**MIDDLE EAST TECHNICAL UNIVERSITY**

**Department of Civil Engineering**

**CE353 Principles of Transportation and Traffic Engineering**

**Step 4**

**Superelevation Application and Topography**

**Report**

**Group 522**

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**Introduction**

In this study the superelevation application will be performed. After that, the elevations at perpendicularly 10 m and 20m to the left and 10m and 20 m to the right of the centerlines of the stations will be determined in order to be used in the last part of the project work.

**Procedure**

**Superelevation Application**

* Calculate for your curves.
* Calculate and for your curves.

**Curve 1**

, km/h

, therefore take =45 m

**Curve 2**

, km/h

can not exceed 0.08, so speed for Curve 2 is changed as;

, take km/hr

, therefore take = 45 m

**Curve 3**

, km/h

can not exceed 0.08, so speed for Curve 3 is changed as;

, take km/hr

, therefore take = 45 m

**Curve 4**

, km/h

, therefore take =45 m

* Superelevation application will be applied making rotation around centerline using (shoulder width + lane width) starting with -2% / -2% crown slopes.
* Find station kilometers of starting and ending points of superelevation applications.
* Prepare the superelevation table.

**Superelevation Table**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Station** | **St. Km(m)** | **Distance(m)** | **emax(%) wrt CL** | | **Elevation difference  wrt. CL** | | **Elevation** | | |
|
| **OE** | **IE** | **OE** | **IE** | **OE** | **CL** | **IE** |
| **A** | 0 | 0 | -2.000 | -2.000 | -0.095 | -0.095 | 513.095 | 513.190 | 513.095 |
| **ST1** | 0+030 | 30.000 | -2.000 | -2.000 | -0.095 | -0.095 | 514.274 | 514.369 | 514.274 |
| **ST2** | 0+060 | 60.000 | -2.000 | -2.000 | -0.095 | -0.095 | 515.454 | 515.549 | 515.454 |
| **ST3** | 0+090 | 90.000 | -2.000 | -2.000 | -0.095 | -0.095 | 516.633 | 516.728 | 516.633 |
| **ST4** | 0+120 | 120.000 | -2.000 | -2.000 | -0.095 | -0.095 | 517.813 | 517.908 | 517.813 |
| **ST5** | 0+150 | 150.000 | -2.000 | -2.000 | -0.095 | -0.095 | 518.992 | 519.087 | 518.992 |
| **ST6** | 0+180 | 180.000 | -2.000 | -2.000 | -0.095 | -0.095 | 520.172 | 520.267 | 520.172 |
| **ST7** | 0+210 | 210.000 | -2.000 | -2.000 | -0.095 | -0.095 | 521.351 | 521.446 | 521.351 |
| **STSU-I** | 0+235.753 | 235.753 | -2.000 | -2.000 | -0.095 | -0.095 | 522.364 | 522.459 | 522.364 |
| **ST8** | 0+240 | 240.000 | -1.339 | -2.000 | -0.064 | -0.095 | 522.562 | 522.626 | 522.531 |
| **ST9** | 0+270 | 270.000 | 3.327 | -3.327 | 0.158 | -0.158 | 523.963 | 523.805 | 523.647 |
| **PC-I** | 0+278.61 | 278.610 | 4.667 | -4.667 | 0.222 | -0.222 | 524.365 | 524.144 | 523.922 |
| **ST10** | 0+300 | 300.000 | 7.000 | -7.000 | 0.333 | -0.333 | 525.317 | 524.985 | 524.652 |
| **ST11** | 0+330 | 330.000 | 7.000 | -7.000 | 0.333 | -0.333 | 526.497 | 526.164 | 525.832 |
| **ST12** | 0+360 | 360.000 | 6.520 | -6.520 | 0.310 | -0.310 | 527.653 | 527.344 | 527.034 |
| **PT-I** | 0+371.92 | 371.920 | 4.666 | -2.000 | 0.222 | -0.095 | 528.034 | 527.812 | 527.717 |
| **ST13** | 0+390 | 390.000 | 1.853 | -2.000 | 0.088 | -0.095 | 528.611 | 528.523 | 528.428 |
