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Research Article

Analyses of Canal Flows in NSP (Nagarjuna Sagar Project) Right Canal Using Flow Pro 2.1 Software

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ABSTRACT

Nagarjuna Sagar Right (Jowhar) Canal Command area spared 37 mandals in Guntur and 23 mandals in Prakasham districts. Hydraulic particulars of main and branch canal was collected from Water resources department, Lingamguntla circle and Ongole circle. The area irrigated under Nagarjuna Sagar Right Canal (Jawahar canal) is 4.75 lakh ha covering Guntur district with 2.84 lakh ha and Prakasam district with 1.91 lakh ha. The computed values at head, middle and tail section s of the main canal were 3.05 m/s, 0.85 m/s and 0.719 m/s and as per the design 3.048 m/s, 0.85 m/s and 0.814 m/s respectively. The variation in values is also not more than 11%. The computed values at head, middle and tail sections of the Addanki branch canal was 0.807 m/s, 0.782 m/s and 0.73 m/s and as per design 0.889 m/s, 0.87 m/s and 0.805 m/s respectively. The maximum variation is even not more than 10%. Darsi branch canal were 0.832 m/s, 0.802 m/s and 0.155 m/s and as per the design 0.82 m/s, 0.753 m/s and 0.135 m/s respectively. The maximum variation is even not more than 14%. Hence, the simulated discharges of flowpro2.1 software compared with designed discharges and velocities and there is no much variation in canal flow.

Keywords: *NSPRCC, Hydraulic particulars, Flowpro, Water surface profile and Critical depth.*

INTRODUCTION

Nagarjuna Sagar Project is built across river Krishna at Nandikonda village of Nalgonda District. The main objective of this Nagarjuna Sagar project is to bring the 9 lakhs hectare of land in to cultivation. The right canal was designed 11,000 cusecs carrying capacity. Rapid growth in industrialization and urbanization in the country resulted as decrease in the availability of water for domestic and irrigation purpose and it creates the high demand in those sectors.

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Guntur and Prakasam Districts of 4.75 lakhs ha area is irrigating by Nagarjuna Sagar Jawahar Canal (Anonymous, 1999). The Canal is divided into 9 branch canals spread across Guntur and Prakasam districts. The Right main canal having Guntur, Zulakallu, Bellarnkonda, Peddanandipadu, Addanki, Eddanapudi, Darsi, Pamidipadu and Ongole branch canals. The scope for resilience and adaptation of large surface irrigation systems is vital to the development of management strategies designed to mitigate the impact of river basin closure on food production and the livelihoods of farmers.

Study area

Nagarjuna Sagar Project Right Canal (Jawahar) Command

The command area lies between the latitudes of 15^0 20' to 16^0 41' 24" N and the longitudes of 79^0 18'44" to 80^0 25' 56" E, encompassing Guntur and Prakasham districts in the state of Andhra Pradesh. The geographical command area consists from block 1 to 22 (GA) as shown in Figure 1.

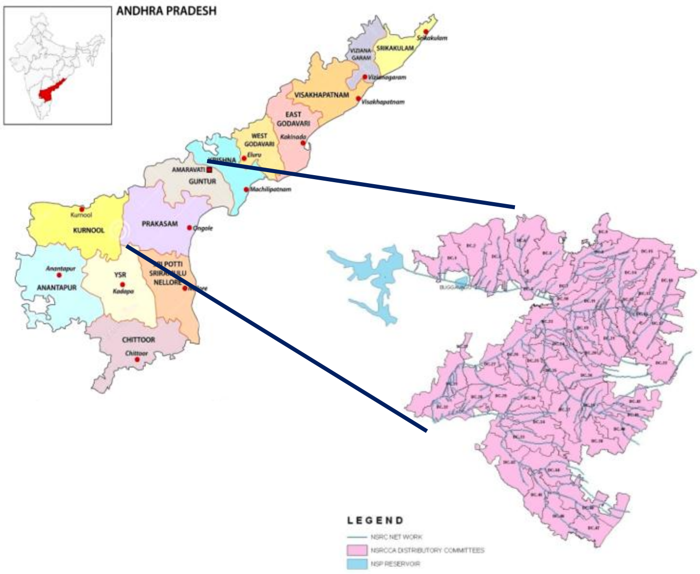


Figure1. Location map of study area

Nagarjuna Sagar Right (Jowhar) Canal Command area spared 37 mandals in Guntur and 23 mandals in Prakasham districts.

