APPENDIX 1:
GANTT CHART

Table: Gantt chart for Final Year Project I

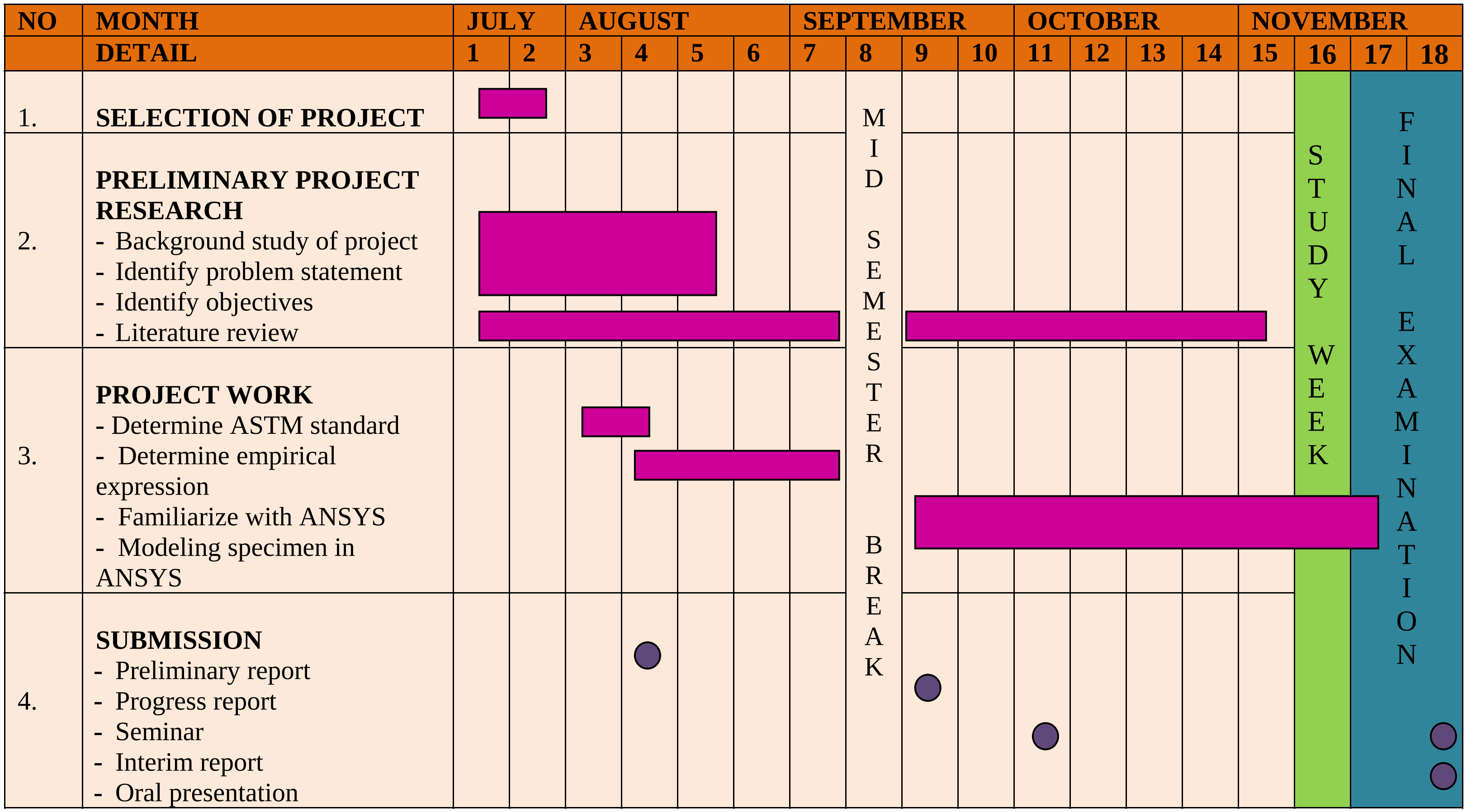

Table: Gantt chart for Final Year Project II

NO	MONTH	JAN		FEBRUARY				MARCH				APRIL				MAY			
	DETAIL	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
1.	**EVALUATION OF FYP I**								MID SEMESTER BREAK								STUDY WEEK	FINAL EXAMINATION	
2.	**PROJECT WORK CONTINUE** - Design graph of Stress Intensity Factor vs $\frac{a}{W}$ from 0.45 to 0.55 -Design graph of Stress Intensity Factor vs $\frac{W}{B}$ from 2.0 to 4.0																		
3.	**ANALYSES** - Analyses result and further recommendation of the project																		
4.	**SUBMISSION** - Progress Report I - Progress Report II - Seminar - Poster Submission - Dissertation (Soft bound) - Oral Presentation - Dissertation (Hardbound)																		