| **ENSU-I** | 0+414.777 | 414.770 | -2.000 | -2.000 | -0.095 | -0.095 | 529.402 | 529.497 | 529.402 |
| **ST14** | 0+420 | 420.000 | -2.000 | -2.000 | -0.095 | -0.095 | 529.607 | 529.702 | 529.607 |
| **ST15** | 0+450 | 450.000 | -2.000 | -2.000 | -0.095 | -0.095 | 530.787 | 530.882 | 530.787 |
| **ST16** | 0+480 | 480.000 | -2.000 | -2.000 | -0.095 | -0.095 | 531.966 | 532.061 | 531.966 |
| **ST17** | 0+510 | 510.000 | -2.000 | -2.000 | -0.095 | -0.095 | 533.146 | 533.241 | 533.146 |
| **STSU-II** | 0+529.33 | 529.330 | -2.000 | -2.000 | -0.095 | -0.095 | 533.906 | 534.001 | 533.906 |
| **ST18** | 0+540 | 540.000 | -0.103 | -2.000 | -0.005 | -0.095 | 534.415 | 534.420 | 534.325 |
| **ST19** | 0+570 | 570.000 | 5.230 | -5.230 | 0.248 | -0.248 | 535.848 | 535.600 | 535.351 |
| **PC-II** | 0+570.58 | 570.580 | 5.333 | -5.333 | 0.253 | -0.253 | 535.876 | 535.623 | 535.369 |
| **ST20** | 0+600 | 600.000 | 8.000 | -8.000 | 0.380 | -0.380 | 537.159 | 536.779 | 536.399 |
| **ST21** | 0+630 | 630.000 | 8.000 | -8.000 | 0.380 | -0.380 | 538.339 | 537.959 | 537.579 |
| **ST22** | 0+660 | 660.000 | 8.000 | -8.000 | 0.380 | -0.380 | 539.518 | 539.138 | 538.758 |
| **ST23** | 0+690 | 690.000 | 8.000 | -8.000 | 0.380 | -0.380 | 540.698 | 540.318 | 539.938 |
| **ST24** | 0+720 | 720.000 | 8.000 | -8.000 | 0.380 | -0.380 | 541.877 | 541.497 | 541.117 |
| **ST25** | 0+750 | 750.000 | 8.000 | -8.000 | 0.380 | -0.380 | 543.056 | 542.676 | 542.296 |
| **ST26** | 0+780 | 780.000 | 8.000 | -8.000 | 0.380 | -0.380 | 544.236 | 543.856 | 543.476 |
| **ST27** | 0+810 | 810.000 | 8.000 | -8.000 | 0.380 | -0.380 | 545.415 | 545.035 | 544.655 |
| **PT-II** | 0+836.95 | 836.950 | 5.333 | -5.333 | 0.253 | -0.253 | 546.348 | 546.095 | 545.842 |
| **ST28** | 0+840 | 840.000 | 4.791 | -4.791 | 0.228 | -0.228 | 546.442 | 546.215 | 545.987 |
| **ST29** | 0+870 | 870.000 | -0.542 | -2.000 | -0.026 | -0.095 | 547.369 | 547.394 | 547.299 |
| **ENSU-II** | 0+878.2 | 878.200 | -2.000 | -2.000 | -0.095 | -0.095 | 547.622 | 547.717 | 547.622 |
| **ST30** | 0+900 | 900.000 | -2.000 | -2.000 | -0.095 | -0.095 | 548.479 | 548.574 | 548.479 |
| **ST31** | 0+930 | 930.000 | -2.000 | -2.000 | -0.095 | -0.095 | 549.658 | 549.753 | 549.658 |
| **ST32** | 0+960 | 960.000 | -2.000 | -2.000 | -0.095 | -0.095 | 550.838 | 550.933 | 550.838 |
| **ST33** | 0+990 | 990.000 | -2.000 | -2.000 | -0.095 | -0.095 | 552.017 | 552.112 | 552.017 |
| **ST34** | 1+020 | 1020.000 | -2.000 | -2.000 | -0.095 | -0.095 | 553.197 | 553.292 | 553.197 |
| **ST35** | 1+050 | 1050.000 | -2.000 | -2.000 | -0.095 | -0.095 | 554.376 | 554.471 | 554.376 |
| **ST36** | 1+080 | 1080.000 | -2.000 | -2.000 | -0.095 | -0.095 | 555.373 | 555.468 | 555.373 |
| **ST37** | 1+110 | 1110.000 | -2.000 | -2.000 | -0.095 | -0.095 | 556.725 | 556.820 | 556.725 |
| **ST38** | 1+140 | 1140.000 | -2.000 | -2.000 | -0.095 | -0.095 | 555.927 | 556.022 | 555.927 |
| **ST39** | 1+170 | 1170.000 | -2.000 | -2.000 | -0.095 | -0.095 | 555.474 | 555.569 | 555.474 |
| **STSU-III** | 1+186.52 | 1186.520 | -2.000 | -2.000 | -0.095 | -0.095 | 555.129 | 555.224 | 555.129 |
| **ST40** | 1+200 | 1200.000 | 0.396 | -2.000 | 0.019 | -0.095 | 554.962 | 554.944 | 554.849 |
