

LAMPIRAN

Lampiran 1. Hasil pengujian kuat tekan *pervious concrete* umur 7 hari

Kode	Kuat Tekan Beton (MPa)			Rata-rata
	Sampel 1	Sampel 2	Sampel 3	
SF ₀ WG ₀	5,723	5,405	6,161	5,763
SF ₁₀ WG _{2,5}	6,677	7,101	7,247	7,008
SF ₁₀ WG _{7,5}	7,101	7,711	8,214	7,675
SF ₁₀ WG _{12,5}	6,942	6,333	6,651	6,642
SF ₁₅ WG _{2,5}	7,472	7,234	7,432	7,379
SF ₁₅ WG _{7,5}	8,810	8,373	8,691	8,625
SF ₁₅ WG _{12,5}	5,803	6,028	5,326	5,719
SF ₂₀ WG _{2,5}	9,618	9,764	9,314	9,565
SF ₂₀ WG _{7,5}	6,810	6,982	7,154	6,982
SF ₂₀ WG _{12,5}	4,650	4,995	4,557	4,734

Lampiran 2. Hasil pengujian kuat tekan *pervious concrete* umur 14 hari

Kode	Kuat Tekan Beton (MPa)			Rata-rata
	Sampel 1	Sampel 2	Sampel 3	
SF ₀ WG ₀	6,439	6,863	5,657	6,319
SF ₁₀ WG _{2,5}	8,055	8,360	8,254	8,223
SF ₁₀ WG _{7,5}	8,691	8,320	8,956	8,656
SF ₁₀ WG _{12,5}	7,459	7,167	7,207	7,278
SF ₁₅ WG _{2,5}	8,545	8,916	8,241	8,567
SF ₁₅ WG _{7,5}	9,274	8,996	9,698	9,322
SF ₁₅ WG _{12,5}	5,631	6,518	6,055	6,068
SF ₂₀ WG _{2,5}	11,168	10,797	10,691	10,886
SF ₂₀ WG _{7,5}	8,280	8,373	7,830	8,161
SF ₂₀ WG _{12,5}	5,525	5,207	4,928	5,220

Lampiran 3. Hasil pengujian kuat tekan *pervious concrete* umur 28 hari

Kode	Kuat Tekan Beton (MPa)			Rata-rata
	Sampel 1	Sampel 2	Sampel 3	
SF ₀ WG ₀	6,598	7,101	6,929	6,876
SF ₁₀ WG _{2,5}	8,784	9,075	8,572	8,810
SF ₁₀ WG _{7,5}	9,420	9,764	9,327	9,504
SF ₁₀ WG _{12,5}	8,015	7,711	8,082	7,936
SF ₁₅ WG _{2,5}	9,353	9,764	9,605	9,574
SF ₁₅ WG _{7,5}	10,506	10,532	10,254	10,431
SF ₁₅ WG _{12,5}	6,783	7,128	6,558	6,823
SF ₂₀ WG _{2,5}	11,632	11,327	11,685	11,548
SF ₂₀ WG _{7,5}	10,042	9,300	9,592	9,645
SF ₂₀ WG _{12,5}	6,960	6,439	6,253	6,461

Lampiran 4. Hasil pengujian berat jenis *pervious concrete* umur 28 hari

Kode	Kuat Tekan Beton (MPa)			Rata-rata
	Sampel 1	Sampel 2	Sampel 3	
SF ₀ WG ₀	1867,516	1830,573	1824,841	1840,977
SF ₁₀ WG _{2,5}	1784,713	1824,204	1775,796	1794,904
SF ₁₀ WG _{7,5}	1716,561	1745,86	1743,949	1735,456
SF ₁₀ WG _{12,5}	1664,958	1668,153	1672,611	1668,577
SF ₁₅ WG _{2,5}	1798,726	1775,159	1745,86	1773,248
SF ₁₅ WG _{7,5}	1721,656	1714,65	1712,102	1716,136
SF ₁₅ WG _{12,5}	1667,516	1645,223	1650,318	1654,352
SF ₂₀ WG _{2,5}	1772,611	1754,14	1738,854	1755,202
SF ₂₀ WG _{7,5}	1688,535	1684,076	1703,822	1692,144
SF ₂₀ WG _{12,5}	1615,287	1635,032	1646,497	1632,272

Lampiran 5. Hasil pengujian permeabilitas *pervious concrete* umur 28 hari

Kode	Permeabilitas (cm/s)			Rata-rata
	Sampel 1	Sampel 2	Sampel 3	
SF ₀ WG ₀	1,36	1,40	1,46	1,41
SF ₁₀ WG _{2,5}	0,89	0,86	0,84	0,86
SF ₁₀ WG _{7,5}	0,77	0,81	0,78	0,78
SF ₁₀ WG _{12,5}	0,87	0,94	0,97	0,93
SF ₁₅ WG _{2,5}	0,82	0,79	0,84	0,82
SF ₁₅ WG _{7,5}	0,75	0,74	0,77	0,75
SF ₁₅ WG _{12,5}	1,07	1,05	1,06	1,06
SF ₂₀ WG _{2,5}	0,70	0,75	0,72	0,73
SF ₂₀ WG _{7,5}	0,82	0,78	0,80	0,80
SF ₂₀ WG _{12,5}	1,04	1,10	1,15	1,10