APPENDIX 2:

PROCEDURE IN USING ANSYS SOFTWARE

In order to using KCALC command for plane strain analysis. Several steps and procedures must be followed in order to conduct the analysis. The steps are as follows:

1. **Preprocessing**

    a. Give the jobname for the analysis

        i. **Utility menu > File > Change Jobname. Insert jobname**

    b. Define element type

        i. **Main Menu > Preprocessor > Element Type > Add/Edit/Delete**

        ii. **Select PLANE2 and SOLID95**

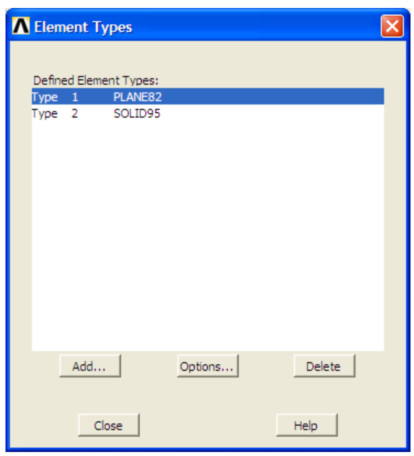

Figure 1.1: Selecting Element Types

        iii. **Click Options and select Plane Strain**

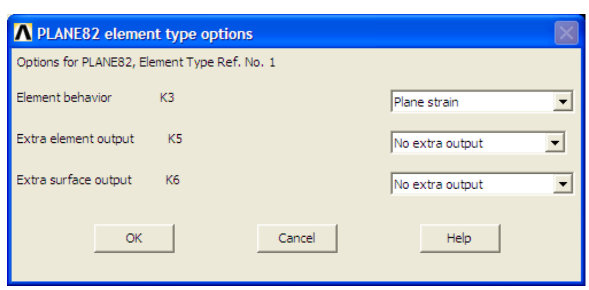

Figure 1.2: Plane element type options

c. Define material properties

i. **Main Menu > Preprocessor > Material Props > Material Models**

ii. **Structural > Linear > Elastic > Isotropic**

iii. **<u>Insert the material properties</u> of Young Modulus (EX) and Poisson's Ratio (PRXY)**

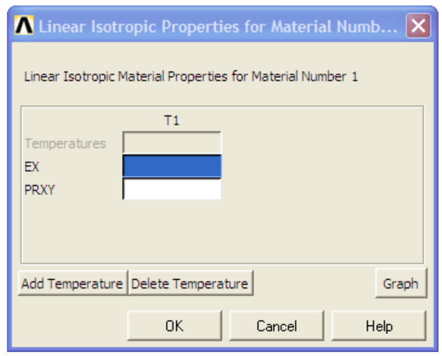

Figure 1.3: Material Properties

d. Define key points

i. **Main Menu > Preprocessor > Modeling > Create > Keypoints > In Active CS**

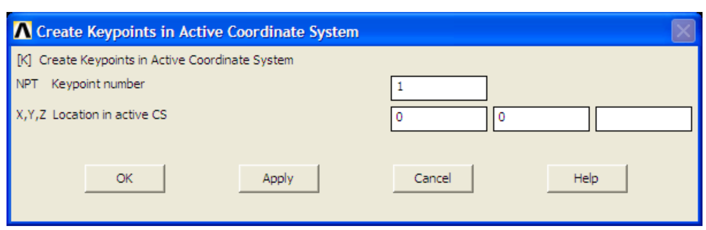

Figure 1.4: Creating key-points by coordinate

ii. **<u>Insert key-points</u> coordinate according to the model**

e. Create the Area

i. **Main Menu > Preprocessor > Modeling > Create > Areas > Arbitrary > through KP > pick > OK**

f. Create circle

i. Main Menu > Preprocessor > modeling > create > areas > circle > solid circle

ii. Insert radius, x and y coordinate

iii. Main menu > Preprocessor > modeling > operate > Booleans > Subtract > areas > pick all > pick circle

g. Meshing the Area

i. **Main Menu > Preprocessor > Meshing > Size Cntrls > Concentrated KPs**. > create > OK

ii. **Pick crack tip key**-point. Fill appropriate value. Click OK

iii. **Main menu** > **Preprocessor** > **meshing** > **manual sizes** > **lines** > **pick lines** > **OK**

