## SECTION 28 – COMPUTATION OF QUANTITIES

0624. General.

a. Excavation in rock should be separated from ordinary excavation owing to the longer time and different methods required.

b. Excavation in side-hill cut should also be recorded separately as the excavated material is usually side cast and is not available for filling elsewhere.

c. Allowances must be applied for swell and shrinkage. For small earthworks the Figures given in Table 6.1 can be used. For work over large areas it is better to allow an over-all 10 percent increase in the computed fill requirement.

d. When possible, quantities should be tabulated (see example in Table 6.3), so that the quantity available or required for filling at any particular change can be readily determined.

e. For planning large scale earthworks a mass diagram should be prepared to simplify the selection of the most economical method of organizing work.

f. For very hasty work the proforma shown in Figure 6.3 may be used.

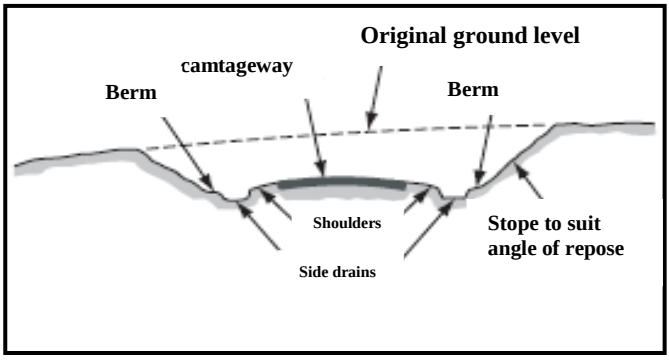



Figure 6-2 (a): Shapes of Earthworks Through Cut

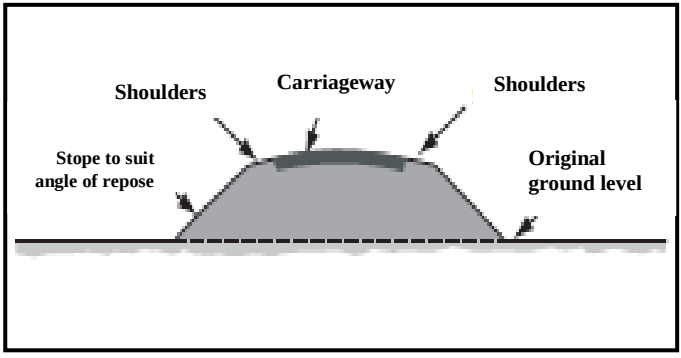



Figure 6-2 (b): Shapes of Earthworks Embankment

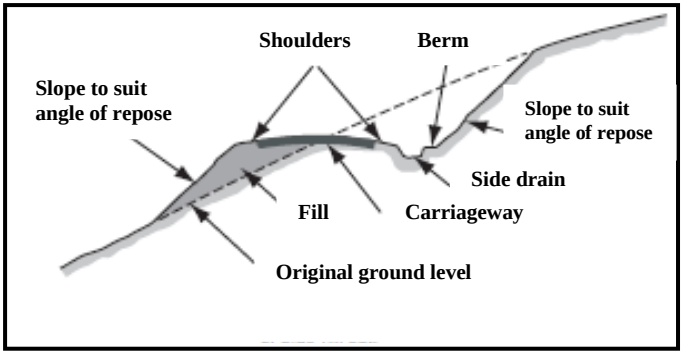



Figure 6-2 (c): Shapes of Earthworks Side Hill Cut

**TABLE 6.3–EXAMPLE OF TABULATION OF EARTHWORK QUANTITES**

| Ser No | Chain age of station (ft) | Average depth of out bank (ft) | Average height of bank (ft) | Cutting (+) (cuyds) | Banking (-) (cuyds) | Material and shrinkage constant (percent) | Quantity corrected by shrinkage constant ( cuyds) | Total quantity of material available at chain age (cu yds) |
|---|---|---|---|---|---|---|---|---|
| (a) | (b) | (c) | (d) | (e) | (f) | (g) | (h) | (j) |
| 1. | 100+00 | 2 | - | 244 | - | 88 | +215 | +215 |
| 2. | 101+00 | 6 | - | 867 | - | 88 | +763 | +978 |
| 3. | 102+00 | 1 | - | 117 | - | 88 | +103 | +1,081 |
| 4. | 102+25 | 0.5 | - | 15 | - | 88 | +13 | +1,094 |
| 5. | 103+00 | - | 1 | - | -117 | 105 | -123 | +971 |
| 6. | 104+00 | - | 8 | - | -1,244 | 105 | -1,306 | -335 |

Notes:-

a. At chainage 10,225 ft the changeover from from cut to fill takes place.

b. At chainage 10,400 ft there is a deficit of 335 cu yds fill which must be imported from borrow pit.

c. Colm (b) is the distance along the centre line from the starting point in hundreds of feet plus feet.