Lampiran 6. Hasil Pengujian *Silica Fume*
(Data Teknis Sika Fume®, PT. Sika Indonesia)

Bahan Kimia	Komposisi
SiO ₂	93.0% min
CaO	0.60% max
Fe ₂ O ₃	0.80 % max
K ₂ O	1.2% max
MgO	0.60% max
Al ₂ O ₃	0.40% max
Na ₂ O	0.20% max
Free CaO	2.0% max
SO ₃	0.40% max
LOI	3.5% max

Lampiran 7. Hasil Pengujian Agregat Kasar

Jenis Pengujian	Hasil
<i>Apparent specific gravity</i>	2,72
<i>Bulk specific gravity (SSD)</i>	2,65
<i>Bulk specific gravity (kering)</i>	2,61
Persentase penyerapan air (%)	1,01%
Kadar air (%)	3,34%
Kadar Lumpur	0,61%
Berat volume padat	1451,52 kg/m ³
Berat volume gembur	1396,97 kg/m ³

Lampiran 8. Komposisi Campuran

Kode	% SF	% WGA	Semen (Kg/m ³)	SF (Kg/m ³)	Agregat Kasar (Kg/m ³)	Air (Kg/m ³)	WGA (Kg/m ³)	SP (Kg/m ³)
SF ₀ ,G ₀	0	0	373,6	0	1980,8	119,5	0	0
SF ₁₀ ,WG _{2,5}	10	2,5	336,2	37,4	1918,3	117,8	49,2	1,7
SF ₁₀ ,WG _{7,5}	10	7,5	336,2	37,4	1820,0	117,8	147,6	1,7
SF ₁₀ ,WG _{12,5}	10	12,5	336,2	37,4	1721,6	117,8	245,9	1,7
SF ₁₅ ,WG _{2,5}	15	2,5	317,5	56,0	1911,8	117,9	49,0	1,6
SF ₁₅ ,WG _{7,5}	15	7,5	317,5	56,0	1813,8	117,9	147,1	1,6
SF ₁₅ ,WG _{12,5}	15	12,5	317,5	56,0	1715,8	117,9	245,1	1,6
SF ₂₀ ,WG _{2,5}	20	2,5	298,9	74,7	1905,4	118,0	48,9	1,5
SF ₂₀ ,WG _{7,5}	20	7,5	298,9	74,7	1807,6	118,0	146,6	1,5
SF ₂₀ ,WG _{12,5}	20	12,5	298,9	74,7	1709,9	118,0	244,3	1,5

Dengan mengacu pada standar ACI 522R (2010) pada tabel 2.7. mengenai rentang proporsi semen yaitu berkisar antara 270 kg/m³ - 415 kg/m³, dan untuk rasio air semen (*w/c*) berkisar antara 0,27-0,34. Sehingga dari kisaran antara semen dan rasio air semen tersebut dilakukan interpolasi agar mendapatkan berat semen yang akan digunakan dalam campuran *pervious concrete*. Adapun penjabarannya sebagai berikut :

1. Interpolasi untuk mendapatkan berat semen ($w/c=0,32$)

Terlebih dahulu menetapkan kisaran w/c yang digunakan. Pada penelitian ini digunakan w/c yaitu 0,32. Selanjutnya dilakukan interpolasi untuk mendapatkan berat semen yaitu sebagai berikut :

$$\begin{array}{ll} \text{Diketahui :} & X1 = 415 & Y = 0,32 \\ & X2 = 270 & Y1 = 0,34 \\ & X = ? & Y2 = 0,27 \end{array}$$

Penyelesaian :

$$\frac{X - X1}{X2 - X1} = \frac{Y - Y1}{Y2 - Y1} \longrightarrow X = X1 + \frac{(X2 - X1) \times (Y - Y1)}{Y2 - Y1}$$

$$X = 415 + \frac{(270 - 415) \times (0,32 - 0,34)}{0,27 - 0,34} = 373,6$$

Maka, didapat berat semen yaitu sebesar 373,5714 kg/m³

2. Perhitungan Berat Air Normal

$$\text{Diketahui : } \frac{w}{c} = 0,32, \text{ dengan berat semen } 373,6 \text{ kg/m}^3$$

$$\text{Maka, } \frac{w}{373,6} = 0,32 \longrightarrow \text{didapat } w = 119,5$$

Sehingga didapat berat air normal yaitu sebesar 119,5 kg/m³.

