SEISMIC GROUP UET LHR

HIGHWAY ENGINEERING

Assignment – II

01 A student trying to test braking ability of his car determined that he needed 32 ft. more to stop his car when driving down hill than when driving up hill at 55mph on a particular road. Determine braking distance and % down grade of highway at that section.

02 A motorist traveling at 55 mph down a grade of 5% on a highway observes an accident ahead involving an over turned truck blocking the road. If motorist was able to stop his vehicle 30 ft. from the over turned truck, what was his distance from truck when he first observed the accident.

03 In an attempt to estimate speed of a vehicle just before it hit a traffic signal pole, a traffic engineer measured the length of skid marks made by vehicle and performed, trial runs at site to obtain an estimate of the deceleration. Determine the estimated unknown velocity if the following data were obtained. Length of skid marks = 585 ft , 590 ft , 580 ft, 595 ft ; Speed of trial run = 30 mph and distance traveled = 300 ft. Examination of the vehicle just after the crash indicated that the speed of impact was 35 mph.

04 A motorist traveling at 55mph on an express way intends to leave the express way using an exit ramp with a maximum allowable speed of 30 mph. At what point on express way should the motorist step on brakes in order to reduce the speed to the maximum allowable speed on ramp just before entering the ramp. The alignment of this section of the road is horizontal.

05 Vehicle traveling at 40 mph on a wet pavement coated with oil droppings, assume perception reaction time "t" = 1 see. What is stopping sight distance if v = 55 mph.

06 Driver of a car traveling at 45 mph requires 125 ft. to stop after brakes have been applied. What is the value of deceleration?

07 A driver traveling at 90 km/hr on a wet road. An object is spotted on the road 140 m ahead of driver and the driver is able to come to a stop just before hitting the object. Assuming standard reaction time determine the grade of the road.

08 An engineering student claims that a country road can be safely negotiated at 110 km/hr in rainy weather. Because of winding nature of the road, one stretch of level pavement has a stopping distance of only 180 m. Comment on the students claim.

Assignment #2

Q=1 Data:

$d_d = 32\ ft$

$V = 55\ mph$

Braking distance = ?

% downgrade = G = ? $a = 11.2\ ft/s^2$

Sol:

$d_d + 32 = d_b$

(Uphill) + (make distance) = (Downhill)

$$\frac{V^2}{30\left(\frac{a}{32.2} + G\right)} + 32 = \left(\frac{V^2}{30\left(\frac{a}{32.2} - G\right)}\right)$$

$$\frac{55^2}{30\left(\frac{11.2}{32.2} + G\right)} + 32 = \frac{55^2}{30\left(\frac{11.2}{32.2} - G\right)}$$

$G = 0.0191$

$\boxed{G = 1.91\ \%}$

$\Rightarrow$ Braking distance on uphill grade

$$d = \frac{V^2}{30\left(\frac{a}{32.2} + G\right)} = \frac{55^2}{30\left(\frac{11.2}{32.2} + 0.0191\right)} = 275$$

$\Rightarrow$ Braking distance on downhill grade:

$$d = \frac{V^2}{30\left(\frac{a}{32.2} - G\right)} = 307\ ft$$

Q=2 (04) **Data:**

$V = 55$ mph

$G_r = -5\% = -0.05$

Distance from truck after stopping = 30 ft

Distance from truck at time of observation = $S = ?$

Sol:

S = Stopping sight distance + Distance after stopping

$$= \frac{V^2}{30\left(\frac{a}{32.2} - G_r\right)} + (1.47)Vt_2 + 30$$

$$= \frac{(55)^2}{30\left(\frac{11.2}{32.2}\right) - 0.05} + (1.47)(55)(2.5) + 30$$

$$\boxed{S = 571 \text{ ft}}$$

Q=3 (04) **Data:** Estimated unknown velocity $= V_u = ?$

D_b = Length of skid marks = 585, 590, 580, 595 ft.

Speed of trial run = V_t = 30 mph

Distance travelled = D_t = 300 ft

Speed of impact = V_i = 35 mph

Sol.

$$D_b = \frac{585 + 590 + 580 + 595}{4} = 587.5 \text{ ft}$$

$$\Rightarrow V_u = \left[\frac{D_b}{D_t} V_t^2 + V_i^2\right]^{1/2}$$

$$= \left[\frac{587.5}{300}(30)^2 + 35^2\right]^{1/2} = 54.66 \text{ mph}$$

Q=4 Data:

Express way speed $= V_1 = 55$ mph $= 24.44$ m/s

Exit ramp speed $= V_2 = 30$ mph $= 13.33$ m/s

Braking distance = ?

Sol:

$$d = \frac{V_1^2 - V_2^2}{2a} = \frac{24.44^2 - 13.33^2}{2(3.4)} = 61.71 \text{ m}$$

$$= 202.5 \text{ ft}$$

The brakes should be applied at least 203 ft from ramp.

Q=5 Data:

$V = 40$ mph (Wet pavement) $= 17.78$ m/s

$t = 1$s

SSD = ?

$V = 55$ mph

Sol:

$$SSD = \frac{V^2}{30\left(\frac{a}{32.2}\right)} + 1.47Vt$$

$$= \frac{40^2}{30\left(\frac{11.2}{32.2}\right)} + 1.47(40)(1) = 212 \text{ ft}$$

$$SSD = \frac{55^2}{30\left(\frac{11.2}{32.2}\right)} + 1.47(55)(1) = 371 \text{ ft}$$

Q=6

Data:

V = 45 mph

Braking distance = 125 ft

a = ?

Sol:

$$d = \frac{V^2}{30\left(\frac{a}{32.2}\right)}$$

$$125 = \frac{45^2}{30\left(\frac{a}{32.2}\right)}$$

$$\boxed{a = 17.39 \text{ ft/s}^2}$$

Q=7

Data:

V = 90 km/h

SSD = 140 m

G = ?

t = 2.5 s

a = 3.4 m/s²

Sol:

$$SSD = \frac{V^2}{254\left(\frac{a}{9.81} \pm G\right)} + 0.278Vt$$

G = 6.52 % uphill

G = −6.52 % downhill

Q=8 Date:

V = 110 km/h (Students claimed speed limit)

SSD = 180 m (Max. allowable SSD)

Sol:

Finding SSD with students claimed speed limit

$$SSD = \frac{V^2}{254\left(\frac{a}{9.81} \pm G\right)} + Vt(0.278)$$

For V = 110 km/h
f = 0.11

$$f = \frac{a}{g}$$

$$a = fg$$
$$= 0.11(9.81$$
$$=$$

$$= \frac{110^2}{254\left(\frac{3.41}{9.81} + 0\right)} + 110(2.5)(0.278)$$

SSD = 214 m

214 (actual SSD) > 180 (Max. allowable SSD)

hence we have to reduce speed, and students claim is wrong.