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TO: SUPERSEDED BY EI 81-041 EFFECTIVE 3/4/1982	<h1>ENGINEERING INSTRUCTION</h1> <p>NEW YORK STATE DEPARTMENT OF TRANSPORTATION</p>
	SUBJECT: EARTHWORK SUMMARY SHEETS - ES-1 AND ES-2 Subject Code: 7.27-1-203
Distribution: <input checked="" type="checkbox"/> Main Office <input checked="" type="checkbox"/> Regions <input type="checkbox"/> Special	Code: <u>EI 76-35</u> Date: <u>May 10, 1976</u> Supersedes:
APPROVED:  DEPUTY CHIEF ENGINEER, FACILITIES DESIGN SUBDIV.	

The Earthwork Summary Sheets are to be used for all projects submitted to P.S. & E. after July 1, 1976. All plans shall contain either Sheet ES-1 or Sheets ES-1 and ES-2.

The sheets are to be used in designs with either method of payment, i.e. Items 203.01 or 203.02 and 203.03. They are also capable of accommodating both small and large projects. On small projects involving simple earthwork, only Sheet ES-1 need be used.

The sheets are designed to conform to the definitions of the latest specifications and are intended to give the bidders maximum description of the work involved.

The space under "Explanation of Earthwork Design" should be used to describe the type of work involved on smaller projects, and to describe all special earthwork features on large projects.

Enclosed with the new Summary Sheets are examples of work ups for various types of projects. The examples illustrate how the new sheets are to be used and especially, what should be described under "Explanation of Earthwork Design."

The excavation is divided into rock, suitable earth and unsuitable material. Even on the smallest projects, this breakdown is necessary.

The balance columns, excess and deficiency, have been deleted. The information for the bidder to obtain this data is supplied under the column headed "Available for Embankment."

The bottom of area "F" in the diagram is assumed to be at the original ground surface. However, if a design includes a construction lift, or the top of a swamp backfill is not at the original ground surface, this assumption would be in error and "F" must be adjusted accordingly.

The computer program presently available can supply the following information which can be used with these revised sheets:

<u>OLD</u>	<u>NEW</u>
CR	C _r
CS	C _a
C	C _e
FS	C _s and F _s
FT	F + F _s (F _t if no benching is necessary)

Shortly, the computer program will be changed to supply only the above new information.

EXAMPLE #1 SIMPLE EARTHWORK, DESIGNED ITEM 203.01

STATION LIMITS 200 TO 250

Source	EXCAVATION			T _u	C _T	F _T
	T _e	C _r	203.02			
Totals						

Source	EXCAVATION			T _u	C _T	F _T
	T _e	C _r	203.03			
Mainline	1500	100	400	400	2000	1200
Driveways	600				600	150
Drainage	50	300				
Totals	2150	400	400	400	2600	1350

Assumed f_e = .85 and f_r = 1.25

T_A = T_ef_e + C_rf_r = 2150(.85) + 400(1.25) = 2328 cu. yds.

Deficiency = F_T - T_A = Excess cu. yds.

Borrow = Deficiency ÷ f_e = cu. yds.

Total 203.01 = C_T + Borrow = 2600 + 2600 = 5200 cu. yds.

NOTES: THE CONTRACTOR'S ATTENTION IS DIRECTED TO THE FACT THAT CONDITIONS AND QUANTITIES AS SHOWN ON THESE TABLES ARE ESTIMATED, AND ARE FOR THE PURPOSE OF PREPARING AN ESTIMATE. IN ANY EVENT, THESE CONDITIONS AND QUANTITIES ARE NOT TO BE DEEMED OR CONSIDERED BY THE CONTRACTOR AS A WARRANTY OR A REPRESENTATION BY THE STATE OF ACTUAL FIELD CONDITIONS TO BE ENCOUNTERED OR EXACT QUANTITIES OF WORK TO BE PERFORMED.