3. Perhitungan Berat Semen dan *Silica Fume*

a. Substitusi 90% semen dan substitusi 10% *silica fume*

Untuk mendapatkan berat *silica fume* yaitu berat semen dikalikan dengan persentase *silica fume*.

$$\begin{array}{ll} \text{Berat semen awal (100\%)} & = 373,5714 \text{ kg/m}^3 \\ \text{Berat } \textit{silica fume} \text{ (10\%)} & = 373,5714 \times 10\% = 37,3571 \text{ kg/m}^3 \\ \text{Berat semen yang digunakan (90\%)} & = 373,5714 - 37,3571 \\ & = 336,2143 \text{ kg/m}^3 \end{array}$$

b. Substitusi 85% semen dan substitusi 15% *silica fume*

$$\text{Berat semen awal (100\%)} = 373,5714 \text{ kg/m}^3$$

$$\text{Berat } \textit{silica fume} \text{ (15\%)} = 373,5714 \times 15\% = 56,0357 \text{ kg/m}^3$$

$$\begin{aligned} \text{Berat semen yang digunakan (85\%)} &= 373,5714 - 56,0357 \\ &= 317,5357 \text{ kg/m}^3 \end{aligned}$$

c. Substitusi 80% semen dan substitusi 20% *silica fume*

$$\text{Berat semen awal (100\%)} = 373,5714 \text{ kg/m}^3$$

$$\text{Berat } \textit{silica fume} \text{ (20\%)} = 373,5714 \times 20\% = 74,714 \text{ kg/m}^3$$

$$\begin{aligned} \text{Berat semen yang digunakan (80\%)} &= 373,5714 - 74,714 \\ &= 298,857 \text{ kg/m}^3 \end{aligned}$$

4. Perhitungan Berat Agregat Kasar dan *Waste Glass Aggregate*

Untuk mendapatkan berat agregat kasar dan *waste glass aggregate* yaitu volume $1\text{m}^3 - (\text{volume semen} + \text{volume } \textit{silica fume} + \text{volume air})$. Adapun Penjabaran perhitungan berat agregat kasar dan *waste glass aggregate* sebagai berikut :

➤ Berat Jenis berdasarkan komposisi bahan :

- Air = 1000 kg/m^3
- Semen = 3150 kg/m^3
- *Silica Fume* = 2200 kg/m^3
- Agregat Kasar = 2600 kg/m^3

a. Penjabaran perhitungan *silica fume* 0% dan *waste glass aggregate* 0%

$$\text{Volume} = \text{Berat} / \text{Berat Jenis}$$

$$\text{Volume semen} = 373,571 \text{ kg} / 3150 \text{ kg/m}^3 = 0,11859 \text{ m}^3$$

$$\text{Volume air} = 119,543 \text{ kg} / 1000 \text{ kg/m}^3 = 0,11954 \text{ m}^3$$

$$\bullet \text{ Maka, Total Volume} = 0,11859 \text{ m}^3 + 0,11954 \text{ m}^3 = 0,23813 \text{ m}^3$$

$$\text{Volume agregat kasar (100\%)} = 1\text{m}^3 - 0,23813 \text{ m}^3 = 0,76187 \text{ m}^3$$

$$\bullet \text{ Kontrol volume komposisi} = (1 \text{ m}^3)$$

$$= \text{Volume semen} + \text{Volume air} + \text{Volume agregat kasar}$$

$$= 0,23813 \text{ m}^3 + 0,76187 \text{ m}^3 = 1\text{m}^3 \text{ (Ok)}$$

• **Sehingga, didapat komposisi berat agregat kasar dan *waste glass aggregate* yang digunakan sebagai berikut :**

$$\text{Berat} = \text{Volume} \times \text{berat jenis}$$

$$\text{Berat agregat kasar (100 \%)} = 0,76187 \text{ m}^3 \times 2600 \text{ kg/m}^3 = 1980,8 \text{ kg}$$

b. Penjabaran perhitungan *silica fume* 10% dan *waste glass aggregate* 2,5%

$$\text{Volume} = \text{Berat} / \text{Berat Jenis}$$

$$\text{Volume semen} = 336,214 \text{ kg} / 3150 \text{ kg/m}^3 = 0,10673 \text{ m}^3$$

$$\text{Volume } \textit{silica fume} = 37,357 \text{ kg} / 2200 \text{ kg/m}^3 = 0,01698 \text{ m}^3$$

$$\text{Volume air} = 119,543 \text{ kg} / 1000 \text{ kg/m}^3 = 0,119543 \text{ m}^3$$

