Florida Department of Transportation

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ROADWAY DESIGN BULLETIN 24-06

(FHWA Approval: 11/19/2024)

DATE: *12/13/2024*

TO: District Directors of Transportation Operations, District Directors of Transportation Development, District Design Engineers, District Consultant Project Management Engineers, District Construction Engineers, District Roadway Design Engineers, District Drainage Engineers, District Pavement Design Engineers, District Materials and Research Engineers

FROM: Derwood Sheppard, P.E., State Roadway Design Engineer

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SUBJECT: **Friction Course Policy**

This bulletin rescinds Roadway Design Bulletin 24-03 and supersedes the ***2025 FDOT Flexible Pavement Design Manual (FPDM)*** that was published on November 1, 2024, via Roadway Design Bulletin 24-04.

BACKGROUND

FDOT Serves as a national leader in roadway safety, pavement performance, and pavement durability. FDOT's preeminence in these areas is supported by continued research into new technologies, as well as evaluating the performance of existing techniques. One such technique is the use of open graded friction course (OGFC) to reduce the potential for hydroplaning and the amount of spray during rain events. Upon review and analysis of the effectiveness of OGFC's performance in these areas, data shows that wet friction values for dense graded friction course are equal to or often superior to OGFC and that OGFC's benefits are primarily seen on high-speed facilities, with only a marginal improvement at lower speeds.

Therefore, to target the most appropriate applications to receive the greatest benefit, the Friction Course Policy is being updated to place OGFC on all limited access roads, and on multilane flush shoulder roads with Design Speeds of 55 mph and greater.

IMPLEMENTATION

The requirements of this bulletin are effective immediately on all Design-Bid-Build projects for which the Phase II submittal has not yet been completed. Implementation of this bulletin for Design-Bid-Build projects after completion of the Phase II submittal is at the discretion of the districts.

The requirements of this bulletin are effective immediately on all Design-Build projects for which the final Request for Proposal (RFP) has not yet been released. Implementation of this bulletin for Design-Build projects after the final RFP has been released is at the discretion of the districts.

REQUIREMENTS

1. The ***2025 Flexible Pavement Design Manual (FPDM)*** has been updated and re-published to the Pavement Design Publications Website to incorporate the requirements of this bulletin.
    a. The specific update to the ***2025 FPDM*** replaces ***Chapter 4*** with the following:

CHAPTER 4
FRICTION COURSE POLICY

4.1 FRICTION COURSE OPTIONS

There are two general types of friction courses currently in use by the Department, dense graded (FC-9.5 & FC-12.5) and open graded (FC-5). Their thickness is shown on the plans with spread rates determined by specification formula and paid for by the ton.

The Maximum Spread rate used for estimating quantities is as follows:

FC-9.5	110 lb/yd^2
FC-12.5	165 lb/yd^2
FC-5	80 lb/yd^2

Actual pay quantities will be based on the actual maximum specific gravity of the mixture used.

Friction Courses FC-12.5 and FC-9.5 are dense graded mixes which are typically placed 1½-in and 1-in thick respectively. These friction courses provide smooth riding surfaces with adequate friction numbers for skid resistance.

The FC-9.5 dense graded mix will allow a 1-in lift of friction course. On some projects, this thinner lift may allow room for an additional structural or overbuild lift, as in some curb and gutter sections, without milling into the base or overlaying friction course into the gutter.

The other friction course, FC-5, consists of an open graded material. FC-5 is placed and shown on the typical section as ¾-in thick. FC-5 provides a skid resistant surface. The open graded texture of the mix provides for the rapid removal of water from between the tire and the pavement to reduce the potential for hydroplaning at higher speeds.

A friction course will be placed on all roads and ramps with a design speed of 35 mph or higher, except for low volume two lane roads having a five-year projected AADT from the opening year of 3,000 vehicles per day or less.