WHEN EXCAVATION IS PAID FOR UNDER ITEM 203.01, UNCLASSIFIED EXCAVATION AND EMBANKMENT, THE EARTHWORK FACTORS, f_e AND f_r, ARE ASSUMED, AND HAVE BEEN USED TO ESTIMATE THE QUANTITY OF BORROW OR SURPLUS MATERIAL.

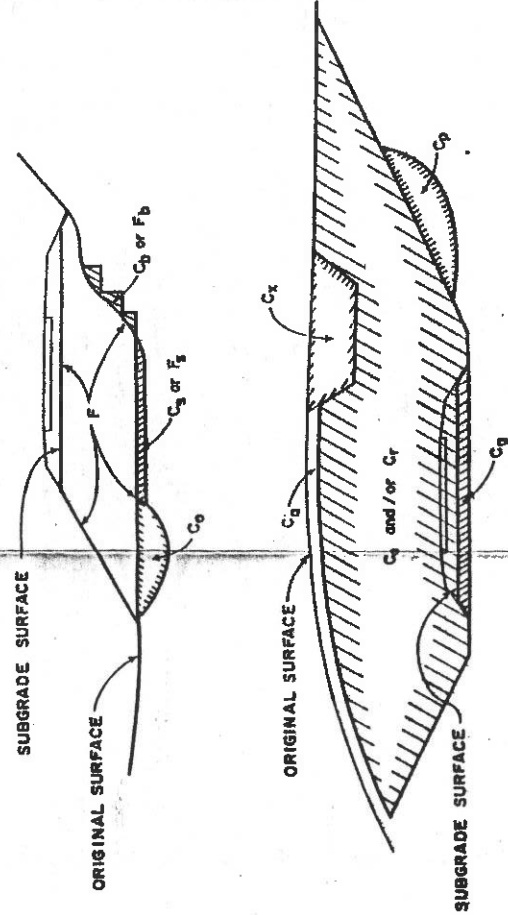
EXPLANATION OF EARTHWORK DESIGN

Most of the fill will be placed between Station 202 and 210. Stripping will be necessary beneath this fill.

Ditch cleaning is estimated for the greater part of the project. The excavated material is considered unsuitable for embankment construction.

Existing shoulders will be excavated to a depth of about 6 inches to accommodate new shoulders. Some of the excavation from Station 210 to 220 is expected to be rock. All material from shoulder excavation is assumed suitable for embankment construction.

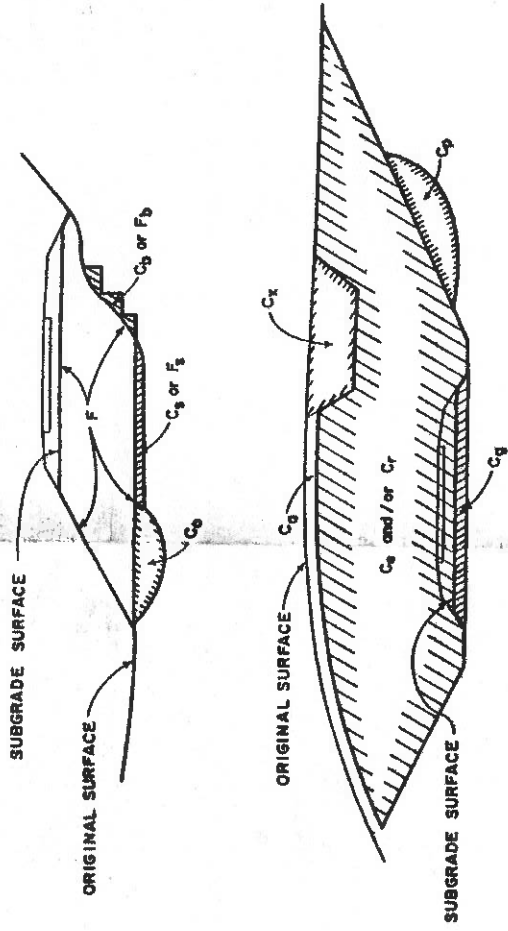
Rock will be encountered in the excavation for the culvert installation at Station 203+50.