- Maka, Total Volume = $0,10673 + 0,01698 + 0,119543 = 0,24326 \text{ m}^3$

$$\begin{aligned} \text{Volume agregat kasar awal (100\%)} &= 1 \text{ m}^3 - 0,24326 \text{ m}^3 \\ &= 0,75674 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Volume agregat kasar yg digunakan (97,5\%)} &= 0,75674 \text{ m}^3 \times 0,975 \\ &= 0,73782 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Volume } \textit{waste glass aggregate} \text{ (2,5\%)} &= 0,75674 \text{ m}^3 \times 0,025 \\ &= 0,01829 \text{ m}^3 \end{aligned}$$

- Kontrol volume komposisi = (1 m^3)

$$\begin{aligned} &= \text{Volume semen} + \text{Volume } \textit{silica fume} + \text{Volume air} + \text{Volume agregat} \\ &\quad \text{kasar} + \text{Volume } \textit{waste glass aggregate} \end{aligned}$$

$$= 0,24326 \text{ m}^3 + 0,73782 \text{ m}^3 + 0,01829 \text{ m}^3 = 1 \text{ m}^3 \text{ (Ok)}$$

- Sehingga, didapat komposisi berat agregat kasar dan *waste glass aggregate* yang digunakan sebagai berikut :

$$\text{Berat} = \text{Volume} \times \text{berat jenis}$$

$$\text{Berat agregat kasar (97,5\%)} = 0,73782 \times 2600 = 1918,3 \text{ kg}$$

$$\text{Berat } \textit{waste glass aggregate} \text{ (2,5\%)} = 0,01892 \times 2600 = 49,2 \text{ kg}$$

c. Penjabaran perhitungan *silica fume* 10% dan *waste glass aggregate* 7,5%

$$\text{Volume} = \text{Berat} / \text{Berat Jenis}$$

$$\text{Volume semen} = 336,214 \text{ kg} / 3150 \text{ kg/m}^3 = 0,10673 \text{ m}^3$$

$$\text{Volume } \textit{silica fume} = 37,357 \text{ kg} / 2200 \text{ kg/m}^3 = 0,01698 \text{ m}^3$$

$$\text{Volume air} = 119,543 \text{ kg} / 1000 \text{ kg/m}^3 = 0,119543 \text{ m}^3$$

- Maka, Total Volume = $0,10673 + 0,01698 + 0,119543 = 0,24326 \text{ m}^3$

$$\begin{aligned} \text{Volume agregat kasar awal (100\%)} &= 1 \text{ m}^3 - 0,24326 \text{ m}^3 \\ &= 0,75674 \text{ m}^3 \end{aligned}$$

$$\begin{aligned}\text{Volume agregat kasar yg digunakan (92,5\%)} &= 0,75674 \text{ m}^3 \times 0,925 \\ &= 0,69999 \text{ m}^3\end{aligned}$$

$$\begin{aligned}\text{Volume waste glass aggregate (7,5\%)} &= 0,75674 \text{ m}^3 \times 0,075 \\ &= 0,05676 \text{ m}^3\end{aligned}$$

- Kontrol volume komposisi = (1 m³)

$$= \text{Volume semen} + \text{Volume silica fume} + \text{Volume air} + \text{Volume agregat kasar} + \text{Volume waste glass aggregate}$$

$$= 0,24326 \text{ m}^3 + 0,69999 \text{ m}^3 + 0,05676 \text{ m}^3 = 1 \text{ m}^3 \text{ (Ok)}$$

- Sehingga, didapat komposisi berat agregat kasar dan waste glass aggregate yang digunakan sebagai berikut :

$$\text{Berat} = \text{Volume} \times \text{berat jenis}$$

$$\text{Berat agregat kasar (92,5\%)} = 0,69999 \times 2600 = 1820,0 \text{ kg}$$

$$\text{Berat waste glass aggregate (7,5\%)} = 0,05676 \times 2600 = 147,6 \text{ kg}$$

d. Penjabaran perhitungan silica fume 10% dan waste glass aggregate 12,5%

$$\text{Volume} = \text{Berat} / \text{Berat Jenis}$$

$$\text{Volume semen} = 336,214 \text{ kg} / 3150 \text{ kg/m}^3 = 0,10673 \text{ m}^3$$

$$\text{Volume silica fume} = 37,357 \text{ kg} / 2200 \text{ kg/m}^3 = 0,01698 \text{ m}^3$$

$$\text{Volume air} = 119,543 \text{ kg} / 1000 \text{ kg/m}^3 = 0,119543 \text{ m}^3$$

- Maka, Total Volume = 0,10673 + 0,01698 + 0,119543 = 0,24326 m³

$$\begin{aligned}\text{Volume agregat kasar awal (100\%)} &= 1 \text{ m}^3 - 0,24326 \text{ m}^3 \\ &= 0,75674 \text{ m}^3\end{aligned}$$

$$\begin{aligned}\text{Volume agregat kasar yg digunakan (87,5\%)} &= 0,75674 \text{ m}^3 \times 0,875 \\ &= 0,66215 \text{ m}^3\end{aligned}$$

$$\begin{aligned}\text{Volume waste glass aggregate (12,5\%)} &= 0,75674 \text{ m}^3 \times 0,125 \\ &= 0,09459 \text{ m}^3\end{aligned}$$