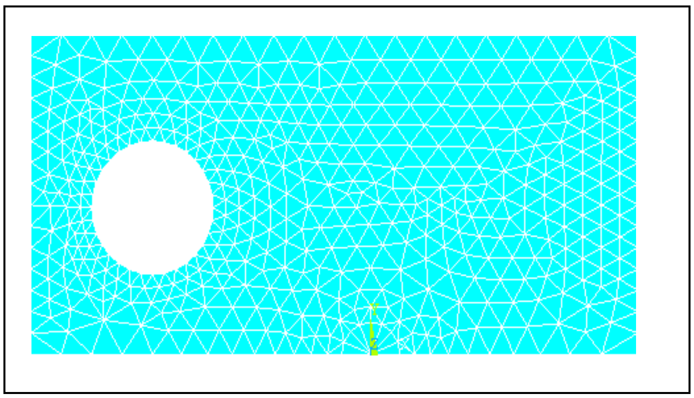

Figure 1.5: Meshed Areas

i. **Choose every line at the model**

ii. **Main Menu > Preprocessor > Meshing > Mesh > Areas > Free**

iii. **Select the area to be meshed. Click OK**

h. Extrude the model

i. **Main Menu > Preprocessor > Modeling > Operate > Extrude > Element Ext Opts**

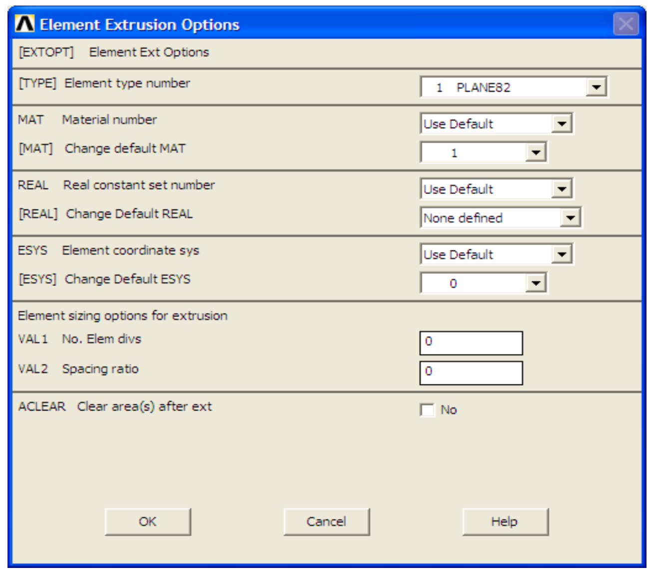

Figure 1.6: Element extrusion option

ii. **Put No of element division and spacing ratio**

iii. **Main Menu > Preprocessor > Modeling > Operate > Extrude > Areas > by xyz offset > Ok**

iv. **Put thickness value. Click OK**

2. Solution

a. Define boundary condition

i. Utility menu > select > select everything > select entities > area > by numpick > apply

ii. **Main Menu > Solution > Define Loads > Apply > Structural > displacement > symmetry boundary condition > on nodes > pick all**

iii. **Insert Y axis = 0 then click OK**

iv. **Main menu > Solution > define loads apply > structural > displacement > lines > pick lines > OK**

