• Payments for all work done otherwise than by departmental labour and for all supplies are made on the basis of measurements recorded in Measurement Books
  
  (Form E. 1313).

• It is an important collective record of Measurements recorded for the works executed and materials supplied.
The measurement books should be considered as very important record. All the books belonging to a division should be numbered serially and a register of them (Form E. 1314) should be maintained in the divisional office showing:

1. the serial number of each book,
2. the name and designation of the person to whom issued,
3. the date of issue and
4. the date of its return.

A similar register should also be maintained in the sub-divisional office.

Books no longer in use should be withdrawn promptly even though not completely written up.
Measurement Book

- Not for the work done by departmental labour

- All the MBs supplied to any office are numbered serially and issued accordingly

- If issued the date, No. of the book and the name of the person to it is issued is recorded in the register.
Measurement Book

- MBs no longer in use is to be returned even if not completely used up

- Measurements should be taken up neatly. Illegible figures, torn up pages, erased figures or defaced books not accepted.

- If works are large, separate MB for each work has to be maintained.
Measurement Book

- All the pages are machined numbered. No page should be torn out/entry should be erased/defaced. If a mistake is made, it should be corrected by crossing out the incorrect word or Figures, and the rewriting the correct words or Figures, and the correction thus made should be initialed.
- Entries should be made in ink or indelible or special copying pencil so that there is no scope for tampering.
- The entries in the “contents/Area” column should invariably by ink.
Measurement Book

- Entries should be continuously not giving any scope for blank pages
- Blank pages should be crossed diagonally
- Corrections should be done by crossing out and rewritten with initials
Measurement Book

Entries must be made directly on the site. Copying from any rough work is not accepted.

Additions if any, to the measurements already taken, should be detailed in the subsequent page with reference to the original page. Along with the reasons thereof.
Measurement Book

- Index should be kept up to date

- Document on which payment is made should invariably bear a reference to the number and page of the book in which the detailed measurements are recorded.
Measurement Book

- All the books belonging to a division should be numbered serially and a register of them should be maintained in the divisional office showing:
  - (1) the serial number of each book,
  - (2) the name and designation of the person to whom issued,
Measurement Book

- (3) the date of issue and
- (4) the date of its return,
- so that its eventual return to the divisional office may be watched. A similar register should also be maintained in the sub-divisional office.
- Books no longer in use should be withdrawn promptly even though not completely written up.
Measurement Book

- Books no longer in use should be withdrawn promptly even though not completely written up.

- The eventual return of all measurement books should be insisted on.

- They should be carefully preserved for ten years.

- To ensure this, measurement books should be carefully listed and made over to the open line authorities when the construction divisions are closed.
Measurement Book

powers to be exercised in recording measurements (Open Line)

SSE(P-Way/Works) in Gr. N (Rs. 1600-2660/) and Gr. 1 (Rs. 2000-3200): Rs. 9300-34800-JE-I/SE/SSE

can record all measurements including ballast measurements subject to the test checks given below,

cannot record earth work sectional measurements unless they are, specially nominated by the Assistant Engineer on considerations of competency and reliability.
Measurement Book

powers to be exercised in recording measurements (Open Line)

Test Check:

up to Rs. 25,000/-:
10% cheek by the, AEN

Above Rs. 25,000 & work exceeds the estimated cost by more than 10%:
20% check by AEN

Quantity and quantity of ballast & pitching stones measurements:
100% check by AEN

Earth work sectional measurements; Discretion of AEN.
Measurement Book

powers to be exercised in recording measurements (Open Line)

Test Check:

Those Inspectors in Gr. I (Rs. 2000-3200) Rs. 9300-34800-JE-I/SE/SSE may finalize measurements for work upto Rs. 10,000/- even when the total value of the works exceeds the estimated value by more than 10%.

SSE/P-way/Works (Rs. 1400-2300) when they holds independent charge, can record measurements for works costing upto Rs. 25,000/- each: 20% AEN

JE's(Mistries) having a diploma/3 years of service& those not having a diploma in Engineering, but 6 years experience to be nominated by name by the Divisional Engineer can record measurements of works up to Rs. 10,000/- subject to a test check of 20% by the inspector of works.
Measurement Book

powers to be exercised in recording measurements (Construction)

- Sub-Overseer Masteries cannot record measurements.

- Inspector of Works and Permanent Way Inspectors cannot record measurements for the supply of ballast, pitching stones and earth work.

- For all other works, Inspectors of Works and Permanent Way Inspectors in Grade I & II can record measurements up to a value of Rupees One lakh: 20 per cent test check by AEN.
Measurement Book

- Measurement of E/W cross sections levels may be recorded by Inspector of Works in the field book which should be in ink or inked before test checking by the Assistant Engineer.
  - 100% check by AEN. (levels along the centre line of alignment)
  - 20% of the remaining levels of the cross sections

- All the corrections in the field book must be initialed by the Assistant Engineer and no subsequent corrections should be made by any person other than the Assistant Engineer who while doing so should record the reasons for the same.