| **PC-III** | 1+227,77 | 1227.770 | 5.333 | -5.333 | 0.253 | -0.253 | 554.618 | 554.365 | 554.112 |
| **ST41** | 1+230 | 1230.000 | 5.730 | -5.730 | 0.272 | -0.272 | 554.591 | 554.319 | 554.046 |
| **ST42** | 1+260 | 1260.000 | 8.000 | -8.000 | 0.380 | -0.380 | 554.074 | 553.694 | 553.314 |
| **ST43** | 1+290 | 1290.000 | 8.000 | -8.000 | 0.380 | -0.380 | 553.449 | 553.069 | 552.689 |
| **ST44** | 1+320 | 1320.000 | 8.000 | -8.000 | 0.380 | -0.380 | 552.824 | 552.444 | 552.064 |
| **ST45** | 1+350 | 1350.000 | 8.000 | -8.000 | 0.380 | -0.380 | 552.199 | 551.819 | 551.439 |
| **PT-III** | 1+377,21 | 1377.210 | 5.333 | -5.333 | 0.253 | -0.253 | 551.505 | 551.252 | 550.998 |
| **ST46** | 1+380 | 1380.000 | 4.837 | -4.837 | 0.230 | -0.230 | 551.423 | 551.194 | 550.964 |
| **ST47** | 1+410 | 1410.000 | -0.496 | -2.000 | -0.024 | -0.095 | 550.545 | 550.569 | 550.474 |
| **ENSU-III** | 1+418.46 | 1418.460 | -2.000 | -2.000 | -0.095 | -0.095 | 550.297 | 550.392 | 550.297 |
| **ST48** | 1+440 | 1440.000 | -2.000 | -2.000 | -0.095 | -0.095 | 549.849 | 549.944 | 549.849 |
| **ST49** | 1+470 | 1470.000 | -2.000 | -2.000 | -0.095 | -0.095 | 549.224 | 549.319 | 549.224 |
| **ST50** | 1+500 | 1500.000 | -2.000 | -2.000 | -0.095 | -0.095 | 548.599 | 548.694 | 548.599 |
| **ST51** | 1+530 | 1530.000 | -2.000 | -2.000 | -0.095 | -0.095 | 547.974 | 548.069 | 547.974 |
| **ST52** | 1+560 | 1560.000 | -2.000 | -2.000 | -0.095 | -0.095 | 547.349 | 547.444 | 547.349 |
| **STSU-IV** | 1+581.1 | 1581.100 | -2.000 | -2.000 | -0.095 | -0.095 | 546.909 | 547.004 | 546.909 |
| **ST53** | 1+590 | 1590.000 | -1.011 | -2.000 | -0.048 | -0.095 | 546.771 | 546.819 | 546.724 |
| **ST54** | 1+620 | 1620.000 | 2.322 | -2.322 | 0.110 | -0.110 | 546.304 | 546.194 | 546.083 |
| **PC-IV** | 1+629,1 | 1629.100 | 3.333 | -3.333 | 0.158 | -0.158 | 546.162 | 546.004 | 545.846 |
| **ST55** | 1+650 | 1650.000 | 5.000 | -5.000 | 0.238 | -0.238 | 545.806 | 545.569 | 545.331 |
| **ST56** | 1+680 | 1680.000 | 5.000 | -5.000 | 0.238 | -0.238 | 545.181 | 544.944 | 544.706 |
| **ST57** | 1+710 | 1710.000 | 5.000 | -5.000 | 0.238 | -0.238 | 544.556 | 544.319 | 544.081 |
| **ST58** | 1+740 | 1740.000 | 5.000 | -5.000 | 0.238 | -0.238 | 543.931 | 543.694 | 543.456 |
| **ST59** | 1+770 | 1770.000 | 5.000 | -5.000 | 0.238 | -0.238 | 543.306 | 543.069 | 542.831 |
| **ST60** | 1+800 | 1800.000 | 5.000 | -5.000 | 0.238 | -0.238 | 542.681 | 542.444 | 542.206 |
| **ST61** | 1+830 | 1830.000 | 5.000 | -5.000 | 0.238 | -0.238 | 542.056 | 541.819 | 541.581 |
| **ST62** | 1+860 | 1860.000 | 4.797 | -4.797 | 0.228 | -0.228 | 541.421 | 541.194 | 540.966 |
| **PT-IV** | 1+873,17 | 1873.170 | 3.333 | -3.333 | 0.158 | -0.158 | 541.078 | 540.919 | 540.761 |
| **ST63** | 1+890 | 1890.000 | 1.463 | -2.000 | 0.070 | -0.095 | 540.638 | 540.569 | 540.474 |
| **ST64** | 1+920 | 1920.000 | -1.870 | -2.000 | -0.089 | -0.095 | 539.855 | 539.944 | 539.849 |
| **ENSU-IV** | 1+921.17 | 1921.170 | -2.000 | -2.000 | -0.095 | -0.095 | 539.824 | 539.919 | 539.824 |
| **B** | 1+947,20 | 1947.200 | -2.000 | -2.000 | -0.095 | -0.095 | 539.282 | 539.377 | 539.282 |