- C₁ - PORTION OF CUT ASSUMED TO BE EARTH SUITABLE FOR EMBANKMENT CONSTRUCTION, EXCLUDING C₉ AND C_p.
- C₂ - PORTION OF CUT ASSUMED TO BE ROCK, INCLUDING C₉ IF APPLICABLE.
- C₃ - EXCAVATION FROM CUT SLOPE NECESSARY TO PLACE SLOPE PROTECTION.
- C₄ - EXCAVATION FOR REQUIRED BENCHING (BOTH LONGITUDINAL AND TRANSVERSE).
- C₅ - EXCAVATION FOR SUBGRADE IMPROVEMENT.
- T₁ - (C₁ + C₂ + C₃ + C₄) TOTAL EARTH EXCAVATION ASSUMED SUITABLE FOR EMBANKMENT CONSTRUCTION.
- C₆ - EXCAVATION OF UNSUITABLE MATERIAL BENEATH EMBANKMENT: SWAMP OR DUMP.
- C₇ - EXCAVATION OF TOPSOIL (UNSUITABLE MATERIAL) IN CUT.
- C₈ - EXCAVATION OF TOPSOIL (UNSUITABLE MATERIAL) UNDER EMBANKMENT.
- C₉ - EXCAVATION OF UNSUITABLE MATERIAL IN CUT: SWAMP OR DUMP.
- T₂ - (C₆ + C₇ + C₈ + C₉) TOTAL EXCAVATION ASSUMED UNSUITABLE FOR EMBANKMENT CONSTRUCTION.
- C_T - (T₁ + T₂ + C₅) TOTAL EXCAVATION.
- F₁ - FILL REQUIRED TO REPLACE BENCHES.
- F₂ - FILL REQUIRED TO REPLACE TOPSOIL REMOVED BENEATH EMBANKMENTS.
- F - FILL REQUIRED TO COMPLETE EMBANKMENT TO THE SUBGRADE SURFACE AND SIDE SLOPES AFTER THE FOUNDATION HAS BEEN PREPARED.
- F_T - (F₁ + F₂ + F) TOTAL FILL REQUIRED.
- T_A - (T₁f_e + C₂f_r) THE VOLUME WHICH THE SUITABLE EXCAVATED MATERIAL COULD OCCUPY IN EMBANKMENT.
- f_e - SHRINKAGE FACTOR FOR EARTH.
- f_r - SWELL FACTOR FOR ROCK.

EXAMPLE #2 SIMPLE EARTHWORK, DESIGNED USING ITEMS 203.02 & 203.03 STATION LIMITS 200 TO 250

Source	EXCAVATION				203.02	203.03
	T _e	C _r	T _u	C _t		
Mainline	1500	100	400	2000	1200	F _T
Driveways	600			600	150	
Drainage	50	300				
Totals	2150	400	400	2600	1350	



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WHEN EXCAVATION IS PAID FOR UNDER ITEM 203.01, UNCLASSIFIED EXCAVATION AND EMBANKMENT, THE EARTHWORK FACTORS, f_e AND f_r , ARE ASSUMED, AND HAVE BEEN USED TO ESTIMATE THE QUANTITY OF BORROW OR SURPLUS MATERIAL.

EXPLANATION OF EARTHWORK DESIGN

Most of the fill will be placed between Station 202 and 210. Stripping will be necessary beneath this fill.

Ditch cleaning is estimated for the greater part of the project. The excavated material is considered unsuitable for embankment construction.

Existing shoulders will be excavated to a depth of about 6 inches to accommodate new shoulders. Some of the excavation from Station 210 to 220 is expected to be rock. All material from shoulder excavation is assumed suitable for embankment construction.

Rock will be encountered in the excavation for the culvert installation at Station 203+50.