Line Diagram of Nagarjuna Sagar Right Main Canal

Milage		Name of the Branch Canal/ Major	Length	Designed discharge in C/S	Block No
M-F-Ft			M-F-Ft		
0-0-000	NAGARJUNA SAGAR RIGHT MAIN CANAL	**Right Canal Head Regulator**		**11,000**	
4-6-000		Pasuvemula Major	1-0-207	5.24	1
7-0-000		Tallapalli Major – I	0-4-365	4.48	2
8-4-000		Tallapalli Major – II	0-4-300	10.13	2
12-1-558		Mallavaram Major	7-7-572	126.18	3
13-6-000		Khambampadu Major	1-6-290	18.53	3
15-7-000		Paluvai Major	5-0-110	64.09	3
20-7-076		Buggavagu O T Regulator		11000	

21-7-00		Rentachintala Major	9-5-655	42.64	4
24-0-110		Daida Major	12-6-360	266.40	4
24-6-440		Charlagudipadu Major	3-4-150	24.16	4
27-3-550		Miryala Major	2-5-495	17.20	5
30-2-220		Ramapuram Major	18-3-018	253.80	5
33-4-000		Pedakodamagundla Major	2-4-402	22.30	5
34-2-655		Cross regulator cum surplus escape		10100	
38-0-330		Kesanupalli Major	6-6-613	68.80	6
40-4-280		**Zulakallu Branch Canal**	1-3-299	564.29	6
42-0-560		Janapadu Major	4-4-000	34.40	6
46-3-000		Guttikonda Major	2-4-535	15.20	7
47-3-550		Kotanemalipuri Major	7-2-330	31.40	7
49-5-570		**Bellamkonda Branch Canal**	11-3-027	645	8&9
52-5-165		**Guntur Branch Canal**	32-1-000	2920	10
52-7-400		O.T. of 1 AR Kothapalli Major(shifted from GBC)		8.64	10
57-0-475		**Addanki Brach Canal**	37-3-272	2469	11
57-2-250		Cross regulator		3947.00	
58-6-543		Inumella D.P		1.07 / 0.25	11A
59-5-300		Inumella Major	8-0-080	23.20	11A
64-2-330		Ipur D.P		1.80	12
66-0-610		Angaluru Major	8-0-440	52.02	12
69-6-049		Perumallapalli Major	20-5-372	192.60	13
74-0-470		Perurupadu Major	3-1-110	28.97	13
78-3-196		Dondapadu Major	6-2-220	48.97	14
81-5-474		Cheekateegalapalem Major	14-1-550	140.14	14
83-2-402		Palakuru Major	0-6-250	5.57	14
85-3-150		Cross regulator cum escape		3346	

Description of Flow pro 2.1

Flow Pro 2.1 Visually design waterways and channels with an intuitive interface. Effortlessly design open-channel waterways, culverts, irrigation channels, sluiceways, and flumes with Flow Pro. Looking for easy to use software to help you plot water surface profiles, or calculates critical depth and slope. Flow Pro saves you time and money by letting you compare more than one hydraulic design alternatives and exports the results to Word or Excel. Visualize depth, flow, and velocity with its built-in graphing software.