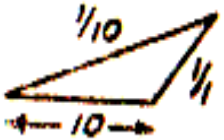
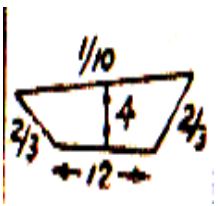
d. Colm (e) gives volume of excavation between cahinages as read from Table 20.

e. Colm (f) gives volume of bankings as read from Table 20.

f. Colm (g) is the correction factor for swell, shrinkage or settlement (see Table 17).

g. Colm (h) colms (e) and (f) corrected by colm (g).

h. Colm (f) is the continuous algebraic sum of colm (h), ie, the quantity of surplaus (+) or deficient (-) fill at that chainage.

| Chainage | Section | Type of material | Gradient | Average cross section | Volume of cut (cuyds) | Volume of fill (cuyds) | Volume of fill+ 10% | Remarks |
|---|---|---|---|---|---|---|---|---|
| (a) | (b) | (c) | (d) | (e) | (f) | (g) | (h) | (j) |
| 0<br>200 | A | OL | 1/20 up to ch 200 |  | 41 | - | - | Not suitable for fill spread downhill to wast by doxer |
| 200<br>500 | B | SC | 1/15 down to ch 500 |  | 322 | - | - | Use for part filling between ch 500-1000 Haul distance approx 500 ft |

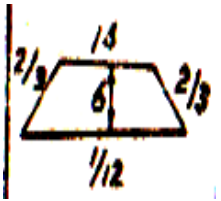
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 500<br>1000 | C | - | Level |  | | 2639 | 2903 | 822 yds from cut in sec B Renaining 2080 yds from borrow pit. Haul distance approx 200 ft |

Figure 6-3: Proforma for the hasty estimation of earthwork.

0625. Computing volume: To compute volume cross sectional areas of cut or fill must be determined at known distance apart.

a. Cross sections should be plotted preferably on squared paper at every 100 ft station and at every marked change of slope along the centre line. Plotting is simplified by using a template of the formation profile made to scale.

b. Areas are most quickly measured by plan meter Approximate value can be found by counting squares.

c. The volume (v) of the prismatic between two cross sections of areas $A_1$ and $A_2$ sq ft, situated L ft apart is given by the equation:-

$$V = \frac{(A_1+A)}{2} \times L \text{ cu ft}$$

If cross sections are taken at 100 ft stations this equation can be simplified to the form:-

$V_y = 1.85 (A_1+A_2)$

Where $V_y$ is in cu yds

and $A_1$ and $A_2$ are in sq ft

These formula are reasonably accurate only when the end areas are of approximately the same shape, but more precise methods are unnecessary when field methods of measuring and setting out are used.

d. Borrow pit volume can be computed from the average cross sectional area. In pits of irregular shape it may be necessary to divide up the plan view into rectangles or triangles of about 20 to 50 ft sides and to compute each portion separately.

e. Swell and shrinkage factors must not be overlooked.

0626. Hasty estimates

a. Bank and through cuts:- Approximate quantities may be calculated from a longitudinal section of the centre line by measuring the average depth of cut or height of fill for each 100 ft length of the alignment and obtaining from Table 6.4 the corresponding volume of cut or fill. Factors for swell and shrinkage must be applied. Table 6.4 is calculated on the assumption that both the existing ground and the proposed formation are level. Errors due to this assumption are usually compensating, except where the natural ground has a continuous cross fall. In about 10 to 15 percent.

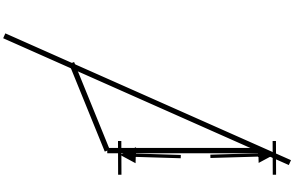
b. Side-hill cuts:- Approximate quantities of excavation can be found from Table 6.5 in which the figures are calculated for the case where the formation level of the centre line is at the existing ground level.