- C_u - PORTION OF CUT ASSUMED TO BE EARTH SUITABLE FOR EMBANKMENT CONSTRUCTION, EXCLUDING C_g AND C_p.
- C_r - PORTION OF CUT ASSUMED TO BE ROCK, INCLUDING C_g IF APPLICABLE.
- C_p - EXCAVATION FROM CUT SLOPE NECESSARY TO PLACE SLOPE PROTECTION.
- C_s - EXCAVATION FOR REQUIRED BENCHING (BOTH LONGITUDINAL AND TRANSVERSE).
- C_g - EXCAVATION FOR SUBGRADE IMPROVEMENT.
- T_e - (C_u + C_p + C_s + C_g) TOTAL EARTH EXCAVATION ASSUMED SUITABLE FOR EMBANKMENT CONSTRUCTION.
- C_o - EXCAVATION OF UNSUITABLE MATERIAL BENEATH EMBANKMENT; SWAMP OR DUMP.
- C_a - EXCAVATION OF TOPSOIL (UNSUITABLE MATERIAL) IN CUT.
- C_b - EXCAVATION OF TOPSOIL (UNSUITABLE MATERIAL) UNDER EMBANKMENT.
- C_x - EXCAVATION OF UNSUITABLE MATERIAL IN CUT; SWAMP OR DUMP.
- T_u - (C_o + C_a + C_b + C_x) TOTAL EXCAVATION ASSUMED UNSUITABLE FOR EMBANKMENT CONSTRUCTION.
- C_T - (T_e + T_u + C_x) TOTAL EXCAVATION.
- F_s - FILL REQUIRED TO REPLACE BENCHES.
- F_g - FILL REQUIRED TO REPLACE TOPSOIL REMOVED BENEATH EMBANKMENTS.
- F - FILL REQUIRED TO COMPLETE EMBANKMENT TO THE SUBGRADE SURFACE AND SIDE SLOPES AFTER THE FOUNDATION HAS BEEN PREPARED.
- F_T - (F_s + F_g + F) TOTAL FILL REQUIRED.
- T_A - (T_e + C_o + C_a + C_b) THE VOLUME WHICH THE SUITABLE EXCAVATED MATERIAL COULD OCCUPY IN EMBANKMENT.
- f_e - SHRINKAGE FACTOR FOR EARTH.
- f_r - SKELL FACTOR FOR ROCK.

Source	EXCAVATION			C _T	F _T
	T _e	C _r	T _u		
Totals					
Assumed f_e = _____ and f_r = _____					
T _A = T _e f _e + C _r f _r = _____					
Deficiency = F _T - T _A = _____ cu. yds.					
Borrow = Deficiency ÷ f _e = _____ cu. yds.					
Total 203.01 = C _T + Borrow = _____ cu. yds.					
Total 203.01 = _____ + _____ = _____ cu. yds.					

EXAMPLE #3 NEW CONSTRUCTION DESIGNED ITEM 203.01

SUMMARY OF EARTHWORK (ITEMS 203.02 AND 203.03 ONLY)					
Source	EXCAVATION			203.02	203.03
	T ₀	C _r	T _u	C _T	F _T
Totals					

SUMMARY OF EARTHWORK (ITEM 203.01 ONLY)					
Source	EXCAVATION			C _T	F _T
	T ₀	C _r	T _u		
ES-2	101,578	950	44,750	147,278	141,138
Drainage	625	30			
Channel Relocation	560		100	660	
Totals	102,763	980	44,850	147,938	141,138

Assumed $f_e = .85$ and $f_r = 1.25$

$T_A = T_0 + C_r + f_r = 102,763 + 980 + 980(1.25) = 88,580$ cu. yds.

Deficiency = $F_T - T_A = 141,138 - 88,580 = 52,558$ cu. yds.

Borrow = $52,558 \div .85 = 61,833$ cu. yds.

