TranSystems

Made By: BKC Date: 10/14/09 Job No: PH10 07 0010

Checked By: Date: Sheet No.

COLUMBIA PARKWAY HAM 471 0025

COMPARING EFFECT OF 3 LANES OF TRUCKS VS 4 LANES OF TRUCK

SIMPLE LEVER RULE WAS USED IN CONJUCTION WITH THE MULTIPLE LANE REDUCTION FACTOR TO COMPARE TRUCK REACTIONS AT THREE TRUSSES.

THIS SIMPLIFIED ANALYSIS SHOWED THAT THE THREE LANE CONFIGURATION HAD GREATER REACTIONS, BY ~18%, ON N. TRUSS AND ~20%, ON THE S. TRUSS, THAN THE FOUR LANE CONFIGURATION.

HOWEVER THE CENTER TRUSS DID NOT EXHIBIT AS CLEAR INDICATIONS AS TO WHETHER THE 3 OR 4 LANE CONFIGURATION CONTROLLED.

TO CLARIFY THE CONTROLLING LOADING CONFIGURATION THE MAXIMUM AXIAL LOADS IN THE CENTER TRUSS WERE COMPARED FOR THE 3 AND 4 LANE LOADING CONFIGURATIONS FOR AN HS-20.

THE RESULTS INDICATE THAT THE 4 LANE CONFIGURATION CREATED GREATER FORCES (AFTER MULTIPLE LANE REDUCTION FACTOR) IN THE CENTER TRUSS. THE WEB MEMBERS EXHIBITED MORE VARIANCE, THAN THE CHORDS, HOWEVER THE FORCES WERE WITH-IN 5% OF EACH OTHER.

BASED UPON THESE RESULTS THE 4 TRUCK LANE CONFIGURATION WILL BE UTILIZED TO RATE THE CENTER TRUSS

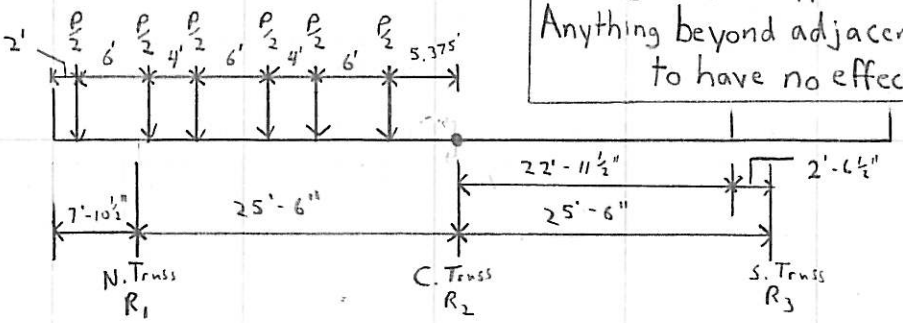
SUMMARY

TRUSS	CONTROLLING # TRUCK LANES	METHOD OF DETERMINATION
NORTH	3 TRUCK LANES	LEVER RULE
CENTER	4 TRUCK LANES	STAAD
SOUTH	3 TRUCK LANES	LEVER RULE

Calculations for 1/4 US Grid

3 Lanes

Assuming simple support between truss lines. Anything beyond adjacent support assumed to have no effect on far support.



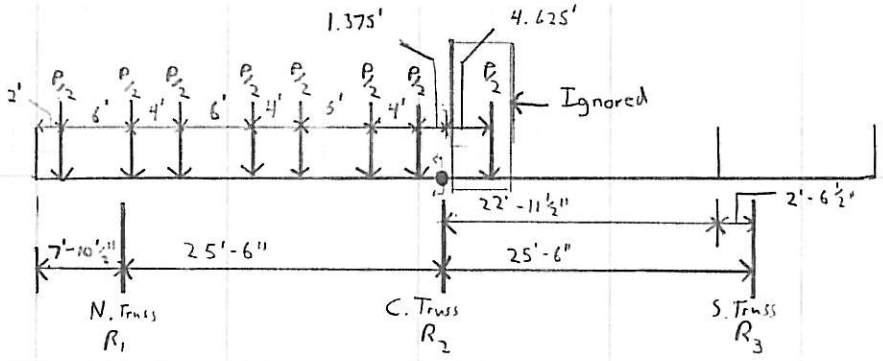
$\circlearrowleft +\sum M_{R_2} = 0 \Rightarrow R_1(25.5\,ft) - \frac{P}{2}(5.375\,ft) - \frac{P}{2}(11.375\,ft) - \frac{P}{2}(15.375\,ft) - \frac{P}{2}(21.375\,ft) - \frac{P}{2}(25.375\,ft) - \frac{P}{2}(31.375\,ft) = 0$

