

Construction cash flow formula

The following is a summary of the formulas and factors required to predict the construction cash flow as taken from a doctoral thesis by Dr C P de Leeuw presented in 1988. The basics will still be valid today but the user will have to adjust "late payments" to line up with the current circumstances

Construction cash flow formula

$$s = b \left\{ 1 - \left(1 - \frac{t_1}{t_2} \right)^\alpha \right\}^\beta$$

Computer: $s = b * (1 - (1 - (t_1 / t_2))^\alpha)^\beta$

where

s =	estimated progressive amount of certificates, excluding CPAP and retention
b =	construction cost at practical completion, excluding "late payments", Contract Price Adjustment Provisions (escalation/fluctuation) and retention
t ₁ =	lapsed construction period * in calendar days
t ₂ =	total construction period * in calendar days
*	the construction period is from handing over of the site to the contractor to practical completion of the building work, excluding any builders' holidays

"Late payments"

"Late payments" are those payments made to the contractor after practical completion. Establish "late payments" and deduct from the contract sum before calculating the construction cash flow during the construction period historically as follows:

Percentage of final contract sum (excluding CPAP)

With final bills of quantities	3,5%*
With provisional bills of quantities	6,0%*

* Historical data from Dr De Leeuw's thesis. Suggest currently 2%

Code

Select a numeric code:

Locality	1.	Lesser Metropolitan areas
	2.	Rural areas including lesser cities
	3.	Major Metropolitan areas
Sector	1.	Public sector
	2.	Private sector

- Superstructure
1. One storey
 2. Two storeys
 3. Three storeys
 4. Four storeys
 5. Five to eight storeys
 6. Nine and more storeys
- Lifts
1. With
 0. Without
- Substantial mass excavation
1. With
 0. Without

Alpha and beta values

The following are the alpha and beta values to be used in the construction cash flow formula

Factor	Construction cash flow		Upper probability limit		Lower probability limit	
	Alpha value	Beta value	Alpha value	Beta value	Alpha value	Beta value
*11100	1,58041	1,78019	1,69456	1,41834	1,50883	2,07911
*11101	1,64156	2,15282	1,69188	1,63391	1,56599	2,48776
11110	1,48481	3,36615	1,34007	2,16434	1,45079	3,94492
11111	1,74575	3,84205	1,65905	2,62263	1,66449	4,30741
*11200	0,82647	0,80722	0,97857	0,69805	0,82940	1,00416
11201	1,61173	1,38845	1,75039	1,11096	1,59114	1,73410
11210	1,02331	1,63241	1,12014	1,23915	1,00455	1,94863
11211	1,24216	2,11197	1,19975	1,48938	1,24364	2,61017
*11300	1,36501	1,54147	1,46368	1,22960	1,32507	1,84365
11301	1,50875	1,75382	1,59560	1,37163	1,45310	2,07609
11310	1,15126	2,23392	1,11090	1,57586	1,17900	2,84513
11311	1,15175	2,71905	1,06095	1,83376	1,21354	3,54886
11400	1,55631	2,33613	1,56173	1,71104	1,51091	2,78372
11401	1,24460	3,14757	1,12759	2,05617	1,29829	4,20900
*11410	1,86336	2,27944	1,96259	1,77421	1,75345	2,58507
11411	1,49016	3,07119	1,41702	2,13208	1,50670	3,90866
11500	1,75147	1,95050	1,88139	1,55835	1,65567	2,24324
11501	1,21397	2,12556	1,17086	1,49402	1,20837	2,67918
11510	1,91284	1,97825	2,10036	1,62061	1,79197	2,25383
11511	1,32617	2,14914	1,34659	1,63039	1,26644	2,44046
11900	1,51308	2,39641	1,51400	1,74977	1,48580	2,91377
11901	1,43017	2,70347	1,37831	1,87511	1,42984	3,37311
11910	1,48962	2,29520	1,47628	1,66745	1,45807	2,74361
11911	1,56159	2,79132	1,49968	1,93009	1,52318	3,30294
*12100	1,46054	1,48727	1,61310	1,22352	1,41219	1,78205
*12101	0,90035	1,45840	0,88775	1,07751	0,91969	1,82155
*12110	1,37219	2,81228	1,27565	1,86705	1,35786	3,38128
12111	0,95749	2,60274	0,87053	1,72954	0,97754	3,15392
*12200	1,89668	2,40183	1,98160	1,84908	1,78488	2,71748
12201	1,32191	1,49791	1,34653	1,12109	1,33837	1,90791
12210	2,34841	4,85715	2,26829	3,28240	2,16181	5,27341
12211	1,01880	2,27849	0,92293	1,50297	1,04608	2,87179