*\*Note that STSU refers to “Starting point of super elevation” and ENSU refers to “Ending point of super elevation”.*

* Plot the rotation diagrams for the superelevation applications.

*(The rotation diagrams are added in Autocad file.)*

**Topography**

* Find the right of way according to your standards. For each station on the map, show the right of way as in the figure. (For second class highways, right of way is 40 m; 20 m to the right and 20 m to the left.)
* By interpolation, find the elevations at perpendicularly 10 m and 20m to the left and 10m and 20 m to the right of the centerlines of the stations.
* Prepare a table

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Station** | **St. Km.** | **Elevation to left (m)** | | **CL Elevation (m)** | **Elevation to right (m)** | |
| **at 20 m** | **at 10 m** | **at 10 m** | **at 20 m** |
| A | 0 | 468,2171 | 466,6476 | 465 | 464,1360 | 462,6606 |
| ST1 | 0+030 | 472,2405 | 469,8703 | 467,152 | 465,2284 | 463,8531 |
| ST2 | 0+060 | 476,2838 | 472,7301 | 470,829 | 468,0607 | 464,4947 |
| ST3 | 0+090 | 480,4101 | 477,2135 | 473,646 | 471,2842 | 469,0099 |
| ST4 | 0+120 | 482,6236 | 480,7632 | 478,013 | 474,4305 | 471,7033 |
| ST5 | 0+150 | 486,6461 | 483,0848 | 480,975 | 478,2221 | 474,3673 |
| ST6 | 0+180 | 490,1936 | 486,5827 | 482,750 | 480,7204 | 477,5576 |
| ST7 | 0+210 | 491,8085 | 489,7769 | 485,930 | 482,3114 | 480,3651 |
| ST8 | 0+240 | 494,2930 | 491,4759 | 489,111 | 485,2711 | 482,2541 |
| ST9 | 0+270 | 497,4743 | 493,6347 | 491,136 | 488,5386 | 485,6863 |
| PC-I | 0+278.61 | 498,3852 | 494,5435 | 491,146 | 489,5154 | 486,7467 |
| ST10 | 0+300 | 500,4309 | 497,0475 | 493,292 | 491,3428 | 489,7979 |
| ST11 | 0+330 | 501,8865 | 500,1096 | 496,734 | 493,7004 | 491,8398 |
| ST12 | 0+360 | 503,9873 | 501,6673 | 500,125 | 497,2569 | 494,7336 |
| PT-I | 0+371.92 | 505,3705 | 502,4780 | 500,898 | 498,8579 | 496,2807 |
| ST13 | 0+390 | 507,9793 | 505,0000 | 502,264 | 500,7816 | 498,8532 |
| ST14 | 0+420 | 511,1788 | 509,3710 | 506,286 | 503,3525 | 501,5362 |
| ST15 | 0+450 | 514,1991 | 511,8607 | 510,304 | 507,7183 | 504,7269 |
| ST16 | 0+480 | 518,5298 | 515,5550 | 512,480 | 511,0205 | 509,0633 |
| ST17 | 0+510 | 521,4143 | 519,8440 | 516,770 | 513,8823 | 511,6920 |
| ST18 | 0+540 | 523,8617 | 521,6695 | 520,087 | 517,2883 | 514,2081 |
| ST19 | 0+570 | 526,8293 | 523,7982 | 521,626 | 520,1307 | 517,2369 |
| PC-II | 0+570.58 | 526,8293 | 523,7982 | 521,626 | 520,1307 | 517,2369 |
| ST20 | 0+600 | 530,0716 | 527,2823 | 524,456 | 522,0820 | 520,6919 |