v. **Set DOF = 0**

vi. **To see the boundary condition at that line use plot lines**

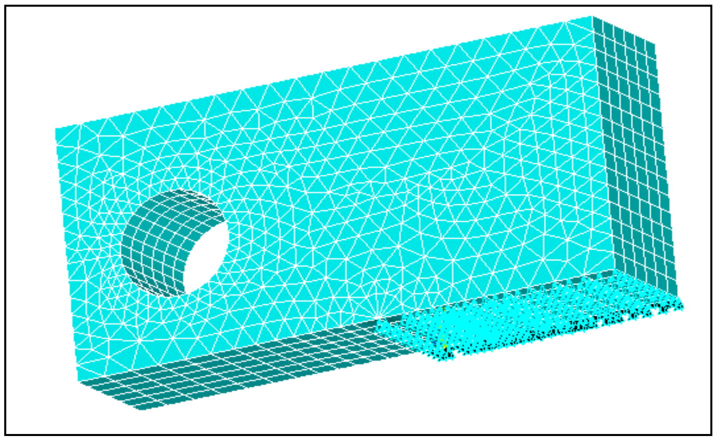

Figure 1.7: Boundary condition on nodes

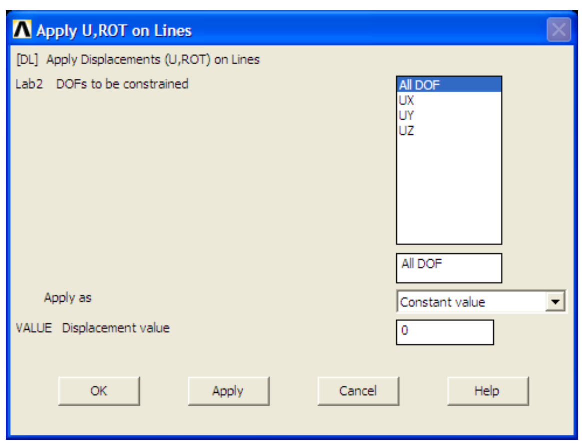

Figure 1.8: Displacement value is set for 0 for all DOF

b. Define load

i. **Utility menu > select > select entities > ares > by numpick > apply**

ii. **Choose area at the top of the circle**

iii. **Utility menu > select > select entities > nodes > attached to > area, all > apply**

iv. **Main Menu > Solution > Define Loads > Apply > Structural > Force/Moment > > on nodes > pick all > OK**

v. **Set the applied load equal to applied load divide by the no of nodes**

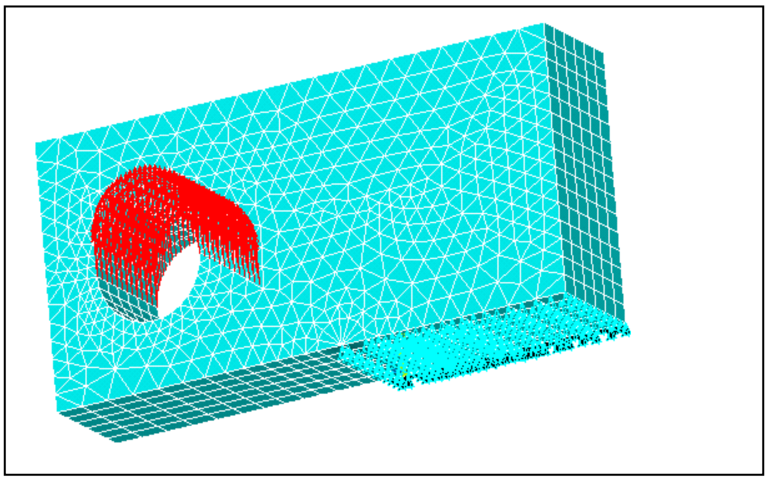

Figure1.9: Applied load to the area selected

c. Solve

i. **Main menu > solution > solve > Current LS > OK**

3. General Postprocessor

a. Plot result

i. **Main menu > General Postproc > Plot result > Contour plot > nodal solution > Von Stress Misses > OK**

b. Define Path

i. **Main menu > General Postproc > Define Path > By nodes**

ii. **Select 3 nodes of crack from the crack tip to the direction of crack. Click OK.**

iii. **Set Path = K1**

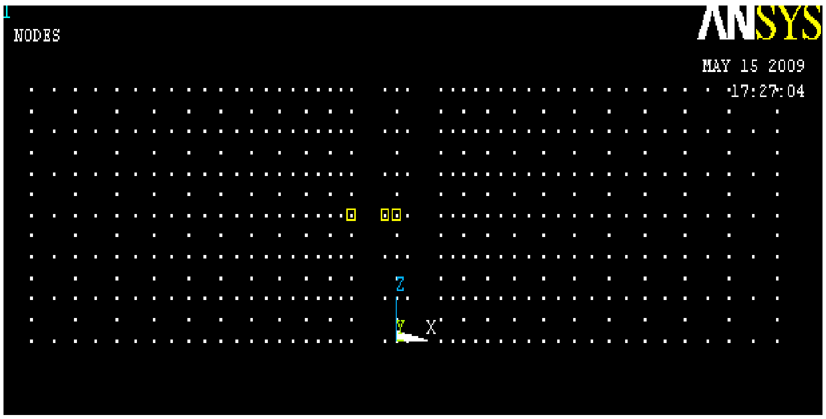

Figure 1.10: Select nodes at crack tip which is in the direction from crack tip to the crack