Total 203.01 = $C_T + Borrow = 147,938 + 61,833 = 209,771$ cu. yds.

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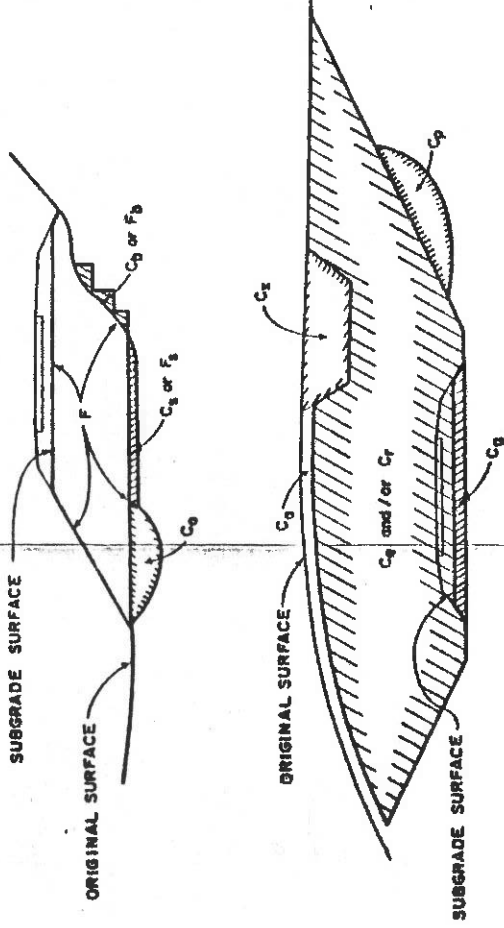
EXPLANATION OF EARTHWORK DESIGN

0+00 to 5+00 > 950 cy of road metal to be excavated. Assumed rock for purpose of balance.

8+00 to 15+00 - Low wet area. 2 foot construction lift of 203.06. A 3 month waiting period is required at subgrade elevation.

21+25 to 26+00 = An estimated 10,000 cy of cut material is expected to be wet silt. 320 cy of Slope Protection, and 1,900 cy of subgrade improvement is anticipated to be needed.

34+00 to 42+50 - 40,800 cy of unsuitable material is to be excavated. Backfill will be 203.06.



- C₀ - PORTION OF CUT ASSUMED TO BE EARTH SUITABLE FOR EMBANKMENT CONSTRUCTION, EXCLUDING C₉ AND C₇.
- C₁ - PORTION OF CUT ASSUMED TO BE ROCK, INCLUDING C₉ IF APPLICABLE.
- C₂ - EXCAVATION FROM CUT SLOPE NECESSARY TO PLACE SLOPE PROTECTION.
- C₃ - EXCAVATION FOR REQUIRED BENCHING (BOTH LONGITUDINAL AND TRANSVERSE).
- C₄ - EXCAVATION FOR SUBGRADE IMPROVEMENT.
- T₀ - (C₀ + C₁ + C₂ + C₃ + C₄) TOTAL EARTH EXCAVATION ASSUMED SUITABLE FOR EMBANKMENT CONSTRUCTION.
- C₅ - EXCAVATION OF UNSUITABLE MATERIAL BENEATH EMBANKMENT: SWAMP OR DUMP.
- C₆ - EXCAVATION OF TOPSOIL (UNSUITABLE MATERIAL) IN CUT.
- C₇ - EXCAVATION OF TOPSOIL (UNSUITABLE MATERIAL) UNDER EMBANKMENT.
- C₈ - EXCAVATION OF UNSUITABLE MATERIAL IN CUT: SWAMP OR DUMP.
- T₁ - (C₅ + C₆ + C₇ + C₈) TOTAL EXCAVATION ASSUMED UNSUITABLE FOR EMBANKMENT CONSTRUCTION.
- C_T - (T₀ + T₁ + C₉) TOTAL EXCAVATION.
- F₀ - FILL REQUIRED TO REPLACE BENCHES.
- F₁ - FILL REQUIRED TO REPLACE TOPSOIL REMOVED BENEATH EMBANKMENTS.
- F - FILL REQUIRED TO COMPLETE EMBANKMENT TO THE SUBGRADE SURFACE AND SIDE SLOPES AFTER THE FOUNDATION HAS BEEN PREPARED.
- F_T - (F₀ + F₁ + F) TOTAL FILL REQUIRED.
- T_A - (T₀ + C₅ + C₆ + C₇) THE VOLUME WHICH THE SUITABLE EXCAVATED MATERIAL COULD OCCUPY IN EMBANKMENT.
- f_e - SHRINKAGE FACTOR FOR EARTH.
- f_r - SHELL FACTOR FOR ROCK.