**TABLE 6.4: EARTHWORK QUANTITIES FOR BANKS AND CUTTINGS**

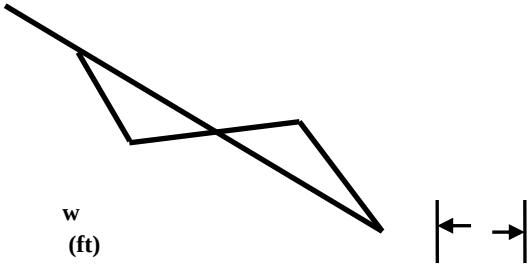
| Average depth of cut or heght of fill (ft) | Quantity per 100 feet, with angle of repose 1 in 1 ½ (cu yds) Wid th of top of bank or base of cutting | | | | | | | | | Add where angle of repose of 1 in 2 (cu yds) | Subtract where angle of respose is 1 in 1 (cu yds) | Subtract where angle of respose is 2 in 1 (cu yds) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 16 ft | 18 ft | 20 ft | 22 ft | 24 ft | 26 ft | 28 ft | 30 ft | 32 ft | | | |
| (a) | (b) | (c) | (d) | (e) | (f) | (g) | (h) | (j) | (k) | (l) | (m) | (n) |
| 1. | 65 | 72 | 80 | 87 | 95 | 102 | 109 | 117 | 124 | 2 | 2 | 4 |
| 2. | 141 | 156 | 170 | 185 | 200 | 215 | 230 | 244 | 259 | 7 | 7 | 15 |
| 3. | 228 | 250 | 272 | 294 | 317 | 339 | 361 | 383 | 405 | 16 | 16 | 33 |
| 4. | 326 | 356 | 385 | 415 | 444 | 474 | 504 | 533 | 563 | 30 | 30 | 59 |
| 5. | 435 | 472 | 509 | 546 | 583 | 620 | 657 | 694 | 731 | 46 | 46 | 93 |
| 6. | 556 | 600 | 614 | 689 | 733 | 777 | 822 | 867 | 911 | 67 | 67 | 133 |
| 7. | 687 | 739 | 791 | 843 | 894 | 946 | 998 | 1,050 | 1,102 | 91 | 914 | 181 |
| 8. | 830 | 889 | 948 | 1,007 | 1,067 | 1,126 | 1,185 | 1,244 | 1,304 | 116 | 116 | 137 |
| 9. | 983 | 1,050 | 1,116 | 1,183 | 1,250 | 1,317 | 1,383 | 1,450 | 1,517 | 150 | 150 | 300 |
| 10. | 1,148 | 1,222 | 1,296 | 1,370 | 1,444 | 1,518 | 1,593 | 1,667 | 1,741 | 185 | 185 | 370 |
| 11. | 1,324 | 1,406 | 1,487 | 1,568 | 1,650 | 1,731 | 1,813 | 1,894 | 1,976 | 224 | 224 | 448 |
| 12. | 1,511 | 1,600 | 1,689 | 1,778 | 1,867 | 1,953 | 2,044 | 2,133 | 2,222 | 267 | 267 | 534 |
| 13. | 1,709 | 1,806 | 1,902 | 1,998 | 2,094 | 2,191 | 2,287 | 2,383 | 2,480 | 313 | 313 | 626 |
| 14. | 1,919 | 2,022 | 2,126 | 2,230 | 2,333 | 2,437 | 2,541 | 2,644 | 2,748 | 363 | 363 | 725 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15. | 2,139 | 2,250 | 2,361 | 2,472 | 2,583 | 2,694 | 2,806 | 2,917 | 3,028 | 416 | 416 | 852 |
| 16. | 2,370 | 2,489 | 2,607 | 2,725 | 2,844 | 2,962 | 3,081 | 3,200 | 3,319 | 476 | 476 | 948 |
| 17. | 2,613 | 2,739 | 2,865 | 2,991 | 3,116 | 3,241 | 3,369 | 3,494 | 3,620 | 534 | 534 | 1068 |
| 18. | 2,867 | 3,000 | 3,133 | 3,267 | 3,400 | 3,533 | 3,667 | 3,800 | 3,933 | 598 | 598 | 1,196 |
| 19. | 3,131 | 3,272 | 3,413 | 3,554 | 3,694 | 3,835 | 3,976 | 4,117 | 4,257 | 667 | 667 | 1,334 |
| 20. | 3,407 | 3,556 | 3,704 | 3,852 | 4,000 | 4,148 | 4,296 | 4,444 | 4,592 | 740 | 740 | 1,480 |
| 21. | 3,694 | 3,850 | 4,005 | 4,161 | 4,317 | 4,472 | 4,628 | 4,783 | 4,939 | 819 | 819 | 1,638 |
| 22. | 3,993 | 4,156 | 4,318 | 4,482 | 4,644 | 4,807 | 4,970 | 5,133 | 5,296 | 896 | 896 | 1,792 |
| 23. | 4,302 | 4,472 | 4,642 | 4,812 | 4,982 | 5,153 | 5,324 | 5,494 | 5,665 | 980 | 980 | 1,960 |
| 24. | 4,622 | 4,800 | 4,938 | 5,156 | 5,333 | 5,511 | 5,689 | 5,967 | 6,044 | 1,066 | 1,066 | 2,132 |
| 25. | 4,954 | 5,139 | 5,324 | 5,509 | 5,694 | 5,879 | 6,065 | 6,250 | 6,435 | 1,158 | 1,158 | 2,316 |
| 26. | 5,296 | 5,489 | 5,681 | 5,374 | 6,066 | 6,259 | 6,452 | 6,644 | 6,837 | 1,252 | 1,252 | 2,504 |
| 27. | 5,650 | 5,850 | 6,050 | 6,250 | 6,450 | 6,650 | 6,850 | 7,050 | 7,250 | 1,350 | 1,350 | 2,700 |
| 28. | 6,015 | 6,222 | 6,430 | 6,637 | 6844 | 7,051 | 7,259 | 7,467 | 7,674 | 1,452 | 1,452 | 2,904 |
| 29. | 6,391 | 6,606 | 6,820 | 7,035 | 7250 | 7,460 | 7,680 | 7,894 | 8,109 | 1,558 | 1,558 | 3,116 |
| 30. | 6,778 | 7,000 | 7,222 | 7,444 | 7657 | 7,889 | 8,111 | 8,333 | 8,555 | 1,667 | 1,667 | 3,334 |