- The signature of the contractor or his authorized agent should be taken on every field book accepting the correctness of levels recorded therein.

- Plotting of the cross sections may be done on graph paper.
Measurement Book

Each set of measurements should commence with entries stating:

(i) In the case of work done:
   (a) Full name of work as given in the estimate;
   (b) Situation of work;
   (c) Name of contractor;
   (d) Number & date of agreement
   (e) Dates of commencement and completion of work
   (f) Date of measurement;

In the case of materials supplied:

(a) Name of supplier;
(b) Number and date of agreement
(c) Purpose of supply;
(d) Dates of commencement and completion of supply; and Date of measurement;
Detailed measurements

- Detailed measurements are not required for lump sum works.

- Final payment may be made on the certificate of the Assistant Engineer that the work has been completed according to the drawings and specifications.
Measurement Book

Standard type Drawings

- Detailed measurements are not required in the case of measurements of standard type staff quarters.

- AEN should certify that the work billed for has been carried out in accordance with standard type drawings then the quantities as given in the schedule of Estimates for standard type quarters.
In the case of bridge girders and steel fabricated structures the contractor can submit bills based on completion drawings. These bills may be checked in the Drawing Office and accepted for payment. No detailed measurements need be recorded.
Cement concrete may be defined as building material obtained by mixing cement, aggregates and water in suitable proportions and then curing this plastic mixture to a hard mass. Hardened concrete resembles stone in weight, hardness and strength to a great extent.
Material Consumption

- **Properties of Cement concrete**: The proportion of ingredients of cement concrete are generally defined by volume. For very important works it would be desirable to have the proportion by weight rather than by volume. Cement is normally measured by weight and a standard bag of 50kg is normally taken equal to 35 litres.

- **Mix Design**: Cement, sand and coarse aggregates are mixed in certain proportion which can be 1:4:8, 1:3:6 & 1:2:4. The first figure in this mix represent quantity of cement, Second figure represent sand and third figure represents coarse aggregate by weight.
# Material Consumption

## Strength of Concrete for different Mixer

<table>
<thead>
<tr>
<th>Mix</th>
<th>Strength in Kg/Cm²</th>
<th>Use in general</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:4:8</td>
<td>50</td>
<td>Foundations</td>
</tr>
<tr>
<td>1:3:6</td>
<td>100</td>
<td>Mass Concrete</td>
</tr>
<tr>
<td>1:2:4</td>
<td>150</td>
<td>Slabs, Beams, Columns</td>
</tr>
<tr>
<td>$1: 1^{1/2} : 3$</td>
<td>200</td>
<td>Piles, water retaining structures</td>
</tr>
</tbody>
</table>
## Material Consumption

<table>
<thead>
<tr>
<th>Nature of work for which used</th>
<th>Nominal Mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Foundations of light structures</td>
<td>1:5:10 or 1:6:12</td>
</tr>
<tr>
<td>(ii) Foundations of buildings, plum concrete, hearting of abutments and piers, retaining walls with stone face in hilly areas, etc.</td>
<td>1:4:8 or 1:5:10</td>
</tr>
<tr>
<td>(iii) Mass concrete and foundations of bridges</td>
<td>1:3:6 or 1:2:4</td>
</tr>
<tr>
<td>(iv) General RCC work in building e.g. beams, slabs, panel walls, stairs, bed blocks, drain linings etc.,</td>
<td>1:2:4</td>
</tr>
<tr>
<td>(v) Important RCC structures, piles, arches, water retaining structures etc.</td>
<td>1:1 1/2:3</td>
</tr>
</tbody>
</table>
**Material Consumption**

- **Controlled Concrete**: Controlled concrete for use in plain and reinforced structures are normally in grades M10, M15, M20, M25 and M30. The maximum total quantity of aggregate by weight per 50Kg of cement should not exceed 450 kg except in special circumstances.

- (i) Aggregate cement ratio determines the cost of the mix.

- Water cement ratio determines the strength of concrete.