EXAMPLE #3 NEW CONSTRUCTION DESIGNED ITEM 203.01

SUBDIVISION No.	LOCATION (Station to Station)	SUITABLE EXCAVATION										UNSUITABLE EXCAVATION					TOTAL EXCAVATION				EMBANKMENT				AVAILABLE FOR EMBANKMENT (203.01 ONLY) T _e + C _r + F _r		
		C _r	C _e	C _p	C _b	C _g	T _e	C _o	C _d	C _s	C _x	T _u	C _r	F _o	F _s	F	FT										
1	0 - 5	*475	475				475										950										980
2	5 - 10																600										
3	10 - 15				144		20,144										800										17,100
4	15 - 20		20,000			1,900	52,220										1,000										45,200
5	20 - 25		50,000	320			28,120										800										24,650
6	25 - 30		28,000	40		80	144										2,000										120
7	30 - 35				144												32,800										
8	35 - 40																6,000										
9	40 - 45																750										
10	45 - 50																475										
11	50 - 55	*475	475														950										980
Totals		*950	98,950	360	288	1,980	101,578	40,800	2,600	1,350	44,750	147,278	288	1,350	139,500	141,138	88,930										

* ROAD METAL (ASPHALT CONCRETE) ASSUMED ROCK FOR BALANCE PURPOSES

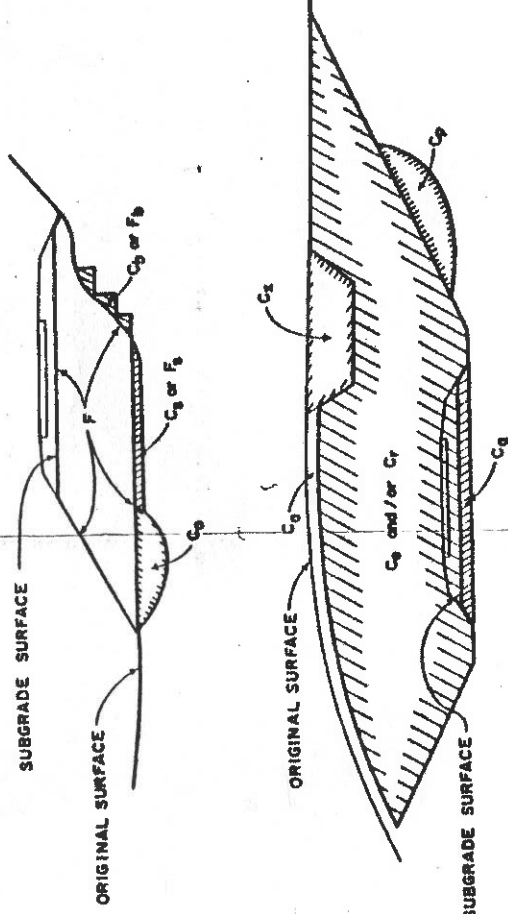
DEFINITIONS AND NOTES ARE LOCATED ON SHEET ES-1

EARTHWORK SUMMARY
SHEET ES-2

EXAMPLE #4 NEW CONSTRUCTION DESIGNED ITEMS 203.02 & 203.03

SUMMARY OF EARTHWORK (ITEMS 203.02 AND 203.03 ONLY)				
Source	EXCAVATION			203.03
	T _e	C _r	T _u	
ES-2	101,578	950	44,750	147,278
Drainage	625	30		
Channel Relocation	560		100	660
Totals	102,763	980	44,850	147,938