| ST21 | 0+630 | 532,2985 | 531,0118 | 529,456 | 526,9069 | 524,3891 |
| ST22 | 0+660 | 537,6118 | 535,3329 | 533,103 | 531,6825 | 530,5608 |
| ST23 | 0+690 | 542,0260 | 541,0774 | 540,125 | 538,4080 | 536,5300 |
| ST24 | 0+720 | 548,5359 | 547,2992 | 545,736 | 544,1872 | 542,0231 |
| ST25 | 0+750 | 550,5476 | 550,3491 | 550,158 | 549,6015 | 547,9560 |
| ST26 | 0+780 | 552,6951 | 552,3463 | 550,979 | 550,0612 | 547,9929 |
| ST27 | 0+810 | 555,0410 | 553,4200 | 551,954 | 550,9168 | 549,7494 |
| PT-II | 0+836.95 | 557,5500 | 555,9330 | 553,698 | 552,1285 | 551,1554 |
| ST28 | 0+840 | 557,6700 | 556,0128 | 553,957 | 552,6812 | 551,7162 |
| ST29 | 0+870 | 560,1691 | 558,8375 | 556,893 | 554,9263 | 552,9659 |
| ST30 | 0+900 | 560,2810 | 558,9870 | 557,107 | 555,1429 | 553,1920 |
| ST31 | 0+930 | 559,8134 | 557,9030 | 556,055 | 554,1026 | 552,3459 |
| ST32 | 0+960 | 558,7367 | 556,8681 | 554,959 | 553,0535 | 551,8249 |
| ST33 | 0+990 | 557,6510 | 555,7558 | 553,884 | 552,2249 | 551,2777 |
| ST34 | 1+020 | 557,0782 | 555,1503 | 553,261 | 551,9138 | 550,9624 |
| ST35 | 1+050 | 558,3008 | 556,2809 | 554,275 | 552,3704 | 551,3729 |
| ST36 | 1+080 | 559,5492 | 557,5000 | 555,515 | 553,4780 | 551,9757 |
| ST37 | 1+110 | 560,3843 | 558,7518 | 556,756 | 554,6966 | 552,6760 |
| ST38 | 1+140 | 561,0097 | 560,0000 | 557,995 | 555,9401 | 553,9466 |
| ST39 | 1+170 | 562,2755 | 560,8394 | 559,087 | 556,8648 | 554,8266 |
| ST40 | 1+200 | 566,8406 | 563,9304 | 561,792 | 560,3202 | 557,7452 |
| PC-III | 1+227,77 | 571,0232 | 569,1377 | 565,654 | 562,7542 | 561,1692 |
| ST41 | 1+230 | 571,1731 | 569,6791 | 565,936 | 563,0018 | 561,3248 |
| ST42 | 1+260 | 574,3660 | 571,8638 | 570,029 | 556,8773 | 563,7330 |
| ST43 | 1+290 | 575,5713 | 572,6314 | 570,818 | 568,6758 | 565,6348 |
| ST44 | 1+320 | 577,1339 | 572,3898 | 570,217 | 567,5000 | 565,3065 |
| ST45 | 1+350 | 577,6320 | 572,7237 | 569,415 | 565,3598 | 562,4148 |
| PT-III | 1+377,21 | 574,8347 | 571,3244 | 567,850 | 563,1046 | 561,0744 |
| ST46 | 1+380 | 575,0000 | 571,6823 | 567,636 | 563,3910 | 561,1993 |
| ST47 | 1+410 | 572,2637 | 567,7049 | 564,952 | 561,3420 | 558,0433 |
| ST48 | 1+440 | 570,3271 | 566,4101 | 562,233 | 559,8829 | 555,0048 |
| ST49 | 1+470 | 566,0231 | 562,2491 | 560,275 | 556,3731 | 552,3221 |
| ST50 | 1+500 | 561,9503 | 559,8768 | 555,847 | 552,1497 | 550,1271 |
| ST51 | 1+530 | 559,8574 | 555,9477 | 552,301 | 550,3253 | 546,7175 |
| ST52 | 1+560 | 556,0456 | 552,4046 | 550,560 | 547,2634 | 544,0103 |
| ST53 | 1+590 | 552,2716 | 550,4631 | 547,245 | 543,4407 | 541,0948 |