The software having File, Channel type, Units, Tools and Help are appeared in the main menu bar. DUFLOW is a microcomputer software package for simulating onedimensional unsteady flow in open-channel systems by Clemmens et al. (1993). In Channel type there is option to select the sections like trapezoidal, circular, U shaped, elongated circular and channel type and name. In units icon select the either SI or English. According to Charles et al. (2018) requires calculated, remote manual adjustments to all the canal check structure gate positions in addition to two flow rate changes made at the head of the canal, followed by are turn to automated upstream control. In Tools icon critical depth and slope, depth, flow rate, slope and Roughness, Orifices, underflow gates, water surface profile and weirs.

Nagarjuna Sagar Right Canal Command area flows were analyzed using the Flow Pro 2.1 version software at three different sections like head section, middle and tail end of the main canal. The input data needed for the software as given in the Table 1 and computed water surface profiles as shown in Figure 1, 2 and 3.

Table 1: Data input of Nagarjuna Sagar Right canal Command area main canal needed for Flow pro 2.1

S No	Particulars	Head section	Middle	Tail end
1	Start Station, m	0	92211+00.000	199616+00.000
2	End station, m	3532+00.000	92593+00.000	202796+00.000
3	Flow rate, m^3/s	311.49	111.77	79.65
4	Width, m	18.593	26.213	18.8976
5	Manning's	0.018	0.0255	0.0255
6	Bottom slope	0.00034072	0.00008333	0.00008333
7	Control depth, m	9.296	3.871	3.871
8	Side slope	0.25:1	2:1	2:1