SUMMARY OF EARTHWORK (ITEM 203.01 ONLY)				
Source	EXCAVATION			FT
	T _e	C _r	T _u	
Totals				
Assumed f _e and f _r				
T _A = T _e f _e + C _r f _r				cu. yds.
T _A				cu. yds.
Deficiency = T _A - T _u				cu. yds.
Borrow = Deficiency ÷ f _e				cu. yds.
Total 203.01 = C _T + Borrow				cu. yds.
Total 203.01				cu. yds.



EXPLANATION OF EARTHWORK DESIGN

0+00 to 5+00 - 950 cy of road metal to be excavated. Assumed rock for purpose of balance.

8+00 to 15+00 - Low wet area. 2 foot construction lift of 203.06. A 3 month waiting period is required at subgrade elevation.

21+25 to 26+00 - An estimated 10,000 cy of cut material is expected to be wet silt. 320 cy of slope protection, and 1,900 cy of subgrade improvement is anticipated to be needed.

34+00 to 42+50 - 40,800 cy of unsuitable material is to be excavated. Backfill will be 203.06.

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- C₀ - PORTION OF CUT ASSUMED TO BE EARTH SUITABLE FOR EMBANKMENT CONSTRUCTION, EXCLUDING C₀ AND C₁.
- C₁ - PORTION OF CUT ASSUMED TO BE ROCK, INCLUDING C₀ IF APPLICABLE.
- C₂ - EXCAVATION FROM CUT SLOPE NECESSARY TO PLACE SLOPE PROTECTION.
- C₃ - EXCAVATION FOR REQUIRED BENCHING (BOTH LONGITUDINAL AND TRANSVERSE).
- C₄ - EXCAVATION FOR SUBGRADE IMPROVEMENT.
- T_e - (C₀ + C₁ + C₂ + C₃ + C₄) TOTAL EARTH EXCAVATION ASSUMED SUITABLE FOR EMBANKMENT CONSTRUCTION.
- C₅ - EXCAVATION OF UNSUITABLE MATERIAL BENEATH EMBANKMENT; SWAMP OR DUMP.
- C₆ - EXCAVATION OF TOPSOIL (UNSUITABLE MATERIAL) IN CUT.
- C₇ - EXCAVATION OF TOPSOIL (UNSUITABLE MATERIAL) UNDER EMBANKMENT.
- C₈ - EXCAVATION OF UNSUITABLE MATERIAL IN CUT; SWAMP OR DUMP.
- T_u - (C₀ + C₁ + C₂ + C₃ + C₄) TOTAL EXCAVATION ASSUMED UNSUITABLE FOR EMBANKMENT CONSTRUCTION.
- C_T - (T_e + T_u + C₅) TOTAL EXCAVATION.
- F₀ - FILL REQUIRED TO REPLACE BENCHES.
- F₁ - FILL REQUIRED TO REPLACE TOPSOIL REMOVED BENEATH EMBANKMENTS.
- F₂ - FILL REQUIRED TO COMPLETE EMBANKMENT TO THE SUBGRADE SURFACE AND SIDE SLOPES AFTER THE FOUNDATION HAS BEEN PREPARED.
- F_T - (F₀ + F₁ + F₂) TOTAL FILL REQUIRED.
- T_A - (T_ef_e + C_rf_r) THE VOLUME WHICH THE SUITABLE EXCAVATED MATERIAL COULD OCCUPY IN EMBANKMENT.
- f_e - SHRINKAGE FACTOR FOR EARTH.
- f_r - SHELL FACTOR FOR ROCK.