- Kontrol volume komposisi = (1 m³)

$$= \text{Volume semen} + \text{Volume silica fume} + \text{Volume air} + \text{Volume agregat kasar} + \text{Volume waste glass aggregate}$$

$$= 0,24326 \text{ m}^3 + 0,66215 \text{ m}^3 + 0,09459 \text{ m}^3 = 1 \text{ m}^3 \text{ (Ok)}$$

- Sehingga, didapat komposisi berat agregat kasar dan *waste glass aggregate* yang digunakan sebagai berikut :

$$\begin{aligned} \text{Berat} &= \text{Volume} \times \text{berat jenis} \\ \text{Berat agregat kasar (87,5\%)} &= 0,66215 \times 2600 = 1721,6 \text{ kg} \\ \text{Berat } \textit{waste glass aggregate} \text{ (12,5\%)} &= 0,09459 \times 2600 = 245,9 \text{ kg} \end{aligned}$$

e. Penjabaran perhitungan *silica fume* 15% dan *waste glass aggregate* 2,5%

$$\begin{aligned} \text{Volume} &= \text{Berat} / \text{Berat Jenis} \\ \text{Volume semen} &= 317,535 \text{ kg} / 3150 \text{ kg/m}^3 = 0,1008 \text{ m}^3 \\ \text{Volume } \textit{silica fume} &= 56,036 \text{ kg} / 2200 \text{ kg/m}^3 = 0,02547 \text{ m}^3 \\ \text{Volume air} &= 119,543 \text{ kg} / 1000 \text{ kg/m}^3 = 0,11954 \text{ m}^3 \end{aligned}$$

- Maka, Total Volume = $0,1008 + 0,0255 + 0,1195 = 0,24582 \text{ m}^3$

$$\begin{aligned} \text{Volume agregat kasar awal (100\%)} &= 1 \text{ m}^3 - 0,24582 \text{ m}^3 \\ &= 0,75418 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Volume Agregat kasar yg digunakan (97,5\%)} &= 0,75418 \text{ m}^3 \times 0,975 \\ &= 0,73533 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Volume } \textit{waste glass aggregate} \text{ (2,5\%)} &= 0,75418 \text{ m}^3 \times 0,025 \\ &= 0,01885 \text{ m}^3 \end{aligned}$$

- Kontrol volume komposisi = (1 m^3)

$$\begin{aligned} &= \text{Volume semen} + \text{Volume } \textit{silica fume} + \text{Volume air} + \text{Volume agregat} \\ &\quad \text{kasar} + \text{Volume } \textit{waste glass aggregate} \\ &= 0,24582 \text{ m}^3 + 0,7353 \text{ m}^3 + 0,0189 \text{ m}^3 = 1 \text{ m}^3 \text{ (Ok)} \end{aligned}$$

- Sehingga, didapat komposisi berat agregat kasar dan *waste glass aggregate* yang digunakan sebagai berikut :

$$\begin{aligned} \text{Berat} &= \text{Volume} \times \text{berat jenis} \\ \text{Berat agregat kasar (97,5\%)} &= 0,73533 \times 2600 = 1911,8 \text{ kg} \\ \text{Berat agregat kaca (2,5\%)} &= 0,01885 \times 2600 = 49,0 \text{ kg} \end{aligned}$$

f. Penjabaran perhitungan *silica fume* 15% dan *waste glass aggregate* 7,5%

$$\begin{aligned} \text{Volume} &= \text{Berat} / \text{Berat Jenis} \\ \text{Volume semen} &= 317,535 \text{ kg} / 3150 \text{ kg/m}^3 = 0,1008 \text{ m}^3 \end{aligned}$$

$$\text{Volume } \textit{silica fume} = 56,036 \text{ kg} / 2200 \text{ kg m}^3 = 0,02547 \text{ m}^3$$

$$\text{Volume air} = 119,543 \text{ kg} / 1000 \text{ kg/m}^3 = 0,11954 \text{ m}^3$$

$$\bullet \text{ Maka, Total Volume} = 0,1008 + 0,0255 + 0,1195 = 0,24582 \text{ m}^3$$

$$\begin{aligned} \text{Volume agregat kasar awal (100\%)} &= 1 \text{ m}^3 - 0,24582 \text{ m}^3 \\ &= 0,75418 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Volume agregat kasar yg digunakan (92,5\%)} &= 0,75418 \text{ m}^3 \times 0,925 \\ &= 0,69762 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Volume } \textit{waste glass aggregate} (7,5\%) &= 0,75418 \text{ m}^3 \times 0,075 \\ &= 0,05656 \text{ m}^3 \end{aligned}$$

$$\bullet \text{ Kontrol volume komposisi} = (1 \text{ m}^3)$$

$$\begin{aligned} &= \text{Volume semen} + \text{Volume } \textit{silica fume} + \text{Volume air} + \text{Volume agregat} \\ &\quad \text{kasar} + \text{Volume } \textit{waste glass aggregate} \\ &= 0,24582 \text{ m}^3 + 0,69762 \text{ m}^3 + 0,05656 \text{ m}^3 = 1 \text{ m}^3 \text{ (Ok)} \end{aligned}$$