Use FC-5 on multi-lane flush shoulder arterials and collectors with a design speed of 55 mph or greater, and on all Limited Access mainline roadways, regardless of design speed.

Use FC-12.5 or FC-9.5 on all other flush shoulder or curbed roadways. However, if there is a history of wet-weather crashes in a high-speed curbed section, FC-5 should be considered. ***Table 4.1*** summarizes these requirements.

The appropriate Traffic Level is to be shown for dense-graded friction courses FC-9.5 and FC-12.5. For Traffic Levels B and C, PG 76-22 should be called for in the friction course. For Traffic Level E, PG 76-22 or High Polymer (HP) should be called for in the friction course.

TABLE 4.1
FRICTION COURSE POLICY

Design Speed (mph)	Two Lane	Multilane
Limited Access Mainline Roadways		
All	FC-5	FC-5
Arterial and Collector Flush Shoulder Roadways		
≤ 50	FC-12.5 or FC-9.5	FC-12.5 or FC-9.5
≥ 55		FC-5
Arterial and Collector Curbed Roadways		
All	FC-12.5 or FC-9.5	FC-12.5 or FC-9.5

NOTES:

1. Include a friction course on all roads and ramps with a design speed ≥ 35 mph, except for two lane roads having a five-year projected AADT (from the opening year) of 3000 vehicles per day or less.
2. FC-5 should be considered for multilane curbed roadways with design speeds ≥ 55 mph when there is a history of wet weather crashes.
3. Coordinate with the District Pavement Design Engineer to determine the appropriate friction course to use on limited access ramps. See Section 4.2 for additional information.

4.2 FRICTION COURSES 12.5 AND 9.5 (FC-12.5 and FC-9.5)

The following are some of the features of the use of FC-12.5 and FC-9.5:

- FC-12.5 and FC-9.5 are allowed directly on top of any structural course mix.
- FC-12.5 and FC-9.5 are considered part of the structural layer and may be considered as both a structural and friction course.
- Coordinate with the District Pavement Design Engineer to determine the appropriate friction course to use on limited access ramps. The type of friction course used must be evaluated for long term maintenance, surface drainage, existing crash patterns, and pavement structural value.
    - Dense graded friction course is typically used on ramps with heavy volumes of truck traffic and/or turning and stopping movements.
    - FC-5 is typically only used on high speed ramps with long tangent sections and/or large radii (e.g., a ramp connecting two limited access facilities).

4.3 FRICTION COURSE 5 (FC-5)

The following are some of the limitations on the use of FC-5:

- **<u>On all roads that require FC-5:</u>**
    - Open graded friction courses such as FC-2 and FC-5 should not be overlaid (due to its potential to allow water into the pavement system) except when approved by the District Materials Engineer.
    - FC-5 should not sit after construction for more than four (4) months before being opened to traffic. If necessary, the FC-5 may need to be let under a separate contract.
    - FC-5 may be placed directly on the milled surface provided the underlying layers are in good structural shape.
- **<u>On multi-lane non-limited access facilities:</u>**
    - FC-5 typically covers the deceleration areas of turn lanes. This is illustrated in ***Figure 4.1***.
    - FC-5 is not to be placed in median openings, turn outs, or gore areas on these facilities. This is illustrated in ***Figures 4.1*** and ***4.2***.
    - FC-5 is to be placed over the entire paved shoulder.

- FC-5 should not be placed in the turning area of signalized intersections, as shown in ***Figure 4.3***. An exception to this is where both of the intersecting roads qualify for FC-5, then the entire intersection should use FC-5.

- **On limited access facilities:**
  - FC-5 is to extend 8-in beyond the edge of the travel lane, onto the paved shoulder.
  - FC-5 is not to be placed in median crossovers or gore areas.
  - To minimize raveling/deterioration due to pavement sawcuts, FC-5 is not required on flexible pavement within proposed Toll facilities that utilize electronic data collection requiring loop installation in the pavement surface. ***Chapter 221*** (in ***Part 2***) of the Florida's Turnpike Enterprise's ***General Tolling Requirements*** (***GTR***) provides additional details for pavement design requirements near Toll facilities.