Factor	Construction cash flow		Upper probability limit		Lower probability limit	
	Alpha value	Beta value	Alpha value	Beta value	Alpha value	Beta value
*12300	1,15969	1,64955	1,17707	1,24358	1,14658	1,99572
*12301	1,28181	1,87680	1,28315	1,38723	1,25737	2,24734
12310	0,97809	2,39056	0,89337	1,59377	1,02019	3,07982
12311	0,97850	2,90971	0,85320	1,85460	1,05007	3,84159
12400	1,37293	1,93204	1,40964	1,46270	1,34154	2,31924
12401	1,09795	2,60313	1,01778	1,75774	1,15276	3,50672
12410	1,64380	1,88516	1,77147	1,51671	1,55689	2,15375
12411	1,31457	2,53997	1,27903	1,82263	1,33780	3,25648
*12500	1,55381	1,90408	1,62755	1,47650	1,48596	2,21751
12501	1,07697	2,07497	1,01289	1,41555	1,08451	2,64844
*12510	1,69697	1,93116	1,81699	1,53549	1,60829	2,22797
12511	1,17651	2,09799	1,16491	1,54475	1,13663	2,41247
12900	1,34232	2,33937	1,30974	1,65786	1,33350	2,88034
12901	1,26877	2,63913	1,9235	1,77662	1,28328	3,33441
*12910	1,32151	2,24057	1,27710	1,57987	1,30861	2,71213
*12911	1,38536	2,72488	1,29735	1,82871	1,36705	3,26505
*21100	1,23027	1,12801	1,41700	0,96301	1,19138	1,36031
*21101	1,63450	1,44645	1,87819	1,24155	1,55095	1,70347
21110	1,14169	2,07400	1,17510	1,53627	1,11267	2,45931
21111	1,73824	2,58141	1,84175	1,99285	1,64850	2,94947
*21200	1,76507	1,90287	1,91774	1,53953	1,66778	2,19295
21201	1,41282	1,54012	1,52423	1,23995	1,35890	1,81558
21210	2,18545	3,84812	2,19520	2,73289	2,01998	4,25553
21211	1,66930	2,43722	1,73199	1,81280	1,58562	2,84267
*21300	1,48180	0,92868	1,91538	0,87817	1,37352	1,09285
*21301	1,27969	1,58406	1,33930	1,23232	1,24875	1,89694
21310	0,93081	0,94336	1,06696	0,79836	0,91719	1,16734
21311	1,15165	1,47942	1,24523	1,14380	1,18704	1,96906
21400	0,65289	1,26193	0,61857	0,91518	0,69148	1,60890
21401	0,52213	1,70026	0,44662	1,09978	0,59418	2,43267
21410	0,83061	1,54829	0,78467	1,09793	0,86618	1,96315
21411	0,66425	2,08608	0,56654	1,31939	0,74429	2,96829
21500	0,94909	1,35739	0,96375	1,06168	0,97099	1,63657
21501	0,65783	1,47922	0,59977	1,01785	0,70867	1,95460
21510	1,03653	1,37671	1,07064	1,09276	1,05405	1,65833
21511	0,71862	1,49563	0,68979	1,11076	0,74273	1,78045
21900	0,90955	1,76603	0,85914	1,23861	0,99267	2,40625
21901	0,85971	1,99231	0,78214	1,32733	0,95528	2,78558
21910	0,89544	1,69144	0,86158	1,22699	0,94591	2,15402
21911	0,93871	2,05705	0,88622	1,44146	0,98022	2,56690
*22100	1,30691	1,29381	1,46182	1,07662	1,26849	1,55877
*22101	0,96244	1,37852	0,98399	1,05391	0,97163	1,70595
22110	1,21282	2,37885	1,21226	1,71750	1,18468	2,81810
22111	1,02353	2,46019	0,96489	1,69165	1,03274	2,95375
*22200	1,24763	1,71876	1,27004	1,29722	1,22298	2,05996
22201	1,15877	1,66155	1,17255	1,25126	1,14303	1,99755
22210	1,54477	3,47579	1,45378	2,30277	1,48124	3,99745
22211	1,36914	2,62937	1,33238	1,82934	1,33373	3,12759
*22300	1,34094	1,48241	1,44775	1,19115	1,30620	1,78392
22301	1,15804	2,52856	1,01232	1,67153	1,18755	3,09646
*22310	0,84232	1,50585	0,80647	1,08291	0,08724	1,90551
22311	1,04217	2,36154	0,94121	1,55146	1,12886	3,21419