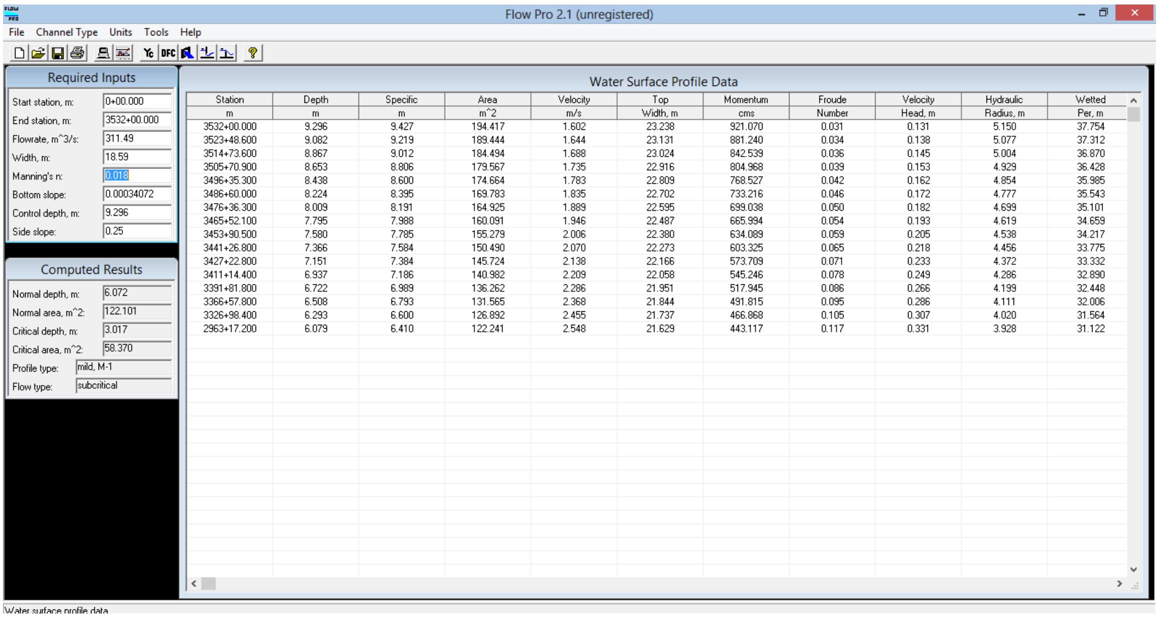
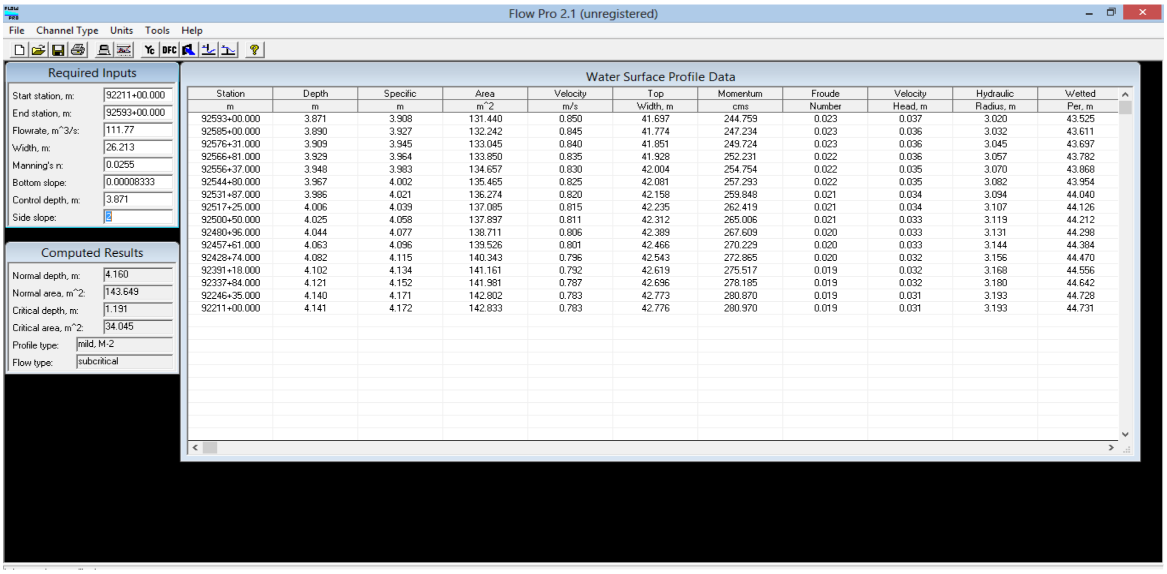
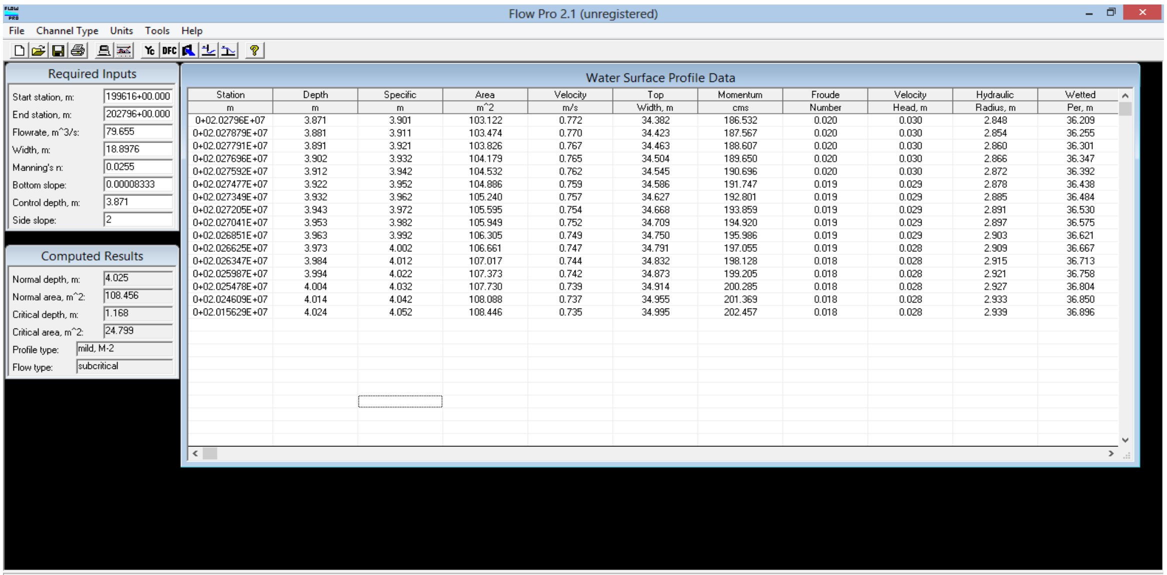