FIGURE 4.1
TYPICAL LIMITS OF FC-5
FOR MULTI-LANE NON-LIMITED ACCESS FACILITIES
NON-SIGNALIZED INTERSECTION/MEDIAN OPENING

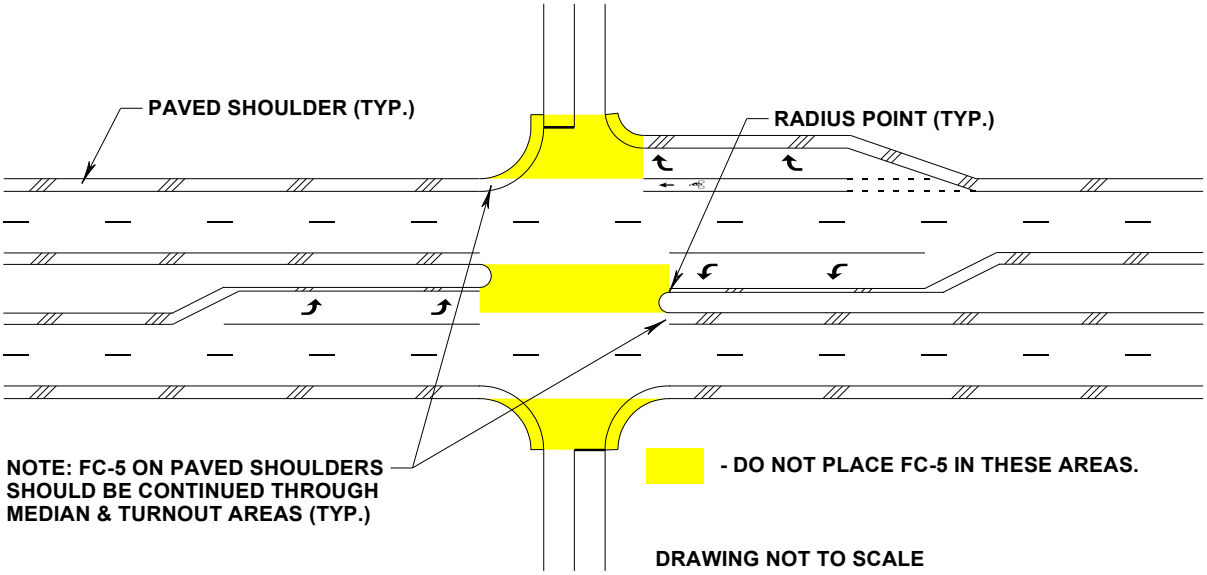


FIGURE 4.2
TYPICAL LIMITS OF FC-5
FOR MULTI-LANE NON-LIMITED ACCESS FACILITIES
MEDIAN OPENING (NO TURN LANES)