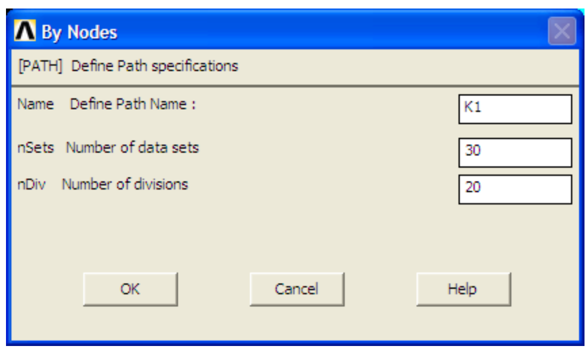

Figure 1.11: Define pathname of the path

c. Define Stress Intensity Factor, K

i. General Postproc > Nodal Calc > Stress Intensity Factor > OK

ii. **The result will appear**

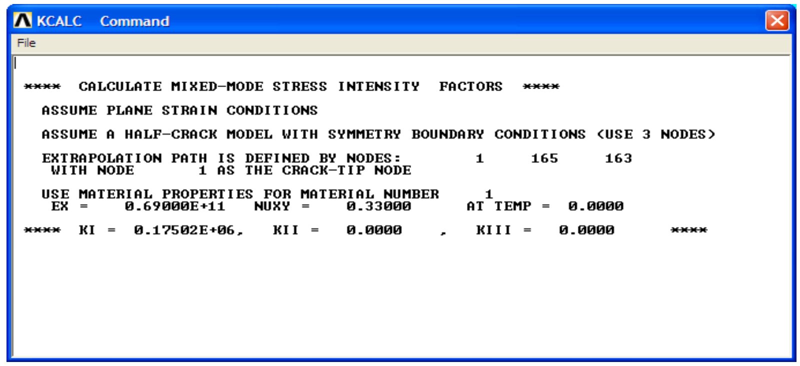

Figure 1.12: Stress intensity factor KCALC results

APPENDIX 3:

RESULT FOR EMPIRICAL CALCULATION AND NUMERICAL METHOD

Table 4.1: K value for $\frac{a}{W}$ ratio from 0.45 to 0.49 for empirical method

W/B	B (m)	0.45	0.46	0.47	0.48	0.49
2.00	0.0250	1.4919	1.5348	1.5796	1.6261	1.6762
2.10	0.0238	1.5665	1.6116	1.6585	1.7074	1.7600
2.20	0.0227	1.6411	1.6883	1.7375	1.7887	1.8438
2.30	0.0217	1.7157	1.7651	1.8165	1.8700	1.9276
2.40	0.0208	1.7903	1.8418	1.8955	1.9513	2.0114
2.50	0.0200	1.8649	1.9185	1.9744	2.0326	2.0952
2.60	0.0192	1.9395	1.9953	2.0534	2.1139	2.1790
2.70	0.0185	2.0141	2.0720	2.1324	2.1952	2.2628
2.80	0.0179	2.0887	2.1488	2.2114	2.2765	2.3466
2.90	0.0172	2.1633	2.2255	2.2904	2.3578	2.4304
3.00	0.0167	2.2379	2.3023	2.3693	2.4391	2.5142
3.10	0.0161	2.3125	2.3790	2.4483	2.5204	2.5980
3.20	0.0156	2.3870	2.4557	2.5273	2.6017	2.6819
3.30	0.0152	2.4616	2.5325	2.6063	2.6830	2.7657
3.40	0.0147	2.5362	2.6092	2.6852	2.7643	2.8495
3.50	0.0143	2.6108	2.6860	2.7642	2.8456	2.9333
3.60	0.0139	2.6854	2.7627	2.8432	2.9269	3.0171
3.70	0.0135	2.7600	2.8394	2.9222	3.0082	3.1009
3.80	0.0132	2.8346	2.9162	3.0012	3.0895	3.1847
3.90	0.0128	2.9092	2.9929	3.0801	3.1708	3.2685
4.00	0.0125	2.9838	3.0697	3.1591	3.2521	3.3523

Table 4.2: K value for $\frac{a}{W}$ ratio from 0.45 to 0.49 for numerical method

B	W/B	0.45	0.46	0.47	0.48	0.49
0.0250	2.00	1.6210	1.6670	1.7150	1.7650	1.8176
0.0238	2.10	1.7027	1.7505	1.8006	1.8531	1.9083
0.0227	2.20	1.7836	1.8337	1.8862	1.9444	1.9992
0.0217	2.30	1.8644	1.9168	1.9717	2.0290	2.0899
0.0208	2.40	1.9452	1.9999	2.0573	2.1174	2.1807
0.0200	2.50	2.0259	2.0829	2.1427	2.2054	2.2713
0.0192	2.60	2.1067	2.1660	2.2282	2.2934	2.3620
0.0185	2.70	2.1874	2.2490	2.3136	2.3814	2.4526
0.0179	2.80	2.2682	2.3321	2.3991	2.4694	2.5433
0.0172	2.90	2.3489	2.4152	2.4846	2.5574	2.6340
0.0167	3.00	2.4296	2.4976	2.5694	2.6448	2.7240
0.0161	3.10	2.5103	2.5811	2.6554	2.7333	2.8152
0.0156	3.20	2.5910	2.6641	2.7408	2.8212	2.9058
0.0152	3.30	2.6716	2.7470	2.8261	2.9090	2.9963
0.0147	3.40	2.7523	2.8300	2.9115	2.9970	3.0869
0.0143	3.50	2.8330	2.9130	2.9969	3.0849	3.1775
0.0139	3.60	2.9137	2.9960	3.0823	3.1756	3.2681
0.0135	3.70	2.9943	3.0789	3.1676	3.2607	3.3586
0.0132	3.80	3.0751	3.1620	3.2531	3.3488	3.4493
0.0128	3.90	3.1557	3.2449	3.3385	3.4388	3.5398
0.0125	4.00	3.2366	3.3281	3.4240	3.5247	3.6306

