

BAB IV

ANALISIS HASIL PENELITIAN

4.1 Analisis karakteristik beton

Kekuatan tekan beton mempunyai kecenderungan untuk bervariasi dari tiap-tiap adukan. Besar variasi itu tergantung dari berbagai faktor (Kardiono Tjokrodimulyo, 1993), antara lain:

1. Variasi mutu bahan dari satu adukan ke adukan berikutnya,
2. variasi cara pengadukan,
3. keterampilan dan stabilitas pengaduk atau pekerja.

Perhitungan kekuatan tekan beton karakteristik, dimaksudkan untuk mencari mutu beton dan tingkat mutu pelaksanaannya. Adapun cara perhitungan kekuatan beton karakteristik dapat digunakan formula 2.3. Hasil perhitungan dapat dilihat pada tabel-tabel berikut ini:

Tabel 4.1 Perhitungan kuat tekan karakteristik beton dengan asal pasir PT. Perwita Karya untuk mutu beton $f'_c = 17.5$ MPa

No	Umur (hari)	Faktor umur	f_c (Mpa)	$f_{c\ 28}$ (Mpa)	$(f_{c\ 28} - f'_{cr})$ (MPa)	$(f_{c\ 28} - f'_{cr})^2$ (MPa)
1	7	0.65	15.252	23.465	-2.025	4.09
2			19.398	29.842	4.353	18.95
3			17.837	27.441	1.952	3.81
4			16.772	25.804	0.314	0.09
5			19.379	29.813	4.324	18.69
6			19.198	29.536	4.074	16.37
7			17.295	26.608	1.119	1.25
8			16.255	25.007	-0.482	0.23
9			16.019	24.644	-0.845	0.71
10			21.713	33.404	7.915	62.64
11	28	1	18.371	18.371	-7.119	50.67
12			25.407	25.407	-0.082	0.01
13			24.771	24.771	-0.718	0.51
14			25.167	25.167	-0.322	0.10
15			21.305	21.305	-4.185	17.51
16			25.131	25.131	-0.358	0.12
17			23.339	23.339	-2.150	4.62
18			23.657	23.657	-1.832	3.35
19			25.253	25.253	-0.236	0.05
20			21.816	21.816	-3.673	13.49
				$\Sigma = 509.782$		$\Sigma = 217.34$

Kuat tekan rata-rata :

$$f'_{cr} = \frac{\sum f_{c\ 28}}{N}$$

$$= 509.782 / 20$$

$$= 25.485 \text{ MPa}$$

Deviasi Standar:

$$S_d = \sqrt{\frac{\sum (f_{c\ 28} - f'_{cr})^2}{N - 1}}$$

$$= \sqrt{\frac{217.34}{20 - 1}} = 3.38 \text{ Mpa}$$

Kuat tekan karakteristik:

$$f'_c = f'_{cr} - 1.64 \cdot S_d$$

$$= 25.485 - 1.64 \cdot 3.38$$

$$= 19.942 \text{ Mpa}$$

Tabel 4.2 Perhitungan kuat tekan karakteristik beton dengan asal pasir PT. Trikarsa Nusantara untuk mutu beton $f'_c = 17.5$ MPa

No	Umur (hari)	Faktor umur	f_c (Mpa)	$f_{c\ 28}$ (Mpa)	$(f_{c\ 28} - f'_{cr})$ (MPa)	$(f_{c\ 28} - f'_{cr})^2$ (MPa)
1	7	0.65	153.19	23.568	-2.054	4.22
2			197.23	30.344	4.721	22.28
3			196.96	30.303	4.680	21.90
4			200.75	30.886	5.263	27.69
5			201.28	30.967	5.343	28.55
6			165.79	25.506	-0.117	0.01
7			154.94	23.838	-1.785	3.18
8			166.86	253671	0.048	0.00
9			183.11	28.172	2.549	6.49
10			182.76	28.117	2.491	6.22
11	28	1	178.87	17.887	-7.735	59.82
12			258.74	25.874	0.252	0.06
13			230.62	23.062	-2.560	6.55
14			211.39	21.139	-4.483	20.10
15			259.31	25.931	0.308	0.09
16			289.43	28.943	3.320	11.02
17			227.08	22.708	-2.914	8.49
18			243.74	24.374	-1.248	1.56
19			217.42	21.742	-3.880	15.05
20			234.20	23.420	-2.202	4.89
				$\Sigma = 512.457$		$\Sigma = 248.21$