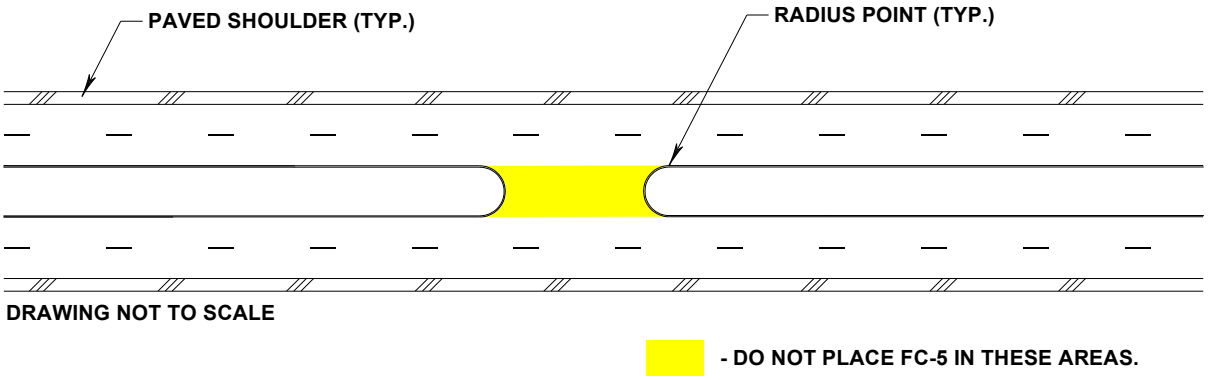
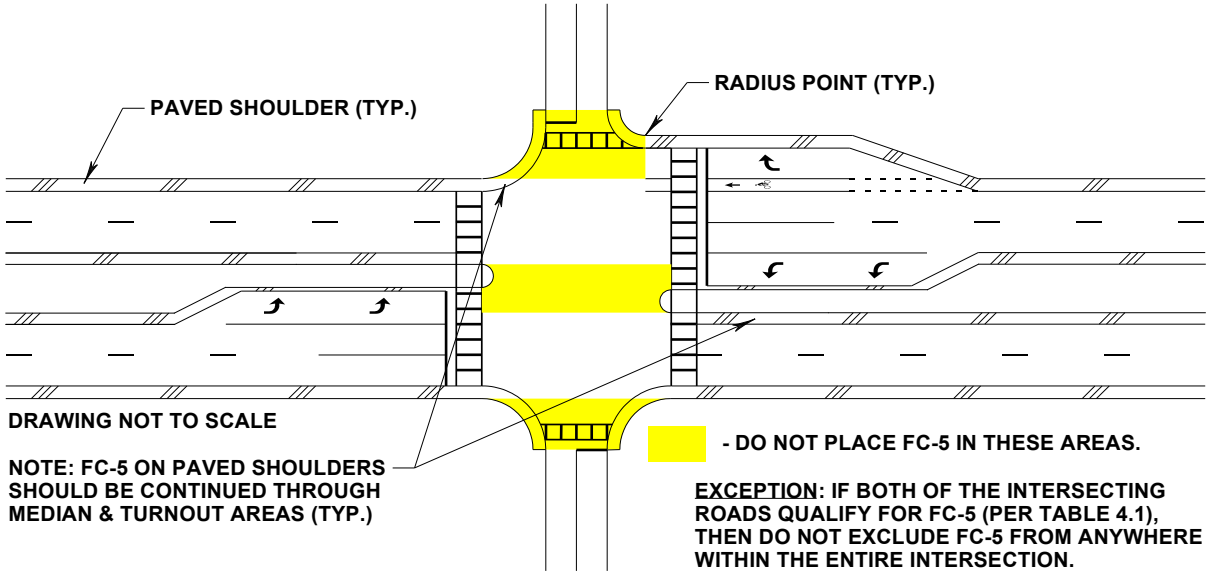


FIGURE 4.3
TYPICAL LIMITS OF FC-5
FOR MULTI-LANE NON-LIMITED ACCESS FACILITIES
SIGNALIZED INTERSECTION



ATTACHMENTS

Attachment A – Supporting Information

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Attachment A

Supporting Information

1. Hydroplaning Potential Theoretical Analysis

A hydroplaning potential analysis was performed for four and six lane arterial roadways. The hydroplaning analysis model that was used was developed through a research project with Applied Research Associates (***Enhanced Hydroplaning Prediction Tool***, 2020). The analysis considered the following inputs: number of lanes, cross-slope, longitudinal grade, surface type, permeability, macrotexture, plane geometry, and rainfall intensity. Five rainfall intensities were analyzed, 0.5 in/hr, 1.0 in/hr, 1.5 in/hr, 2.0 in/hr, and 2.5 in/hr. The analysis indicated the potential for hydroplaning would be reduced on arterial roadways with an OGFC compared to those with a dense graded friction course (DGFC). Tables 1 and 2 show the potential vehicle speed where hydroplaning could occur for each friction course type in each travel lane of the four and six lane arterial roadways. The research also indicated that vehicles slow down by up to 12 mph from the posted speed limit when rainfall intensities are 2 in/hr or greater.