• Sehingga, didapat komposisi berat agregat kasar dan *waste glass aggregate* yang digunakan sebagai berikut :

$$\text{Berat} = \text{Volume} \times \text{berat jenis}$$

$$\text{Berat agregat kasar (92,5\%)} = 0,69762 \times 2600 = 1813,8 \text{ kg}$$

$$\text{Berat agregat kaca (7,5\%)} = 0,05656 \times 2600 = 147,1 \text{ kg}$$

g. Penjabaran perhitungan *silica fume* 15% dan *waste glass aggregate* 12,5%

$$\text{Volume} = \text{Berat} / \text{Berat Jenis}$$

$$\text{Volume semen} = 317,535 \text{ kg} / 3150 \text{ kg/m}^3 = 0,1008 \text{ m}^3$$

$$\text{Volume } \textit{silica fume} = 56,036 \text{ kg} / 2200 \text{ kg/m}^3 = 0,02547 \text{ m}^3$$

$$\text{Volume air} = 119,543 \text{ kg} / 1000 \text{ kg/m}^3 = 0,11954 \text{ m}^3$$

$$\bullet \text{ Maka, Total Volume} = 0,1008 + 0,0255 + 0,1195 = 0,24582 \text{ m}^3$$

$$\begin{aligned} \text{Volume agregat kasar awal (100\%)} &= 1 \text{ m}^3 - 0,24582 \text{ m}^3 \\ &= 0,75418 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Volume agregat kasar yg digunakan (87,5\%)} &= 0,75418 \text{ m}^3 \times 0,875 \\ &= 0,65991 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Volume } \textit{waste glass aggregate} (12,5\%) &= 0,75418 \text{ m}^3 \times 0,125 \\ &= 0,09427 \text{ m}^3 \end{aligned}$$

- Kontrol volume komposisi = (1 m³)
 = Volume semen + Volume *silica fume* + Volume air + Volume agregat kasar + Volume *waste glass aggregate*
 = 0,24582 m³ + 0,65991 m³ + 0,09427 m³ = 1m³ (Ok)

- **Sehingga, didapat komposisi berat agregat kasar dan *waste glass aggregate* yang digunakan sebagai berikut :**

$$\text{Berat} = \text{Volume} \times \text{berat jenis}$$

$$\text{Berat agregat kasar (87,5\%)} = 0,65991 \times 2600 = 1715,8 \text{ kg}$$

$$\text{Berat agregat kaca (12,5 \%)} = 0,09427 \times 2600 = 245,1 \text{ kg}$$

h. Penjabaran perhitungan *silica fume* 20% dan *waste glass aggregate* 2,5%

$$\text{Volume} = \text{Berat} / \text{Berat Jenis}$$

$$\text{Volume semen} = 298,857 \text{ kg} / 3150 \text{ kg/m}^3 = 0,09488 \text{ m}^3$$

$$\text{Volume } \textit{silica fume} = 74,714 \text{ kg} / 2200 \text{ kg/m}^3 = 0,03396 \text{ m}^3$$

$$\text{Volume air} = 119,543 \text{ kg} / 1000 \text{ kg/m}^3 = 0,11954 \text{ m}^3$$

- Maka, Total Volume = **0,09488+0,03396+0,11954 = 0,24838 m³**

$$\begin{aligned} \text{Volume agregat kasar awal (100\%)} &= 1\text{m}^3 - 0,24838 \text{ m}^3 \\ &= 0,75162 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Volume agregat kasar yg digunakan(97,5\%)} &= 0,75162 \text{ m}^3 \times 0,975 \\ &= 0,73283 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Volume } \textit{waste glass aggregate} (2,5\%) &= 0,75162 \text{ m}^3 \times 0,025 \\ &= 0,01879 \text{ m}^3 \end{aligned}$$

- Kontrol volume komposisi = (1 m³)
 = Volume semen + Volume *silica fume* + Volume air + Volume agregat kasar + Volume *waste glass aggregate*
 = 0,24838 m³ + 0,73283 m³ + 0,01879 m³ = 1m³ (Ok)

