the pressure of the asphalt against the face of the curb achieved during compaction.

Composite lumber curbs, like wood curbs, are nailed to the guardrail posts so the bottom of the curb is below the top of the

The composite curb used on Monarch Pass was a hollow 2 x 8 with four cross webs as shown in **Figure 19**. Probably as a result of its hollow nature, the material had deformation problems, a low resistance to buckling and was fairly easily broken. Solid material may have performed better.

### 5.1 Composite Lumber Repairs



**Figure 20. A small movement of the guardrail separated this curb from the pavement.**

Generally, if the curb is damaged, repairs consist of removing the damaged section of lumber, installing a new piece, backfilling any lost base material and patch paving in front of the curb. If the problem is due to the curb being separated from the pavement but not damaged, as happened in **Figure 20**, repairs usually consist of patching the separated area with asphalt. (Crack sealing materials were tried on small breaches between the curb and pavement, but none performed well.) This type of repair led maintenance personnel to form a small berm against the face of the curb using asphalt patching material. The curb

material acts as a back form for the asphalt and, because the patch material adheres well to the surface of the pavement and poorly to the curb, the asphalt berm stays in place if the curb is



moved. This technique results in a curb similar to a slip formed asphalt curb and, although not as durable, it is much cheaper.

**Figure 21** shows an asphalt berm in front of a lumber curb. In locations where the guardrail is repeatedly subjected to small movements, this preventive maintenance treatment can be effective in reducing the repairs needed by the shoulder behind the curb.

**Figure 21. An asphalt berm in front of a wood curb.**

## **6.0 CONCLUSIONS**

DuraFlex Curb and composite lumber curbs are suitable in most areas where there is limited shoulder and the curb needs to be at the face of the guardrail posts. They save valuable space and function as a lateral constraint and formwork to contain the edge of the asphalt. Both can do the job of controlling water and both are less susceptible to weather damage than wood.

### **6.1 DuraFlex Curb**

Because asphalt does not adhere to HDPE, DuraFlex Curb creates a weakened plane in the pavement. A flat, even, smooth base below the curb is very important to form the closest fit possible between the pavement and the horizontal leg of the curb. The closer the curb material fits to the underlying pavement, the better the top lift will be able to bond through the holes in the HDPE. Since water will be able to penetrate into the pavement along any gaps between the curb material and the asphalt, they must be kept to a minimum.

**Figures 14 and 15**, above, show cracks in the asphalt along the edge of the curb's horizontal leg. It appears that the HDPE promotes weakness in the asphalt which resulted in the pavement beginning to delaminate. Apparently, the asphalt did not bond to the curb, and there was not enough adhesion through the holes in the curb to prevent the top lift from separating. It is also likely that reduced density of the hand placed and compacted asphalt contributed to weakening the pavement in the area.

DFC is dependent on the guardrail posts for its initial positioning during installation. When it is not fastened directly to the posts, movements of the guardrail and posts will not necessarily affect the performance of the curb. Because it is essentially a part of the pavement, the DFC will continue to function as long as there is no direct damage to the curb or the asphalt at the edge of the pavement.

As a direct result of its embedment in the pavement, replacement of a section of DFC is more difficult than replacing a section of lumber curb. It requires removal and replacement of some of the pavement, and careful preparation of the surface that the new section will sit on.

For the Monarch Pass project 2,035 feet of DFC were used at a unit price of \$7.20 per lineal foot for a total cost of \$14,652.

### **6.2 Composite Lumber**

Composite lumber curb is totally dependent on the guardrail posts for support and positioning. Any movement of the guardrail will open a gap between the curb and the pavement allowing water to erode the shoulder. Sections of curb are easily replaced, however, if the damage was the result of movement of the guardrail posts, the curb will no longer fit tightly against the pavement and the gap will have to be filled. Hand construction of a berm against the face of the curb works well for smaller gaps, and may be advisable as a preventative measure.

For the Monarch Pass project 6978 feet of CL was used at a unit price of \$7.80 per lineal foot for a total cost of \$54,428.

### **6.3 Both DuraFlex Curb and Composite Lumber Curb**

Monarch Pass was a difficult location for an evaluation of these alternate curb materials. There is evidence that runoff in quantities beyond the capabilities of a 6 inch-high curb occur frequently.