Rainfall Intensity (in/hr)	DGFC Lane 1 (mph)	DGFC Lane 2 (mph)	OGFC Lane 1 (mph)	OGFC Lane 2 (mph)
0.5	106.7	76.6	999	999
1	75.3	62.9	999	999
1.5	66.8	57.5	999	94.3
2	62.2	54.2	999	70.8
2.5	59.1	51.9	999	62.7

Table 1: Four-Lane Roadway Hydroplaning Analysis Summary

Rainfall Intensity (in/hr)	DGFC Lane 1 (mph)	DGFC Lane 2 (mph)	DGFC Lane 3 (mph)	OGFC Lane 1 (mph)	OGFC Lane 2 (mph)	OGFC Lane 3 (mph)
0.5	106.7	76.6	71.8	999	999	999
1	75.3	62.9	60.1	999	999	999
1.5	66.8	57.5	55.1	999	94.3	75.4
2	62.2	54.2	52.1	999	70.8	63.4
2.5	59.1	51.9	50.0	144	62.7	57.7

Table 2: Six-Lane Roadway Hydroplaning Analysis Summary

2. Wet Weather Crash Empirical Analysis

A wet weather crash analysis was performed on limited access roadways surfaced with and without open graded friction courses. The analysis compared the wet weather crash rate on nine separate roadways before the OGFC was placed and after the OGFC was placed. The analysis indicated the average wet weather crash rate was reduced by an average of 43% across the nine roadways after OGFC was paved.

The crash data was obtained from Signal 4, the current FDOT crash database. A summary of the data is shown in Table 3. The crash rate definition is shown in Figure 1.

Roadway ID	Geographic district	State road number	US road number	Posted speed limit	Year paved	Number of days dense mix open to traffic	Number of days OGFC open to traffic	AADT	OGFC wet weather crash rate	Dense mix wet weather crash rate	Change in wet weather crash rate	Percent change in wet weather crash rate
61001000	3	SR 8	I-10	70	2019	151	1,592	20,803	12.1	49.5	37.4	76%
92473000	5	SR 429		70	2023	185	420	225,168	7.0	31.6	24.7	78%
16470000	1	SR 570		65	2023	144	1,042	87,725	4.9	16.7	11.8	71%
73001000	5	SR 9	I-95	70	2020	316	1,072	67,147	3.7	13.9	10.2	73%
78080000	2	SR 9	I-95	70	2020	191	917	41,586	4.0	12.2	8.2	67%
94470000	4	SR 91		70	2021	119	720	52,365	11.2	18.1	6.8	38%
79002000	5	SR 9	I-95	70	2021	154	1,124	57,261	5.7	6.9	1.2	18%
78080000	2	SR 9	I-95	70	2019	282	1,210	81,396	15.4	13.7	-1.6	-12%
89470000	4	SR 91		70	2020	70	260	77,050	13.3	11.1	-2.2	-20%
Average						**179**	**929**	**78,945**	**8.6**	**19.3**	**10.7**	**43%**

Table 3: Wet Weather Crash Analysis Summary

$$R = \frac{C \times 100{,}000{,}000}{V \times 365 \times N \times L}$$

R = Roadway crash rate for the road segment expressed as crashes per 100 million vehicle-miles of travel
C = Total number of roadway crashes in the study period
V = Traffic volumes using Average Annual Daily Traffic (AADT) volumes
N = Number of years of data
L = Length of the roadway segment in miles

Figure 1: Crash Rate Definition