Table: K_I value for $\frac{a}{w}$ ratio from 0.50 to 0.55 for empirical method

B (m)	w/b	0.50	0.51	0.52	0.53	0.54	0.55
0.0250	2.00	1.7280	1.7817	1.8407	1.9016	1.9642	2.0321
0.0238	2.10	1.8144	1.8708	1.9328	1.9966	2.0624	2.1337
0.0227	2.20	1.9008	1.9599	2.0248	2.0917	2.1606	2.2354
0.0217	2.30	1.9872	2.0490	2.1168	2.1868	2.2588	2.3370
0.0208	2.40	2.0736	2.1380	2.2089	2.2819	2.3570	2.4386
0.0200	2.50	2.1600	2.2271	2.3009	2.3769	2.4552	2.5402
0.0192	2.60	2.2464	2.3162	2.3930	2.4720	2.5534	2.6418
0.0185	2.70	2.3328	2.4053	2.4850	2.5671	2.6516	2.7434
0.0179	2.80	2.4192	2.4944	2.5770	2.6622	2.7498	2.8450
0.0172	2.90	2.5056	2.5835	2.6691	2.7573	2.8480	2.9466
0.0167	3.00	2.5920	2.6725	2.7611	2.8523	2.9462	3.0482
0.0161	3.10	2.6785	2.7616	2.8531	2.9474	3.0445	3.1498
0.0156	3.20	2.7649	2.8507	2.9452	3.0425	3.1427	3.2514
0.0152	3.30	2.8513	2.9398	3.0372	3.1376	3.2409	3.3530
0.0147	3.40	2.9377	3.0289	3.1292	3.2326	3.3391	3.4546
0.0143	3.50	3.0241	3.1180	3.2213	3.3277	3.4373	3.5562
0.0139	3.60	3.1105	3.2071	3.3133	3.4228	3.5355	3.6578
0.0135	3.70	3.1969	3.2961	3.4054	3.5179	3.6337	3.7595
0.0132	3.80	3.2833	3.3852	3.4974	3.6129	3.7319	3.8611
0.0128	3.90	3.3697	3.4743	3.5894	3.7080	3.8301	3.9627
0.0125	4.00	3.4561	3.5634	3.6815	3.8031	3.9283	4.0643

Table: K_I value for $\frac{a}{w}$ ratio from 0.50 to 0.55 for numerical method

B (m)	w/b	0.5	0.51	0.52	0.53	0.54	0.55
0.0250	2	1.8728	1.9311	1.9925	2.0574	2.1259	2.1987
0.0238	2.1	1.9664	2.0276	2.0922	2.1604	2.2324	2.309
0.0227	2.2	2.0601	2.1243	2.1919	2.2635	2.339	2.4193
0.0217	2.3	2.1536	2.2208	2.2916	2.3665	2.4455	2.5295
0.0208	2.4	2.2472	2.3173	2.3913	2.4695	2.552	2.6397
0.0200	2.5	2.3407	2.4138	2.4908	2.5724	2.6584	2.7499
0.0192	2.6	2.4341	2.5102	2.5904	2.6752	2.7648	2.86
0.0185	2.7	2.5276	2.6066	2.6899	2.7781	2.8712	2.9701
0.0179	2.8	2.6211	2.7031	2.7896	2.881	2.9776	3.0803
0.0172	2.9	2.7146	2.7995	2.8891	2.9839	3.084	3.1904
0.0167	3	2.8074	2.8953	2.988	3.0861	3.1896	3.2997
0.0161	3.1	2.9013	2.9922	3.0881	3.1895	3.2966	3.4104
0.0156	3.2	2.9947	3.0886	3.1876	3.2923	3.4029	3.5204
0.0152	3.3	3.088	3.1848	3.2869	3.395	3.509	3.6303
0.0147	3.4	3.1815	3.281	3.3865	3.4978	3.6154	3.7404
0.0143	3.5	3.2748	3.3775	3.4859	3.6006	3.7216	3.8503
0.0139	3.6	3.3683	3.4739	3.5854	3.7034	3.8279	3.9603
0.0135	3.7	3.4739	3.5702	3.6864	3.806	3.9341	4.0702
0.0132	3.8	3.5551	3.6666	3.7844	3.9089	4.0405	4.1803
0.0128	3.9	3.6484	3.7629	3.8838	4.0116	4.1467	4.2902
0.0125	4	3.7419	3.8594	3.9834	4.1146	4.2531	4.4004