## TABLE 6.5: QUANTITIES OF EXCAVATION IN SIDE-HILL SLOPES



**w**
**(ft)**



**w**
**(ft)**

| Side-hill slope of natural ground surface | Quantity of excavation (cu yds per 100 ft)* | | | |
|---|---|---|---|---|
| | Angle repose of soil | | | |
| | 2 in 1 | 1 in 1 | 1 in 1½ | 1 in 2 |
| (a) | (b) | (c) | (d) | (e) |
| 1 in 1 | 3.7 $W^2$ | - | - | - |
| 1 in 1½ | 1.85 $W^2$ | 3.7 | - | - |
| 1 in 2 | 1.23 $W^2$ | 1.85 $W^2$ | 3.7 $W^2$ | - |
| 1 in 3 | 0.741 $W^2$ | 0.925 $W^2$ | 1.23 $W^2$ | 1.85 $W^2$ |
| 1 in 4 | 0.529 $W^2$ | 0.617 $W^2$ | 0.741 $W^2$ | 0.925 $W^2$ |
| 1 in 5 | 0.411 $W^2$ | 0.463 $W^2$ | 0.329 $W^2$ | 0.617 $W^2$ |
| 1 in 7 | 0.284 $W^2$ | 0.308 $W^2$ | 0.336 $W^2$ | 0.370 $W^2$ |
| 1 in 10 | 0.195 $W^2$ | 0.205 $W^2$ | 0.218 $W^2$ | 0.231 $W^2$ |
| 1 in 12 | 0.161 $W^2$ | 0.168 $W^2$ | 0.176 $W^2$ | 0.185 $W^2$ |
| 1 in 15 | 0.127 $W^2$ | 0.132 $W^2$ | 0.137 $W^2$ | 0.142 $W^2$ |
| 1 in 20 | 0.095 $W^2$ | 0.098 $W^2$ | 0.100 $W^2$ | 0.103 $W^2$ |
| 1 in 25 | 0.70 $W^2$ | 0.077 $W^2$ | 0.079 $W^2$ | 0.081 $W^2$ |

***** W=actual width of cut (in feet), whether the formation is in full cut or part in cut and part on fill.