Factor	Construction cash flow		Upper probability limit		Lower probability limit	
	Alpha value	Beta value	Alpha value	Beta value	Alpha value	Beta value
22400	0,57596	1,04365	0,55833	0,78236	0,61397	1,34045
22401	0,46060	1,40616	0,40313	0,94016	0,52757	2,02677
*22410	0,73274	1,28048	0,70825	0,93858	0,76909	1,63559
22411	0,58599	1,72525	0,51137	1,12789	0,66086	2,47302
22500	0,84198	1,32509	0,83372	1,00591	0,87146	1,61779
22501	0,58359	1,44401	0,51885	0,96439	0,63603	1,93218
22510	0,91955	1,34394	0,92619	1,03536	0,94601	1,63930
22511	0,63752	1,46004	0,59673	1,05241	0,66659	1,76002
22900	0,80690	1,72399	0,74323	1,17355	0,89091	2,37864
22901	0,76269	1,94490	0,67661	1,25761	0,85736	2,75362
22910	0,79439	1,65118	0,74533	1,16254	0,84895	2,12931
22911	0,83277	2,00809	0,76665	1,36574	0,87975	2,53745
*31100	1,28298	1,44803	1,37906	1,15859	1,25547	1,75047
*31101	1,31480	1,75161	1,34728	1,32982	1,28064	2,08486
31110	1,19061	2,66241	1,14363	1,84826	1,17252	3,16469
31111	1,39825	3,12602	1,32114	2,13453	1,36119	3,60983
*31200	1,47018	1,34230	1,67975	1,14230	1,40695	1,59608
*31201	1,40701	1,59778	1,50530	1,27107	1,36052	1,90005
31210	1,81587	2,63749	1,87115	1,92760	1,73313	3,05622
*31211	2,52320	2,41097	2,80636	1,97841	2,29867	2,64005
*31300	1,84180	1,69067	2,07588	1,42718	1,74335	1,97838
*31301	1,47208	1,40279	1,65922	1,17806	1,41406	1,67210
31310	2,26722	2,23034	2,49801	1,82225	2,10693	2,53741
31311	1,80738	2,28248	1,90107	1,78686	1,77732	2,75877
*31400	1,22970	1,99480	1,20441	1,43734	1,22011	2,41963
31401	0,98341	2,68769	0,86960	1,72726	1,04842	3,65850
31410	1,62260	2,58241	1,57712	1,82173	1,56857	3,03522
31411	1,29762	3,47940	1,13870	2,18918	1,34784	4,58928
31500	1,67413	1,98303	1,77545	1,56788	1,58537	2,26932
31501	1,16037	2,16100	1,10493	1,50316	1,15707	2,71032
*31510	1,82837	2,01124	1,97239	1,61379	1,72098	2,29949
31511	1,32533	2,19462	1,30085	1,58400	1,31604	2,66697
31900	1,80635	2,77642	1,80743	1,99856	1,75692	3,35345
31901	1,70738	3,13217	1,64543	2,14172	1,69075	3,38210
31910	1,85960	2,67089	1,87943	1,96480	1,77677	3,08827
31911	1,94945	3,24822	1,90852	2,24595	1,88278	3,38644
*32100	1,26692	1,44169	1,35931	1,15148	1,24123	1,74449
*32101	1,51326	1,46548	1,69613	1,22444	1,45356	1,74535
32110	1,17571	2,65076	1,12725	1,83692	1,15922	3,15387
32111	1,60930	2,61538	1,66322	1,96538	1,54499	3,02197
*32200	1,40272	1,68455	1,47693	1,31682	1,35522	1,99375
*32201	1,15401	1,72375	1,15799	1,28267	1,14439	2,09049
*32210	1,73254	3,30997	1,64522	2,22211	1,66941	3,81768
*32211	2,06949	2,60106	2,15887	1,99646	1,93351	2,90466
*32300	1,22167	1,54906	1,27315	1,20074	1,19821	1,86467
32301	0,97643	1,28529	1,01761	0,99115	0,97189	1,57600
*32310	1,50385	2,04353	1,53204	1,53313	1,44810	2,39158
32311	1,19884	2,09130	1,16593	1,50335	1,22156	2,60022
*32400	1,08481	1,64976	1,08712	1,22873	1,08334	2,01591
32401	0,86754	2,22280	0,78492	1,47657	0,93089	3,04807
*32410	1,43141	2,13573	1,42354	1,55733	1,39274	2,52878
32411	1,14472	2,87756	1,02781	1,87145	1,19675	3,82354