Table: K_I value for $\frac{b}{w}$ ratio from 2.0 to 2.4 for empirical method

a/w	A (m)	2	2.1	2.2	2.3	2.4
0.45	0.0225	1.492	1.566	1.641	1.716	1.790
0.46	0.023	1.535	1.612	1.688	1.765	1.842
0.47	0.0235	1.580	1.659	1.738	1.816	1.895
0.48	0.0240	1.626	1.707	1.789	1.870	1.951
0.49	0.0245	1.676	1.760	1.844	1.928	2.011
0.50	0.025	1.728	1.814	1.901	1.987	2.074
0.51	0.0255	1.782	1.871	1.960	2.049	2.138
0.52	0.0260	1.841	1.933	2.025	2.117	2.209
0.53	0.0265	1.902	1.997	2.092	2.187	2.282
0.54	0.027	1.964	2.062	2.161	2.259	2.357
0.55	0.0275	2.032	2.134	2.235	2.337	2.439

Table: K_I value for $\frac{B}{w}$ ratio from 2.0 to 2.4 for numerical method

a/w	A (m)	2	2.1	2.2	2.3	2.4
0.45	0.0225	1.621	1.703	1.784	1.864	1.945
0.46	0.0230	1.667	1.751	1.834	1.917	2.000
0.47	0.0235	1.715	1.801	1.886	1.972	2.057
0.48	0.0240	1.765	1.853	1.944	2.029	2.117
0.49	0.0245	1.818	1.908	1.999	2.090	2.181
0.50	0.025	1.873	1.966	2.060	2.154	2.247
0.51	0.0255	1.931	2.028	2.124	2.221	2.317

0.52	0.0260	1.993	2.092	2.192	2.292	2.391
0.53	0.0265	2.057	2.160	2.264	2.367	2.470
0.54	0.027	2.126	2.232	2.339	2.446	2.552
0.55	0.0275	2.199	2.309	2.419	2.530	2.640

Table: K_I value for $\frac{B}{W}$ ratio from 2.5 to 2.9 for empirical method

a/w	A (m)	2.5	2.6	2.7	2.8	2.9
0.45	0.0225	1.865	1.939	2.014	2.089	2.163
0.46	0.023	1.919	1.995	2.072	2.149	2.226
0.47	0.0235	1.974	2.053	2.132	2.211	2.290
0.48	0.0240	2.033	2.114	2.195	2.276	2.358
0.49	0.0245	2.095	2.179	2.263	2.347	2.430
0.50	0.025	2.160	2.246	2.333	2.419	2.506
0.51	0.0255	2.227	2.316	2.405	2.494	2.583
0.52	0.0260	2.301	2.393	2.485	2.577	2.669
0.53	0.0265	2.377	2.472	2.567	2.662	2.757
0.54	0.027	2.455	2.553	2.652	2.750	2.848
0.55	0.0275	2.540	2.642	2.743	2.845	2.947

Table: K_I value for $\frac{B}{W}$ ratio from 2.5 to 2.9 for numerical method

a/w	A (m)	2.5	2.6	2.7	2.8	2.9
0.45	0.0225	2.026	2.107	2.187	2.268	2.349
0.46	0.023	2.083	2.166	2.249	2.332	2.415
0.47	0.0235	2.143	2.228	2.314	2.399	2.485
0.48	0.024	2.205	2.293	2.381	2.469	2.557
0.49	0.0245	2.271	2.362	2.453	2.543	2.634
0.50	0.025	2.341	2.434	2.528	2.621	2.715
0.51	0.0255	2.414	2.510	2.607	2.703	2.800
0.52	0.026	2.491	2.590	2.690	2.790	2.889
0.53	0.0265	2.572	2.675	2.778	2.881	2.984
0.54	0.027	2.658	2.765	2.871	2.978	3.084
0.55	0.0275	2.750	2.860	2.970	3.080	3.190