Kuat tekan rata-rata:

$$f'_{cr} = \frac{\sum f_{c\ 28}}{N}$$

$$= 512.457 / 20$$

$$= 25.623 \text{ MPa}$$

Deviasi standar:

$$S_d = \sqrt{\frac{\sum (f_{c\ 28} - f'_{cr})^2}{N - 1}}$$

$$= \sqrt{\frac{248.21}{20 - 1}} = 3.614 \text{ MPa}$$

Kuat tekan karakteristik:

$$f'_c = f'_{cr} - 1.64 \cdot S_d$$

$$= 25.623 - 1.64 \cdot 3.614$$

$$= 19.695 \text{ MPa}$$

Tabel 4.3 Perhitungan kuat tekan karakteristik beton dengan asal pasir Sungai Krasak untuk mutu beton $f'_c = 17.5$ MPa

No	Umur (hari)	Faktor umur	f_c (Mpa)	$f_{c\ 28}$ (Mpa)	$(f_{c\ 28} - f'_{cr})$ (MPa)	$(f_{c\ 28} - f'_{cr})^2$ (MPa)
1	7	0.65	23.328	35.889	6.842	46.81
2			23.945	36.839	7.792	60.71
3			14.759	22.706	-6.341	40.20
4			20.973	32.267	3.220	10.36
5			18.408	28.320	-0.727	0.52
6			19.092	29.372	0.325	0.10
7			20.519	31.568	2.521	6.35
8			21.802	33.542	4.495	20.20
9			16.719	25.733	-3.325	11.05
10			18.540	28.522	-0.525	0.27
11	28	1	29.646	29.646	0.599	0.35
12			23.250	23.250	-5.797	33.59
13			29.340	29.340	0.293	0.08
14			27.486	27.486	-1.561	2.43
15			25.624	25.624	-3.423	11.71
16			29.843	29.843	0.796	0.63
17			27.236	27.236	-1.811	3.27
18			28.734	28.734	-0.313	0.09
19			26.153	26.153	-2.894	8.37
20			28.871	28.871	-0.176	0.03
				$\Sigma = 580.930$		$\Sigma = 257.24$

Kuat tekan rata-rata:

$$\begin{aligned} f'_{cr} &= \frac{\sum f_{c\ 28}}{N} \\ &= 580.930 / 20 \\ &= 29.047 \text{ Mpa} \end{aligned}$$

Deviasi standar:

$$\begin{aligned} S_d &= \sqrt{\frac{\sum (f_{c\ 28} - f'_{cr})^2}{N-1}} \\ &= \sqrt{\frac{257.24}{20-1}} = 3.68 \text{ MPa} \end{aligned}$$

Kuat tekan karakteristik:

$$\begin{aligned} f'_c &= f'_{cr} - 1.64 \cdot S_d \\ &= 29.047 - 1.64 \cdot 3.68 \\ &= 23.012 \text{ MPa} \end{aligned}$$

Tabel 4.4 Perhitungan kuat tekan karakteristik beton dengan asal pasir PT. Perwita Karya untuk mutu beton $f'_c = 22.5$ MPa

No	Umur (hari)	Faktor umur	f_c (Mpa)	$f_{c\ 28}$ (Mpa)	$(f_{c\ 28} - f'_{cr})$ (MPa)	$(f_{c\ 28} - f'_{cr})^2$ (MPa)
1	7	0.65	22.472	34.572	4.735	22.42
2			22.364	34.406	4.569	20.87
3			19.086	29.364	-0.473	0.22
4			24.145	37.147	7.310	53.43
5			20.751	31.925	2.088	4.35
6			20.332	31.280	1.443	2.08
7			18.735	28.823	-1.014	1.027
8			19.250	29.165	-0.222	0.05
9			22.223	34.189	4.352	18.94
10			21.215	32.638	2.802	7.85
11	28	1	22.989	22.989	-6.848	46.90
12			24.623	24.623	-5.214	27.18
13			26.577	26.577	-3.260	10.62
14			29.838	29.838	0.001	0.00
15			27.166	27.166	-2.671	7.14
16			24.561	24.561	-5.276	27.84
17			29.476	29.476	-0.361	0.13
18			32.754	32.754	2.917	8.51
19			27.204	27.204	-2.633	6.93
20			28.317	28.317	-1.520	2.31
				$\Sigma = 597.463$		$\Sigma = 268.84$