- **Sehingga, didapat komposisi berat agregat kasar dan *waste glass aggregate* yang digunakan sebagai berikut :**

$$\text{Berat} = \text{Volume} \times \text{berat jenis}$$

$$\text{Berat agregat kasar (97,5\%)} = 0,73283 \times 2600 = 1905,4 \text{ kg}$$

$$\text{Berat agregat kaca (2,5\%)} = 0,01879 \times 2600 = 48,9 \text{ kg}$$

i. Penjabaran perhitungan *silica fume* 20% dan *waste glass aggregate* 7,5%

$$\text{Volume} = \text{Berat} / \text{Berat Jenis}$$

$$\text{Volume semen} = 298,857 \text{ kg} / 3150 \text{ kg/m}^3 = 0,09488 \text{ m}^3$$

$$\text{Volume } \textit{silica fume} = 74,714 \text{ kg} / 2200 \text{ kg/m}^3 = 0,03396 \text{ m}^3$$

$$\text{Volume air} = 119,543 \text{ kg} / 1000 \text{ kg/m}^3 = 0,11954 \text{ m}^3$$

• Maka, Total Volume = $0,09488 + 0,03396 + 0,1195 = 0,24838 \text{ m}^3$

$$\begin{aligned} \text{Volume agregat kasar awal (100\%)} &= 1 \text{ m}^3 - 0,24838 \text{ m}^3 \\ &= 0,75162 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Volume agregat kasar yg digunakan (92,5\%)} &= 0,75162 \text{ m}^3 \times 0,925 \\ &= 0,69525 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Volume } \textit{waste glass aggregate} (7,5\%) &= 0,75162 \text{ m}^3 \times 0,075 \\ &= 0,05637 \text{ m}^3 \end{aligned}$$

• Kontrol volume komposisi = (1 m^3)

$$\begin{aligned} &= \text{Volume semen} + \text{Volume } \textit{silica fume} + \text{Volume air} + \text{Volume agregat} \\ &\quad \text{kasar} + \text{Volume } \textit{waste glass aggregate} \end{aligned}$$

$$= 0,24838 \text{ m}^3 + 0,69525 \text{ m}^3 + 0,05637 \text{ m}^3 = 1 \text{ m}^3 \text{ (Ok)}$$

• **Sehingga, didapat komposisi berat agregat kasar dan *waste glass aggregate* yang digunakan sebagai berikut :**

$$\text{Berat} = \text{Volume} \times \text{berat jenis}$$

$$\text{Berat agregat kasar (92,5\%)} = 0,69525 \times 2600 = 1807,65 \text{ kg}$$

$$\text{Berat agregat kaca (7,5\%)} = 0,05637 \times 2600 = 146,6 \text{ kg}$$

j. Penjabaran perhitungan *silica fume* 20% dan *waste glass aggregate* 7,5%

$$\text{Volume} = \text{Berat} / \text{Berat Jenis}$$

$$\text{Volume semen} = 298,857 \text{ kg} / 3150 \text{ kg/m}^3 = 0,09488 \text{ m}^3$$

$$\text{Volume } \textit{silica fume} = 74,714 \text{ kg} / 2200 \text{ kg/m}^3 = 0,03396 \text{ m}^3$$

$$\text{Volume air} = 119,543 \text{ kg} / 1000 \text{ kg/m}^3 = 0,11954 \text{ m}^3$$

• Maka, Total Volume = $0,09488 + 0,03396 + 0,1195 = 0,24838 \text{ m}^3$

$$\begin{aligned} \text{Volume agregat kasar awal (100\%)} &= 1 \text{ m}^3 - 0,24838 \text{ m}^3 \\ &= 0,75162 \text{ m}^3 \end{aligned}$$

$$\begin{aligned}\text{Volume agregat kasar yg digunakan (87,5\%)} &= 0,75162 \text{ m}^3 \times 0,875 \\ &= 0,65767 \text{ m}^3\end{aligned}$$

$$\begin{aligned}\text{Volume waste glass aggregate (12,5\%)} &= 0,75162 \text{ m}^3 \times 0,125 \\ &= 0,09395 \text{ m}^3\end{aligned}$$

- Kontrol volume komposisi = (1 m³)

$$\begin{aligned}&= \text{Volume semen} + \text{Volume silica fume} + \text{Volume air} + \text{Volume agregat} \\ &\quad \text{kasar} + \text{Volume waste glass aggregate}\end{aligned}$$

$$= 0,24838 \text{ m}^3 + 0,65767 \text{ m}^3 + 0,09395 \text{ m}^3 = 1 \text{ m}^3 \text{ (Ok)}$$

- Sehingga, didapat komposisi berat agregat kasar dan waste glass aggregate yang digunakan sebagai berikut :

$$\text{Berat} = \text{Volume} \times \text{berat jenis}$$

$$\text{Berat agregat kasar (87,5\%)} = 0,65767 \times 2600 = 1709,9 \text{ kg}$$

$$\text{Berat waste glass aggregate (12,5 \%)} = 0,09395 \times 2600 = 244,3 \text{ kg}$$

5. Perhitungan Berat Superplasticizer dan Air

Superplasticizer yang digunakan pada penelitian ini yaitu 0,5%. Untuk mendapatkan berat *superplasticizer* yaitu mengkalikan dengan berat semen.