Table: K_I value for $\frac{B}{W}$ ratio from 3.0 to 3.4 for empirical method

a/w	A (m)	3	3.1	3.2	3.3	3.4
0.45	0.0225	2.238	2.312	2.387	2.462	2.536
0.46	0.023	2.302	2.379	2.456	2.532	2.609
0.47	0.0235	2.369	2.448	2.527	2.606	2.685
0.48	0.024	2.439	2.520	2.602	2.683	2.764
0.49	0.0245	2.514	2.598	2.682	2.766	2.849
0.50	0.025	2.592	2.678	2.765	2.851	2.938

0.51	0.0255	2.673	2.762	2.851	2.940	3.029
0.52	0.026	2.761	2.853	2.945	3.037	3.129
0.53	*0.0265*	*2.852*	*2.947*	*3.042*	*3.138*	*3.233*
0.54	0.027	2.946	3.044	3.143	3.241	3.339
0.55	0.0275	3.048	3.150	3.251	3.353	3.455

Table: K_I value for $\frac{b}{w}$ ratio from 3.0 to 3.4 for numerical method

a/w	a	3	3.1	3.2	3.3	3.4
0.45	0.0225	2.4296	2.5103	2.5910	2.6716	2.7523
0.46	0.0230	2.4976	2.5811	2.6641	2.7470	2.8300
0.47	0.0235	2.5694	2.6554	2.7408	2.8261	2.9115
0.48	0.0240	2.6448	2.7333	2.8212	2.9090	2.9970
0.49	0.0245	2.7240	2.8152	2.9058	2.9963	3.0869
0.50	0.0250	2.8074	2.9013	2.9947	3.0880	3.1815
0.51	0.0255	2.8953	2.9922	3.0886	3.1848	3.2810
0.52	0.0260	2.9880	3.0881	3.1876	3.2869	3.3865
0.53	0.0265	3.0861	3.1895	3.2923	3.3950	3.4978
0.54	0.0270	3.1896	3.2966	3.4029	3.5090	3.6154
0.55	0.0275	3.2997	3.4104	3.5204	3.6303	3.7404

Table: K_I value for $\frac{B}{W}$ ratio from 3.5 to 4.0 for empirical method

a/w	A (m)	3.5	3.6	3.7	3.8	3.9	4.0
0.45	0.0225	2.6108	2.6854	2.7600	2.8346	2.9092	2.9838
0.46	0.0230	2.6860	2.7627	2.8394	2.9162	2.9929	3.0697
0.47	0.0235	2.7642	2.8432	2.9222	3.0012	3.0801	3.1591
0.48	0.0240	2.8456	2.9269	3.0082	3.0895	3.1708	3.2521
0.49	0.0245	2.9333	3.0171	3.1009	3.1847	3.2685	3.3523
0.50	0.0250	3.0241	3.1105	3.1969	3.2833	3.3697	3.4561
0.51	0.0255	3.1180	3.2071	3.2961	3.3852	3.4743	3.5634
0.52	0.0260	3.2213	3.3133	3.4054	3.4974	3.5894	3.6815
0.53	0.0265	3.3277	3.4228	3.5179	3.6129	3.7080	3.8031
0.54	0.0270	3.4373	3.5355	3.6337	3.7319	3.8301	3.9263
0.55	0.0275	3.5562	3.6578	3.7595	3.8611	3.9627	4.0643

Table: K_I value for $\frac{B}{W}$ ratio from 3.5 to 4.0 for numerical method

a/w	A (m)	3.5	3.6	3.7	3.8	3.9	4
0.45	0.0225	2.8330	2.9137	2.9944	3.0751	3.1557	3.2366
0.46	0.0230	2.9130	2.9960	3.0789	3.1620	3.2449	3.3281
0.47	0.0235	2.9969	3.0823	3.1676	3.2531	3.3385	3.4240
0.48	0.0240	3.0849	3.1756	3.2607	3.3488	3.4366	3.5247
0.49	0.0245	3.1775	3.2681	3.3586	3.4493	3.5398	3.6306
0.50	0.0250	3.2748	3.3683	3.4616	3.5551	3.6484	3.7419

0.51	0.0255	3.3775	3.4739	3.5702	3.6666	3.7629	3.8594
0.52	0.0260	3.4859	3.5854	3.6848	3.7844	3.8838	3.9834
0.53	0.0265	3.6006	3.7034	3.8060	3.9089	4.0116	4.1146
0.54	0.0270	3.7216	3.8279	3.9341	4.0405	4.1467	4.2531
0.55	0.0275	3.8503	3.9603	4.0702	4.1803	4.2902	4.4004