- Water aggregate ratio determines the workability of concrete.
Material Consumption

- **Water Cement Ratio**: The ratio of the volume of water to volume of cement used in a concrete mix is termed as water cement ratio. As a result of experiments it is observed that for a given proportion of ingredients in a concrete mix, there is almost a fixed amount of water (optimum) which gives maximum strength. A small variation in a quantity of water causes much wider variation in the strength of concrete. In case the water used is less, the resultant concrete will be comparatively dry, difficult to place in position and may pose problems in compaction. Moreover, with less water complete setting of cement cannot be ensured and hence the strength of concrete get reduced appreciably.
Material Consumption

- Method of Calculation of Quantities for concrete work:
- Volume of dry concrete = 1.5 x Vol. of wet concrete. (This factor 1.5 decreases with lean mixes and increases with rich concrete mixes)
- Hence, if x cum of wet concrete is to be produced in proportion 1:2:4.
- Vol. of dry concrete = 1.5 x
- Volume of Cement = 1/7 x 1.5x
- Volume of Sand = 2/7 x 1.5x
- Volume of Aggregate = 4/7 x 1.5x
- Volume of one bag of cement = 0.035cum.
### Quantities of Ingredients of Stone Masonry in Cement Mortar per Cubic Metre

<table>
<thead>
<tr>
<th>SL No</th>
<th>Type</th>
<th>Mix</th>
<th>Mortar required</th>
<th>Cement in bag</th>
<th>Sand cu.m</th>
<th>Stone Cu.m</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Coarsed stone dressed</td>
<td>1:3</td>
<td>0.33</td>
<td>3.15</td>
<td>0.33</td>
<td>1.05</td>
</tr>
<tr>
<td>2</td>
<td>Random rubble</td>
<td>1:3</td>
<td>0.45</td>
<td>4.30</td>
<td>0.45</td>
<td>1.00</td>
</tr>
<tr>
<td>3</td>
<td>Random rubble</td>
<td>1:4</td>
<td>0.45</td>
<td>3.20</td>
<td>0.45</td>
<td>1.00</td>
</tr>
</tbody>
</table>
## Material Consumption

Quantities of Ingredients of Cement Plastering over Brick Work
1.25cm. Thick per Square Metre.

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Mix</th>
<th>Cement Bags</th>
<th>Sand Cu.m</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1:3</td>
<td>0.140</td>
<td>0.015</td>
<td>33% extra for stone masonry</td>
</tr>
<tr>
<td>2</td>
<td>1:4</td>
<td>0.110</td>
<td>0.015</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1:5</td>
<td>0.095</td>
<td>0.165</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1:6</td>
<td>0.079</td>
<td>0.165</td>
<td></td>
</tr>
</tbody>
</table>
## Material Consumption

Quantities of Ingredients of Cement pointing over Brick work per Square Metre.

<table>
<thead>
<tr>
<th>Sl No</th>
<th>Mix</th>
<th>Cement Bags</th>
<th>Sand in Cu.m</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1:2</td>
<td>0.055</td>
<td>0.0036</td>
<td>33% extra for stone masonry in each mix</td>
</tr>
<tr>
<td>2</td>
<td>1:3</td>
<td>0.035</td>
<td>0.0036</td>
<td></td>
</tr>
</tbody>
</table>
## Material consumption

### Estimated Quantities of Materials Required Per CU.M of compacted Mortar and concrete

<table>
<thead>
<tr>
<th>Nominal Mix</th>
<th>Water</th>
<th>Cement</th>
<th>Sand in Liters</th>
<th>Broken stone in litres</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nominal Mix</td>
<td>Water</td>
<td>Cement</td>
<td>Sand in Liters</td>
</tr>
<tr>
<td></td>
<td>Quantity per 50kg bag of cement in litres</td>
<td>By weight kg</td>
<td>By bags Nos</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>4</td>
<td>27.5</td>
<td>310</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>6</td>
<td>37.5</td>
<td>215</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>8</td>
<td>47.5</td>
<td>165</td>
</tr>
</tbody>
</table>
# Material Consumption

## Reinforcement – Areas and Weight of Rods

<table>
<thead>
<tr>
<th>Dia. Of bar in mm</th>
<th>Area in Square C.M</th>
<th>Weight per foot in Kgs</th>
<th>Weight per Meter in Kgs</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>0.28</td>
<td>0.07</td>
<td>0.22</td>
</tr>
<tr>
<td>8</td>
<td>0.50</td>
<td>0.119</td>
<td>0.39</td>
</tr>
<tr>
<td>10</td>
<td>0.79</td>
<td>0.189</td>
<td>0.62</td>
</tr>
<tr>
<td>12</td>
<td>1.13</td>
<td>0.271</td>
<td>0.89</td>
</tr>
<tr>
<td>16</td>
<td>2.01</td>
<td>0.482</td>
<td>1.58</td>
</tr>
<tr>
<td>18</td>
<td>2.54</td>
<td>0.60</td>
<td>2.00</td>
</tr>
<tr>
<td>20</td>
<td>3.14</td>
<td>0.75</td>
<td>2.46</td>
</tr>
<tr>
<td>24</td>
<td>4.52</td>
<td>1.08</td>
<td>3.55</td>
</tr>
</tbody>
</table>
Thank You