In the long term, neither DuraFlex Curb nor composite lumber can effectively control runoff and prevent shoulder erosion under these conditions:



**Figure 22. Wide highway and steep shoulders.**



**Figure 23. Slopes start under the guardrail.**



**Figure 24. Inadequate base for the DFC.**

- US-50 on the west side of the pass is a two-lane highway with wide lanes and several passing zones. Its large surface area (**Figure 22**) collects a significant amount of water from rain and melting snow, and the grade and slope of the pavement give considerable velocity and force to the runoff. The water volume that the pavement gathers can overwhelm the curbs, which have an effective height of only four to six inches, with disastrous results – see **Figure 9**, above.

- High over-steepened embankments begin right at the edge of the pavement – in some places even in front of the guardrail (**Figures 23 & 24**). They are sandy gravel with sparse vegetation and are very susceptible to rapid erosion by the fast moving water running off the pavement surface. Because the slopes begin so close to the highway, any erosion very quickly becomes a danger to the integrity of the pavement.

- Because of the proximity of the tops of the slopes to the edge of the highway before construction began, ground level at the base of the guardrail posts was several inches below the surface of the pavement in places. Asphalt had to be hand placed in these areas to provide a base for the curb, however, the slopes of the shoulders made compaction very difficult. **Figure 24** shows a section of DFC before the top mat was laid. The asphalt laid over the top of the curb will have no support in the areas of the holes. In a situation like the one shown here, it will be impossible to properly compact the top lift of asphalt and nearly impossible to fill in and compact the area below the DFC.

## 7.0 RECOMMENDATIONS

Use of any of the curb materials discussed in this report should be suited to the site conditions. Any use of these recommendations should be reviewed and approved by a hydraulic engineer prior to implementation. In locations apt to experience large volumes of water, or where overflow or gaps in the curb can quickly develop in to hazardous conditions these materials should be considered temporary solutions to be used only until more extensive water control measures can be designed and constructed. It is important to remember that the DuraFlex Curb, when it has a two inch lift of asphalt placed over its horizontal leg, is only four inches in height.

To enable DuraFlex Curb to perform as well as possible, it should be installed in locations where the base under the curb and the top lift of asphalt over the curb can be placed and thoroughly compacted by construction rollers. Because the horizontal leg of the curb is embedded into the pavement surface and the HDPE is completely waterproof, some amount of moisture is certain to find its way into the pavement along the curb material. Freeze/thaw cycles will almost surely cause the pavement to de-laminate in the area, and the situation will be exacerbated if the asphalt was not properly compacted.

Satisfactory performance can probably be expected in locations where the consequences of a break or overflow are not likely to very rapidly lead to severe structural problems for the



**Figure 25. US-24 on Ute Pass.**

roadway. US-24 near Divide **Figure 25** is such a location: a narrow, gently sloping, two-lane road, crowned in the center, with gently sloping shoulders. Water carried by the curb in this kind of location will have little energy to cause problems even if it does find a gap in the curb.

A small asphalt berm along the face of lumber or DFC curb can improve its durability and function. This is true especially in situations where the guardrail is very close to the shoulder stripe.

Rubbing by a large truck or scraping by a snowplow will probably move the rail and the curb causing it to separate from the pavement surface. Because the berm bonds

well to the surface of the pavement it will not move with the curb and its water carrying ability will not be damaged.

A berm in front of the DFC would keep the majority of the runoff away from the curb and reduce the possibility for water to penetrate the asphalt along the surface of curb and cause freeze/thaw problems.

The hollow cross-section composite lumber material used on US-50 was susceptible to cracking and breaking. Solid lumber may be more durable and better suited for use as highway curb.

If DuraFlex Curb is installed in a situation where it is desirable to nail the curb directly to the guardrail posts, use only a nail without a washer to allow the nail to tear through the curb relatively easily, no washer is used with the nail.

## **APPENDIX A**

<http://www.healthyhomeplans.com/articles/information13.php> 11/15/06

The Healthy Home Plans web site on November 15, 2006 had the following information (paraphrased) describing plastic lumber.

Plastic lumber can be made by combining high density polyethylene (HDPE) from post-consumer waste, primarily milk jugs, polyethylene terephthalate (PET) from post-consumer soda bottles or several commingled recovered plastics and reclaimed wood and sawdust that would otherwise be discarded by manufacturing plants. It is one of the prime uses for recycled plastic trash bags and waste wood fibers and is claimed to be more rigid than 100 percent recycled plastic lumber because the wood fibers act as reinforcement. The material resists moisture penetration and degradation from fungal rot. Composite lumber can be recycled after use; does not contain toxins found in treated wood; does not absorb moisture and does not splinter, crack, rot or warp.

Plastic lumber expands and contracts more than wood, is heavier than dry wood of the same size and can lose its strength characteristics at temperatures above 160° F.