$R_1 = 2.16P$

Per AASHTO : 0.90 Factor Applied

With Multiple Lane Reduction Factor: $2.16(0.9) = 1.94$

4 Lanes



$\circlearrowleft +\sum M_{R_2} = 0 \Rightarrow R_1(25.5\,ft) - \frac{P}{2}(5.375\,ft) - \frac{P}{2}(11.375\,ft) - \frac{P}{2}(15.375\,ft) - \frac{P}{2}(21.375\,ft) - \frac{P}{2}(25.375\,ft) - \frac{P}{2}(31.375\,ft) - \frac{P}{2}(1.375\,ft) = 0$

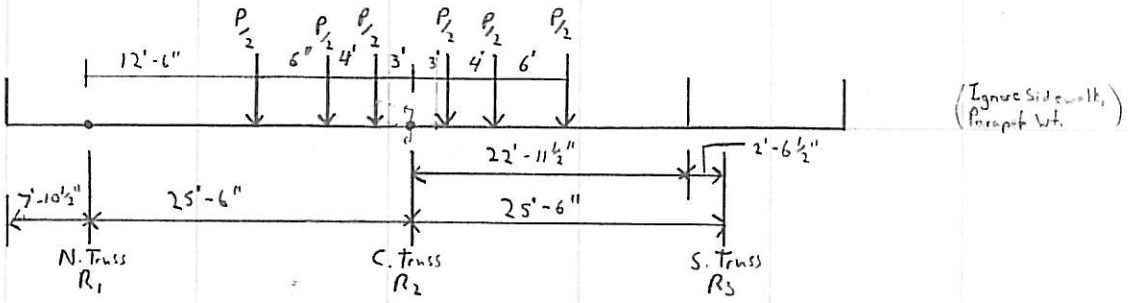
$R_1 = 2.19P$

Per AASHTO : 0.75 Factor Applied

With Multiple Lane Reduction Factor: $2.19(0.75) = 1.64$

Calculations for 1/8 US Grid

3 Lanes



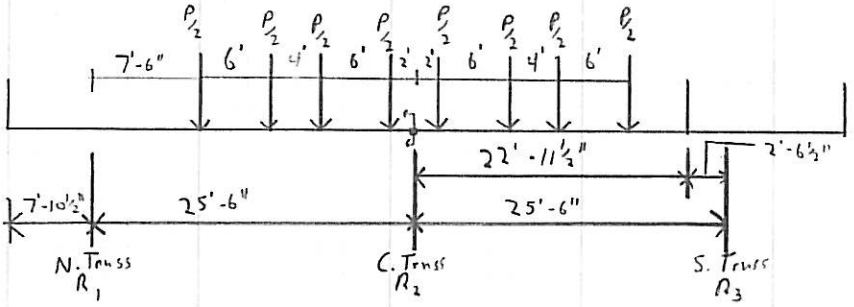
$$\circlearrowleft \sum M_{R_1} = 0 \Rightarrow R_{2_L}(25.5\,ft) - \frac{P}{2}(12.5\,ft) - \frac{P}{2}(18.5\,ft) - \frac{P}{2}(22.5\,ft) = 0$$

$$R_{2_L} = 1.05P$$

$$R_{2_L} = R_{2_R} \therefore R_2 = 2.10P$$

With Multiple Lane Reduction Factor: $2.10(0.9) = 1.89$

4 Lanes



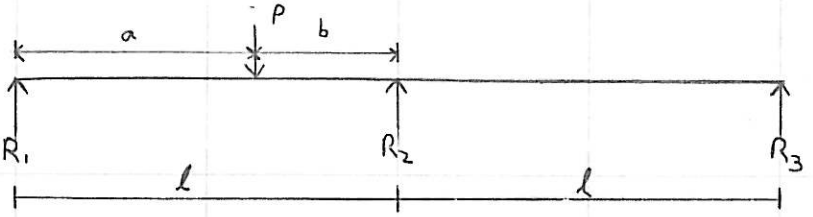
$$\circlearrowleft \sum M_{R_1} = 0 \Rightarrow R_{2_L}(25.5\,ft) - \frac{P}{2}(7.5\,ft) - \frac{P}{2}(13.5\,ft) - \frac{P}{2}(17.5\,ft) - \frac{P}{2}(23.5\,ft) = 0$$

$$R_{2_L} = 1.215P$$

$$R_{2_L} = R_{2_R} \therefore R_2 = 2.43P$$

With Multiple Lane Reduction Factor: $2.43(0.75) = 1.82$

Calculations for 1/8 US Grid



Equation for R_2 per AISC Steel Manual (Case 31, Table 3-23): $R_2 = \frac{Pa}{2\ell^3}\left(2\ell^2 + b(\ell + a)\right)$