- Berat air = 119,543 kg

- Berat semen setiap variasi

$$\text{SF}_0\text{WG}_0 = 373,6$$

$$\text{SF}_{10}\text{WG}_{2,5} = 336,214$$

$$\text{SF}_{10}\text{WG}_{7,5} = 336,214$$

$$\text{SF}_{10}\text{WG}_{12,5} = 336,214$$

$$\text{SF}_{15}\text{WG}_{2,5} = 317,536$$

$$\text{SF}_{15}\text{WG}_{7,5} = 317,536$$

$$\text{SF}_{15}\text{WG}_{12,5} = 317,536$$

$$\text{SF}_{20}\text{WG}_{2,5} = 298,857$$

$$\text{SF}_{20}\text{WG}_{7,5} = 298,857$$

$$\text{SF}_{20}\text{WG}_{12,5} = 298,857$$

- Berat *superplasticizer* = (berat semen x 0,5%)

$$\text{SF}_{10}\text{WG}_{2,5} = (336,2 \times 0,5\%) = 1,68$$

$$\text{SF}_{10}\text{WG}_{7,5} = (336,2 \times 0,5\%) = 1,68$$

$$\text{SF}_{10}\text{WG}_{12,5} = (336,2 \times 0,5\%) = 1,68$$

$$\text{SF}_{15}\text{WG}_{2,5} = (317,5 \times 0,5\%) = 1,59$$

$$\begin{aligned}
 SF_{15}WG_{7,5} &= (317,5 \times 0,5\%) = 1,59 \\
 SF_{15}WG_{12,5} &= (317,5 \times 0,5\%) = 1,59 \\
 SF_{20}WG_{2,5} &= (298,9 \times 0,5\%) = 1,49 \\
 SF_{20}WG_{7,5} &= (298,9 \times 0,5\%) = 1,49 \\
 SF_{20}WG_{12,5} &= (298,9 \times 0,5\%) = 1,49
 \end{aligned}$$

- Berat air setiap variasi = berat air campuran normal – *berat superplasticizer*

$$\begin{aligned}
 SF_{10}WG_{2,5} &= 119,5 - 1,68 = 117,8 \\
 SF_{10}WG_{7,5} &= 119,5 - 1,68 = 117,8 \\
 SF_{10}WG_{12,5} &= 119,5 - 1,68 = 117,8 \\
 SF_{15}WG_{2,5} &= 119,5 - 1,59 = 117,9 \\
 SF_{15}WG_{7,5} &= 119,5 - 1,59 = 117,9 \\
 SF_{15}WG_{12,5} &= 119,5 - 1,59 = 117,9 \\
 SF_{20}WG_{2,5} &= 119,5 - 1,49 = 118,0 \\
 SF_{20}WG_{7,5} &= 119,5 - 1,49 = 118,0 \\
 SF_{20}WG_{12,5} &= 119,5 - 1,49 = 118,0
 \end{aligned}$$

6. Rekapitulasi Volume Material (m³)

KODE	% SF	% WGA	volume semen	volume <i>silica fume</i>	volume agregat kasar	volume air	volume agregat kaca	Total (m ³)
SF ₀ WG ₀	0	0	0,11859	0	0,76187	0,11954	0	1
SF ₁₀ WG _{2,5}	10	2,5	0,10673	0,01698	0,73782	0,11954	0,01892	1
SF ₁₀ WG _{7,5}	10	7,5	0,10673	0,01698	0,69999	0,11954	0,05676	1
SF ₁₀ WG _{12,5}	10	12,5	0,10673	0,01698	0,66215	0,11954	0,09459	1
SF ₁₅ WG _{2,5}	15	2,5	0,10080	0,02547	0,73533	0,11954	0,01885	1
SF ₁₅ WG _{7,5}	15	7,5	0,10080	0,02547	0,69762	0,11954	0,05656	1
SF ₁₅ WG _{12,5}	15	12,5	0,10080	0,02547	0,65991	0,11954	0,09427	1
SF ₂₀ WG _{2,5}	20	2,5	0,09488	0,03396	0,73283	0,11954	0,01879	1
SF ₂₀ WG _{7,5}	20	7,5	0,09488	0,03396	0,69525	0,11954	0,05637	1
SF ₂₀ WG _{12,5}	20	12,5	0,09488	0,03396	0,65767	0,11954	0,09395	1

Dapat disimpulkan bahwa dari tabel tersebut perbedaan antara berat agregat kasar dan *waste glass aggregate* dipengaruhi oleh persentase *waste glass aggregate* dan *silica fume* yang bervariasi.