

**Table (1) :chemical properties of silica fume\***

| Oxide composition | Abbreviation                   | Oxide Content (%) | Limit of Requirement (ASTM C 1240)[12] | Specification |
|-------------------|--------------------------------|-------------------|--|---------------|
| Silica            | SiO <sub>2</sub>               | 94.87             | 85.0 (min)                             |               |
| Alumina           | Al <sub>2</sub> O <sub>3</sub> | 1.18              | -                                      |               |
| Iron oxide        | Fe <sub>2</sub> O <sub>3</sub> | 0.09              | -                                      |               |
| Lime              | CaO                            | 0.23              | -                                      |               |
| Magnesia          | MgO                            | 0.02              | -                                      |               |
| Sulfate           | SO <sub>3</sub>                | 0.25              | -                                      |               |
| Potassium oxide   | K <sub>2</sub> O               | 0.48              | -                                      |               |
| Loss on ignition  | L.O.I.                         | 2.88              | 6.0(max)                               |               |
| Moisture content  | -                              | 0.48              | 3.0(max)                               |               |

\*The test have been performed in the materials test laboratory in the College of Engineering ,University of Kufa

## 2.2 Superplasticizer (S.P.):


Glenium 51 is a fantastic effective concrete superplasticizer that was employed in this amendment [7] .

**Table (2) :Properties of Glenium 51\***

| Form                 | Viscous Liquid  |
|----------------------|---|
| Commercial name      | Glenium 51  |
| Chemical composition | Sulphonated melamine and naphthaline formaldehyde condensates |
| Subsidiary effect    | Increased early and ultimate compressive strength             |
| Form                 | Viscous liquid  |
| Color                | Light brown   |
| Relative density     | 1.1 gm/cm <sup>3</sup> at 20 °C                               |
| pH                   | 6.6   |
| Viscosity            | 128 ± 30 cps @ 20° C  |
| Transport            | Not classified as dangerous                                   |
| Labeling             | No hazard label required                                      |
| Chloride content     | None  |

\*Supplied by manufacturer .

**Table (3) :Properties of steel fiber\***

| Configuration   | Property                  | Specification          |
|---|---------------------------|------------------------|
|  | Description               | Hooked                 |
|   | Length                    | 30 mm                  |
|   | Diameter                  | 0.375 mm               |
|   | Density                   | 7800 kg/m <sup>3</sup> |
|   | Tensile strength          | 1800 MPa               |
|   | Modulus of elasticity     | 200GPa                 |
|   | Aspect ratio( $L_f/D_f$ ) | 80                     |

\*Supplied by the manufacturer .

**Table (4): Properties of steel Bars**

| <b>Diameter</b><br><b>(Steel bar)</b><br><b>mm</b> | <b>f<sub>y</sub></b><br><b>MPa</b> | <b>f<sub>u</sub></b><br><b>MPa</b> | <b>Elongation</b><br><b>%</b> |
|--|------------------------------------|------------------------------------|-------------------------------|
| 20   | 580                                | 680                                | 14                            |
| 12   | 513                                | 643                                | 12                            |
| 10   | 490                                | 633                                | 11                            |
| 8  | 446                                | 621                                | 10                            |

**Table (5): Properties of the various types of mixes for RPC**

| Mix*  | Cement<br>kg/m <sup>3</sup> | Sand<br>kg/m <sup>3</sup> | Silica<br>Fume*<br>% | Silica<br>Fume<br>kg/m <sup>3</sup> | w/cemen-<br>titious | S.P.<br>**<br>% | Steel<br>Fiber***<br>% | Steel<br>Fiber<br>kg/m <sup>3</sup> |
|-------|-----------------------------|---------------------------|----------------------|-------------------------------------|---------------------|-----------------|------------------------|-------------------------------------|
| M0,25 | 1000                        | 1000                      | 25                   | 250                                 | 0.2                 | 1.7             | 0                      | 0                                   |
| M1,25 | 1000                        | 1000                      | 25                   | 250                                 | 0.2                 | 1.7             | 1                      | 78                                  |
| M2,25 | 1000                        | 1000                      | 25                   | 250                                 | 0.2                 | 1.7             | 2                      | 156                                 |
| M2,20 | 1000                        | 1000                      | 20                   | 200                                 | 0.2                 | 1.7             | 2                      | 156                                 |
| M2,15 | 1000                        | 1000                      | 15                   | 150                                 | 0.2                 | 1.7             | 2                      | 156                                 |

♣ The letter M denotes Mix no.

\* Silica Fume weight as a of the total cement weight.

\*\* Superplasticizer, percent of binder weight.

\*\*\* ratio of total mixture volume

**Table (6): Beam details and concrete properties**

| Group<br>No. | Parameter                                   | Beam        | V <sub>f</sub><br>% | SF<br>% | Tensile<br>reinf. | Concrete in section   |
|--------------|---|-------------|---------------------|---------|-------------------|-----------------------|
| <b>1</b>     | <b>Changing<br/>concrete<br/>in section</b> | <b>NC</b>   | -                   | -       | 2φ12              | Normal in all section |
|              |   | <b>RPC1</b> | 2                   | 25      | 2φ12              | RPC in all section    |
|              |   | <b>RPC2</b> | 2                   | 25      | 2φ12              | RPC only in flange    |
|              |   | <b>RPC3</b> | 2                   | 25      | 2φ12              | RPC only in web       |

**Table (7): Results of Mechanical Properties of Hardened Concrete Tests**

| No.<br>of<br>mix | Mix<br>type  | Steel<br>fiber<br>Vf<br>% | Silica<br>fume<br>SF % | ( <u>fc'</u> )<br>( MPa)<br>[10] | (ft)<br>(MPa)<br>= [11] | (fr)<br>(MPa)<br>=[12] | (Ec)<br>(MPa)<br>[13] |
|------------------|--------------|---------------------------|------------------------|----------------------------------|-------------------------|------------------------|-----------------------|
| 1                | M0,25        | 0                         | 25                     | 92.52                            | 6.71                    | 6.3                    | 37481                 |
| 2                | M1,25        | 1                         | 25                     | 113.53                           | 11.95                   | 14.7                   | 42469                 |
| 3                | M2,25        | 2                         | 25                     | 124.95                           | 16.29                   | 19.0                   | 45024                 |
| 4                | M2,20        | 2                         | 20                     | 120.45                           | 15.24                   | 18.1                   | 44751                 |
| 5                | M2,15        | 2                         | 15                     | 114.33                           | 14.86                   | 17.4                   | 44529                 |
| 6                | M-<br>normal | -                         | -                      | 27.04                            | 2.88                    | 3.5                    | 25641                 |