3 Lanes:

$$R_{2L} = \frac{P}{2}\left[\frac{22.5\text{ ft}}{2(25.5\text{ ft})^3}\left(2(25.5\text{ ft})^2 + 3\text{ ft}(25.5\text{ ft} + 22.5\text{ ft})\right) + \frac{18.5\text{ ft}}{2(25.5\text{ ft})^3}\left(2(25.5\text{ ft})^2 + 7\text{ ft}(25.5\text{ ft} + 18.5\text{ ft})\right) + \frac{12.5\text{ ft}}{2(25.5\text{ ft})^3}\left(2(25.5\text{ ft})^2 + 13\text{ ft}(25.5\text{ ft} + 12.5\text{ ft})\right)\right]$$

$R_{2L} = 1.28P \Rightarrow R_{2L} = R_{2R} \therefore R_2 = 2.56$

With Multiple Lane Reduction Factor: $2.56(0.9) = 2.30$

4 Lanes:

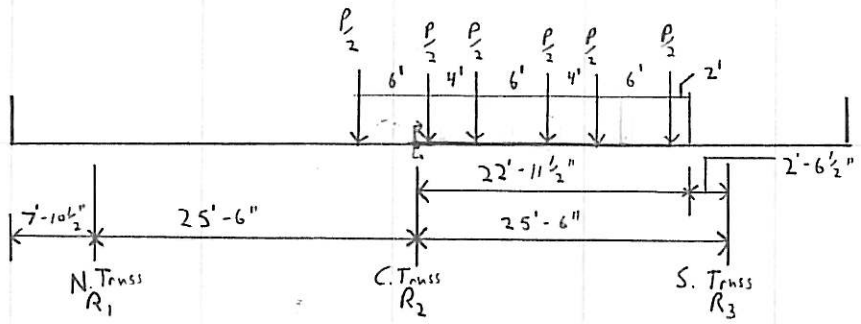
$$R_{2L} = \frac{P}{2}\left[\frac{23.5\text{ ft}}{2(25.5\text{ ft})^3}\left(2(25.5\text{ ft})^2 + 2\text{ ft}(25.5\text{ ft} + 23.5\text{ ft})\right) + \frac{17.5\text{ ft}}{2(25.5\text{ ft})^3}\left(2(25.5\text{ ft})^2 + 8\text{ ft}(25.5\text{ ft} + 17.5\text{ ft})\right) + \frac{13.5\text{ ft}}{2(25.5\text{ ft})^3}\left(2(25.5\text{ ft})^2 + 12\text{ ft}(25.5\text{ ft} + 13.5\text{ ft})\right) + \frac{7.5\text{ ft}}{2(25.5\text{ ft})^3}\left(2(25.5\text{ ft})^2 + 18\text{ ft}(25.5\text{ ft} + 7.5\text{ ft})\right)\right]$$

$R_{2L} = 1.50P \Rightarrow R_{2L} = R_{2R} \therefore R_2 = 3.00$

With Multiple Lane Reduction Factor: $3.00(0.75) = 2.25$

Calculations for 1/8 US Grid

3 Lanes

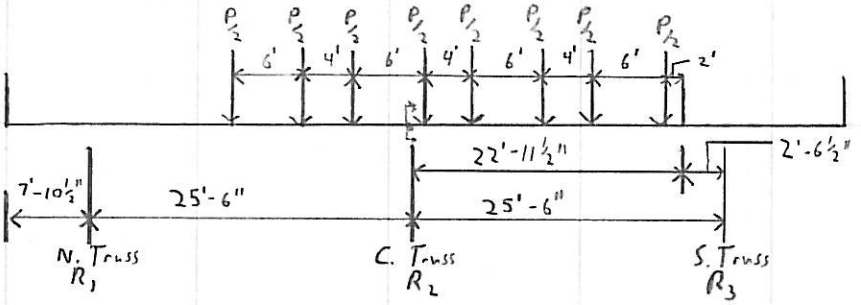


$\circlearrowleft + \sum M_{R_2} = 0 \Rightarrow R_3(25.5\,ft) - \frac{P}{2}(0.9583\,ft) - \frac{P}{2}(4.9583\,ft) - \frac{P}{2}(10.9583\,ft) - \frac{P}{2}(14.9583\,ft) - \frac{P}{2}(20.9583\,ft) = 0$

$R_3 = 1.04P$

With Multiple Lane Reduction Factor: $1.04(0.9) = 0.94$

4 Lanes



R_3 = Same as Above = $1.04P$

With Multiple Lane Reduction Factor: $1.04(0.75) = 0.78$

Reaction	Multiple Lane Reduction Factor 3 Lanes	Multiple Lane Reduction Factor 4 Lanes	Governing
R_1 North Truss	1.94	1.64	3 Lane
R_2 Center Truss	1.89	1.82	3 Lane
R_3 South Truss	0.94	0.78	3 Lane

Calculations for 1/8 US Grid