| ST54 | 1+620 | 550,0629 | 547,0273 | 543,384 | 541,0473 | 538,3918 |
| PC-IV | 1+629,1 | 548,8171 | 545,7013 | 542,318 | 540,3651 | 537,1459 |
| ST55 | 1+650 | 545,3139 | 542,6965 | 540,943 | 539,3814 | 534,4368 |
| ST56 | 1+680 | 541,1022 | 539,8789 | 536,953 | 533,3909 | 531,1647 |
| ST57 | 1+710 | 536,1583 | 533,8051 | 531,890 | 530,1939 | 527,5913 |
| ST58 | 1+740 | 532,3780 | 531,4059 | 530,268 | 529,5382 | 528,7043 |
| ST59 | 1+770 | 535,8988 | 534,0126 | 533,093 | 529,6867 | 529,1702 |
| ST60 | 1+800 | 540,4731 | 539,4162 | 537,959 | 536,3059 | 534,7903 |
| ST61 | 1+830 | 543,3515 | 542,0839 | 541,230 | 540,3781 | 539,0284 |
| ST62 | 1+860 | 547,7329 | 545,8934 | 544,084 | 542,3732 | 541,4474 |
| PT-IV | 1+873,17 | 549,3591 | 547,7027 | 545,822 | 543,9410 | 542,3098 |
| ST63 | 1+890 | 550,7837 | 549,1949 | 547,848 | 545,9877 | 544,1538 |
| ST64 | 1+920 | 552,7910 | 551,7104 | 550,779 | 549,6896 | 547,8332 |
| B | 1+947,20 | 556,2524 | 554,3612 | 552,500 | 551,5777 | 550,6442 |

**Discussion of Results**

, and values for 4 curves are calculated. Some adjustments are applied to these values of Curve 2 and Curve 3, because according to standards, cannot exceed 0.08. Therefore,design speed of these 2 curves are recalculated and and of them are obtained accordingly. There is also a standard on which determines its minimum value 45m. Thus, values that are smaller than 45m corrected to be compiled with standards.

Note that, according to the ‘Geometric Standards of Highways’, lane width and shoulder width are taken as 3.25m and 1.5m respectively. Considering the standards, superelevation grades calculated above and design properties of curves (speed and radius), rotation diagrams are plotted.

Right of way is determined according to the standards which say it is 40m (20m to right, 20m to left) in this case. Elevations at perpendicularly 10 m and 20m to the left and 10m and 20 m to the right of the centerlines are calculated. These elevation values in addition to elevation of centerline at these stations are given above in tabular form.

**Conclusion**

Step 4 is composed of two parts as superelevation application and topography. In superelevation section, maximum superelevation grades at each station is determined. Rotation diagrams are drawn as well. In topography section, the aim is to find the elevations at perpendicularly 10 m and 20m to the left and 10m and 20 m to the right of the centerlines of the stations. The data obtained in Step 4 is utilized in Step 5.