Factor	Construction cash flow		Upper probability limit		Lower probability limit	
	Alpha value	Beta value	Alpha value	Beta value	Alpha value	Beta value
32500	1,48520	1,93583	1,53591	1,48553	1,42286	2,24328
32501	1,02941	2,10957	0,95586	1,42421	1,03846	2,67922
*32510	1,62203	1,96337	1,70627	1,52902	1,54457	2,27311
*32511	1,17594	2,14239	1,12534	1,50080	1,18114	2,63637
32900	1,60250	2,71034	1,56357	1,89358	1,57683	3,31498
32901	1,51469	3,05762	1,42343	2,02923	1,51745	3,83756
*32910	1,64974	2,60732	1,62586	1,86160	1,59465	3,05284
32911	1,79245	3,17091	1,65102	2,12798	1,68979	3,82011

* Calculated from historical data (not interpolated)

Construction cash flow after practical completion

1 month	0%
2 months	0%
3 months	30%
4 months	55%
5 months	80%
6 months	95%
7 months	100%

The above is based on historical data from Dr De Leeuw's thesis. Suggest currently much more condensed

Alpha and beta values for subcontract work

The following are the alpha and beta values for subcontract work

Subcontract	Alpha value	Beta value
Air conditioning	1,84153	1,09614
Aluminium windows	1,72065	0,95112
Built-in cupboards	0,15903	0,33377
Carpets	0,01769	0,14244
Electrical installation	1,15158	1,16805
False ceilings	1,68288	1,16465
Kitchen cupboards	3,18319	1,44689
Kitchen equipment	1,20291	0,74676
Lifts	0,97715	0,60273
Mass excavation	1,15181	0,25147
Piling	18,40564	1,32602
Partitions	1,38093	1,08352
Precast concrete external façades	2,03616	1,12076
Shopfronts and shopfront doors	1,42255	0,66987
Sprinkler installation	1,23737	0,66118
Steel roof construction	2,22144	0,55649
Steel structure	2,70006	0,58563
Ventilation	0,57155	0,20772

“Late payments” for subcontract work

The following are the late payments for subcontract work expressed as a percentage of the final contract sum

Subcontract	Final bills of quantities	Provisional bills of quantities
Air conditioning	3,0%	5,0%
Aluminium windows	0,0%	1,0%
Built-in cupboards	0,0%	0,0%
Carpets	0,0%	31,0%*
Electrical installation	4,0%	6,0%
False ceilings	0,0%	0,0%
Kitchen cupboards	1,0%	1,0%
Kitchen equipment	0,0%	0,0%
Lifts	1,0%	15,0%
Mass excavation	0,0%	0,0%
Partitions	1,0%	0,0%
Piling	0,0%	0,0%
Precast concrete external façades	0,0%	0,0%
Shopfronts and shopfront doors	0,0%	10,0%
Sprinkler installation	0,0%	6,0%
Steel roof construction	0,0%	0,0%
Steel structure	0,0%	3,0%
Ventilation	3,0%	5,0%

* Sample size too small

The above is based on historical data from Dr De Leeuw's thesis. Suggest currently lower percentages

Rate of payment of subcontract work after practical completion

The following are the progressive rate of payments of subcontract work after practical completion of construction work

Subcontract	1 month %	2 months %	3 months %	4 months %	5 months %	6 months %	7 months %
Air conditioning	0	0	25	50	90	95	100
Aluminium windows	0	0	95	100			
Built-in cupboards	0	100					
Carpets *	0	5	25	25	70	70	100
Electrical installation	0	0	25	100			
False ceilings	0	0	100				
Kitchen cupboards	0	0	50	100			
Kitchen equipment	0	0	0	0	100		
Lifts	0	60	100				
Mass excavation	0	0	100				
Partitions	0	0	100				
Piling	0	100					
Precast concrete external façades	0	100					
Shopfronts and shopfront doors	0	0	100				
Sprinkler installation	0	0	0	100			
Steel roof construction	0	0	100				
Steel structure	0	0	0	100			
Ventilation	0	40	50	100			

* Actually 0%, 5%, 25%, 25%, 70%, 70% and 100%

The above is based on historical data from Dr De Leeuw's thesis. Suggest currently much condensed

Monitoring contractor's progress

$$t_1 = t_2 \left[1 - \left\{ 1 - \left(\frac{s}{b} \right)^{\frac{1}{\beta}} \right\}^{\frac{1}{\alpha}} \right]$$

Computer. $t_1 = t_2 * (1 - (1 - (s/b)^{(1/\beta)})^{(1/\alpha)})$

where the symbols are the same as that for the construction cash flow

The above formula will provide in calendar days how far the contractor is ahead or behind on construction cash flow as determined by the construction cash flow formula. Where a too long building period is allowed, the comparison of actual with predicted may be distorted