Kuat tekan rata-rata:

$$\begin{aligned}
 f'_{cr} &= \frac{\sum f_{c28}}{N} \\
 &= 597.463 / 20 \\
 &= 29.873 \text{ MPa}
 \end{aligned}$$

Deviasi standar:

$$\begin{aligned}
 S_d &= \sqrt{\frac{\sum (f_{c28} - f'_{cr})^2}{N - 1}} \\
 &= \sqrt{\frac{268.84}{20 - 1}} = 3.76 \text{ Mpa}
 \end{aligned}$$

Kuat tekan karakteristik:

$$\begin{aligned}
 f'_c &= f'_{cr} - 1.64 \cdot S_d \\
 &= 29.873 - 1.64 \cdot 3.76 \\
 &= 23.074 \text{ MPa}
 \end{aligned}$$

Tabel 4.5 Perhitungan kuat tekan karakteristik beton dengan asal pasir PT. Trikarsa Nusantara untuk mutu beton $f'_c = 22.5$ MPa

No	Umur (hari)	Faktor umur	f_c (Mpa)	$f_{c\ 28}$ (Mpa)	$(f_{c\ 28} - f'_{cr})$ (MPa)	$(f_{c\ 28} - f'_{cr})^2$ (MPa)
1	7	0.65	22.243	34.220	4.224	17.84
2			21.175	32.577	2.581	6.66
3			23.558	36.243	6.248	39.03
4			20.358	31.320	1.324	1.75
5			19.350	29.770	-0.226	0.05
6			23.235	35.746	5.750	33.06
7			19.597	30.149	0.154	0.02
8			22.400	34.461	4.465	19.93
9			18.021	27.725	-2.271	5.15
10			21.001	32.309	2.313	5.34
11	28	1	28.085	28.085	-1.911	3.65
12			31.392	31.392	1.396	1.94
13			28.699	28.699	-1.297	1.68
14			33.324	33.324	3.329	11.07
15			29.655	29.665	-0.341	0.11
16			24.049	24.049	-5.946	35.35
17			24.429	24.429	-5.567	30.98
18			24.959	24.959	-5.037	25.36
19			25.239	25.239	-4.757	22.62
20			25.565	25.565	-4.431	19.63
				$\Sigma = 599.918$		$\Sigma = 281.32$

Kuat tekan rata-rata:

$$f'_{cr} = \frac{\sum f_{c\ 28}}{N}$$

$$= 599.918 / 20$$

$$= 29.966 \text{ MPa}$$

Deviasi standar:

$$S_d = \sqrt{\frac{\sum (f_{c\ 28} - f'_{cr})^2}{N - 1}}$$

$$= \sqrt{\frac{281.32}{20 - 1}} = 3.848 \text{ Mpa}$$

Kuat tekan karakteristik:

$$f'_c = f'_{cr} - 1.64 \cdot S_d$$

$$= 29.966 - 1.64 \cdot 3.848$$

$$= 23.685 \text{ MPa}$$

Tabel 4.6 Perhitungan kuat tekan karakteristik beton dengan asal pasir Sungai Krasak untuk mutu beton $f'_c = 22.5$ MPa

No	Umur (hari)	Faktor umur	f_c (Mpa)	$f_{c\ 28}$ (Mpa)	$(f_{c\ 28} - f'_{cr})$ (MPa)	$(f_{c\ 28} - f'_{cr})^2$ (MPa)
1	7	0.65	25.644	39.452	4.147	17.19
2			26.272	40.419	5.113	26.14
3			21.633	33.281	-2.025	4.09
4			23.217	35.718	0.413	0.17
5			23.880	36.739	1.433	2.05
6			23.052	35.465	0.159	0.02
7			23.235	35.746	0.440	0.19
8			25.636	39.441	4.135	17.09
9			25.766	39.640	4.334	18.78
10			27.013	41.559	6.253	39.10
11	28	1	31.023	31.023	-4.238	18.34
12			37.151	37.151	1.846	3.40
13			35.041	35.041	-0.264	0.06
14			30.380	30.380	-4.925	24.25
15			29.188	29.188	-6.118	37.42
16			36.453	36.453	1.148	1.31
17			30.514	30.514	-4.791	22.95
18			34.417	34.417	-0.889	0.79
19			29.561	29.561	-5.744	32.99
20			34.922	34.922	-0.383	0.14
				$\Sigma = 706.109$		$\Sigma = 266.57$

Kuat tekan rata-rata:

$$\begin{aligned} f'_{cr} &= \frac{\sum f_{c\ 28}}{N} \\ &= 706.109 / 20 \\ &= 35.305 \text{ MPa} \end{aligned}$$

Deviasi standar:

$$\begin{aligned} S_d &= \sqrt{\frac{\sum (f_{c\ 28} - f'_{cr})^2}{N - 1}} \\ &= \sqrt{\frac{266.57}{20 - 1}} = 3.746 \text{ Mpa} \end{aligned}$$

Kuat tekan karakteristik:

$$\begin{aligned} f'_c &= f'_{cr} - 1.64 \cdot S_d \\ &= 35.305 - 1.64 \cdot 3.746 \\ &= 29.163 \text{ MPa} \end{aligned}$$

Tabel 4.7 Perhitungan kuat tekan karakteristik beton dengan asal pasir PT. Perwita Karya untuk mutu beton $f'_c = 30$ MPa

No	Umur (hari)	Faktor umur	f_c (Mpa)	$f_{c\ 28}$ (Mpa)	$(f_{c\ 28} - f'_{cr})$ (MPa)	$(f_{c\ 28} - f'_{cr})^2$ (MPa)
1	7	0.65	27.196	41.840	3.604	12.98
2			23.116	35.563	-2.673	7.14
3			28.777	44.273	6.037	36.44
4			24.848	38.228	-0.008	0.00
5			26.446	40.687	2.450	6.00
6			29.055	44.700	6.463	41.77
7			24.423	37.574	-0.662	0.43
8			29.145	44.839	6.603	43.59
9			26.878	41.350	3.114	9.69
10			29.136	44.825	6.589	43.41
11	28	1	35.263	35.263	-2.947	8.84
12			34.543	34.543	-3.694	13.64
13			34.708	34.708	-3.529	12.45
14			34.134	34.134	-4.102	16.83
15			34.202	34.202	-4.034	16.27
16			34.984	34.984	-3.252	10.57
17			33.086	33.086	-5.151	26.52
18			36.301	36.301	-1.935	3.74
19			37.753	37.753	-0.484	0.23
20			35.874	35.874	-2.363	5.58
				$\Sigma = 764.726$		$\Sigma = 316.20$

Kuat tekan rata-rata:

$$f'_{cr} = \frac{\sum f_{c\ 28}}{N}$$

$$= 764.726 / 20$$

$$= 38.236 \text{ MPa}$$

Deviasi standar:

$$S_d = \sqrt{\frac{\sum (f_{c\ 28} - f'_{cr})^2}{N - 1}}$$

$$= \sqrt{\frac{316.20}{20 - 1}} = 4.080 \text{ MPa}$$

Kuat tekan karakteristik:

$$f'_c = f'_{cr} - 1.64 \cdot S_d$$

$$= 38.236 - 1.64 \cdot 4.080$$

$$= 31.546 \text{ MPa}$$

Tabel 4.8 Perhitungan kuat tekan karakteristik beton dengan asal pasir PT. Trikarsa Nusantara untuk mutu beton $f'_c = 30$ MPa

No	Umur (hari)	Faktor umur	f_c (Mpa)	$f_{c\ 28}$ (Mpa)	$(f_{c\ 28} - f'_{cr})$ (MPa)	$(f_{c\ 28} - f'_{cr})^2$ (MPa)
1	7	0.65	27.233	41.897	3.760	14.13
2			29.044	44.682	6.545	42.84
3			24.425	37.576	-0.560	0.31
4			25.073	38.574	0.437	0.19
5			25.618	39.413	1.276	1.62
6			29.240	44.984	6.847	46.88
7			27.163	41.789	3.652	13.34
8			27.220	41.876	3.740	13.98
9			28.249	43.461	5.324	28.34
10			26.378	40.582	2.445	5.97
11	28	1	35.787	35.787	-2.350	5.52
12			34.590	34.590	-3.546	12.57
13			36.155	36.155	-1.982	3.92
14			36.252	36.252	-1.885	3.55
15			34.096	34.096	-4.040	16.32
16			36.174	36.174	-1.963	3.85
17			36.241	36.241	-1.895	3.59
18			34.377	34.377	-3.760	14.13
19			30.981	30.981	-7.165	51.20
20			33.247	33.247	-4.890	23.91
				$\Sigma = 762.735$		$\Sigma = 306.24$

Kuat tekan rata-rata:

$$f'_{cr} = \frac{\sum f_{c\ 28}}{N}$$

$$= 762.735 / 20$$

$$= 38.137 \text{ MPa}$$

Deviasi standar

$$S_d = \sqrt{\frac{\sum (f_{c\ 28} - f'_{cr})^2}{N - 1}}$$

$$= \sqrt{\frac{306.24}{20 - 1}} = 4.015 \text{ Mpa}$$

Kuat tekan karakteristik:

$$f'_c = f'_{cr} - 1.64 \cdot S_d$$

$$= 38.137 - 1.64 \cdot 4.015$$

$$= 31.553 \text{ MPa}$$

Tabel 4.9 Perhitungan kuat tekan karakteristik beton dengan asal pasir Sungai Krasak untuk mutu beton $f'_c = 30$ MPa

No	Umur (hari)	Faktor umur	f_c (Mpa)	$f_{c\ 28}$ (Mpa)	$(f_{c\ 28} - f'_{cr})$ (MPa)	$(f_{c\ 28} - f'_{cr})^2$ (MPa)
1	7	0.65	28.570	43.954	0.427	0.18
2			30.525	46.962	3.343	11.79
3			28.371	43.648	0.121	0.01
4			32.788	50.444	6.916	47.83
5			30.861	47.479	3.951	15.61
6			27.311	42.016	-1.511	2.28
7			32.762	50.403	6.875	47.27
8			28.431	43.740	0.213	0.04
9			30.818	74.412	3.885	15.09
10			28.308	43.551	0.024	0.00
11	28	1	41.940	41.940	-1.588	2.52
12			39.903	39.903	-3.625	13.13
13			42.805	42.805	-0.722	0.52
14			37.972	37.972	-5.555	30.85
15			44.458	44.458	0.931	0.86
16			42.450	42.450	-1.077	1.16
17			36.453	36.453	-7.074	50.04
18			43.932	43.932	0.404	0.16
19			40.121	40.121	-3.407	11.60
20			40.904	40.904	-2.263	6.88
				$\Sigma = 870.545$		$\Sigma = 870.54$

Kuat tekan rata-rata:

$$f'_{cr} = \frac{\sum f_{c\ 28}}{N}$$

$$= 870.545 / 20$$

$$= 25.485 \text{ MPa}$$

Deviasi standar:

$$S_d = \sqrt{\frac{\sum (f_{c\ 28} - f'_{cr})^2}{N - 1}}$$

$$= \sqrt{\frac{870.54}{20 - 1}} = 3.684 \text{ Mpa}$$

Kuat tekan karakteristik:

$$f'_c = f'_{cr} - 1.64 \cdot S_d$$

$$= 25.485 - 1.64 \cdot 3.684$$

$$= 20.485 \text{ MPa}$$

4.2 Ringkasan Hasil Pengujian

Dari hasil analisis kuat tekan karakteristik beton dengan variasi hasil agregat halus (pasir) di atas, dapat ditabelkan sebagai berikut:

Tabel 4.10
Kuat tekan beton karakteristik untuk setiap asal pasir dan mutu beton

No	Asal pasir	Mutu beton	f_{cr} (MPa)	f_c (MPa)
1	PT. Perwita Karya	$f_c = 17.5$	25.489	19.942
2	PT. Trikarsa N		25.623	19.695
3	Sungai Krasak		29.047	23.012
4	PT. Perwita Karya	$f_c = 22.5$	29.873	23.074
5	PT. Trikarsa N		29.996	23.685
6	Sungai Krasak		35.305	29.163
7	PT. Perwita Karya	$f_c = 30$	38.236	31.546
8	PT. Trikarsa N		38.137	31.553
9	Sungai Krasak		43.527	37.485