Fig. 1: Flow Pro computed water surface profile data and other parameters at head section of the NSRC command area



Station m	Depth m	Specific m	Area m^2	Velocity m/s	Top Width, m	Momentum cms	Froude Number	Velocity Head, m	Hydraulic Radius, m	Wetted Per, m
92593+00.000	3.871	3.908	131.440	0.850	41.697	244.759	0.023	0.037	3.020	43.525
92585+00.000	3.890	3.927	132.242	0.845	41.774	247.234	0.023	0.036	3.032	43.611
92576+31.000	3.909	3.945	133.045	0.840	41.851	249.724	0.023	0.036	3.045	43.697
92566+81.000	3.929	3.964	133.850	0.835	41.928	252.231	0.022	0.036	3.057	43.782
92556+37.000	3.948	3.983	134.657	0.830	42.004	254.754	0.022	0.035	3.070	43.868
92544+80.000	3.967	4.002	135.465	0.825	42.081	257.293	0.022	0.035	3.082	43.954
92531+87.000	3.986	4.021	136.274	0.820	42.158	259.848	0.021	0.034	3.094	44.040
92517+25.000	4.006	4.039	137.085	0.815	42.235	262.419	0.021	0.034	3.107	44.126
92500+50.000	4.025	4.058	137.897	0.811	42.312	265.006	0.021	0.033	3.119	44.212
92480+96.000	4.044	4.077	138.711	0.806	42.389	267.609	0.020	0.033	3.131	44.298
92457+61.000	4.063	4.096	139.526	0.801	42.466	270.229	0.020	0.033	3.144	44.384
92428+74.000	4.082	4.115	140.343	0.796	42.543	272.865	0.020	0.032	3.156	44.470
92391+18.000	4.102	4.134	141.161	0.792	42.619	275.517	0.019	0.032	3.168	44.556
92337+84.000	4.121	4.152	141.981	0.787	42.696	278.185	0.019	0.032	3.180	44.642
92246+35.000	4.140	4.171	142.802	0.783	42.773	280.870	0.019	0.031	3.193	44.728
92211+00.000	4.141	4.172	142.833	0.783	42.776	280.970	0.019	0.031	3.193	44.731

Fig. 2: Flow Pro computed water surface profile data and other parameters at middle section of the NSRC command area



Station m	Depth m	Specific m	Area m^2	Velocity m/s	Top Width, m	Momentum cms	Froude Number	Velocity Head, m	Hydraulic Radius, m	Wetted Per, m
0+02.02796E+07	3.871	3.901	103.122	0.772	34.382	186.532	0.020	0.030	2.848	36.209
0+02.027879E+07	3.881	3.911	103.474	0.770	34.423	187.567	0.020	0.030	2.854	36.255
0+02.027791E+07	3.891	3.921	103.826	0.767	34.463	188.607	0.020	0.030	2.860	36.301
0+02.027696E+07	3.902	3.932	104.179	0.765	34.504	189.650	0.020	0.030	2.866	36.347
0+02.027592E+07	3.912	3.942	104.532	0.762	34.545	190.696	0.020	0.030	2.872	36.392
0+02.027477E+07	3.922	3.952	104.886	0.759	34.586	191.747	0.019	0.029	2.878	36.438
0+02.027349E+07	3.932	3.962	105.240	0.757	34.627	192.801	0.019	0.029	2.885	36.484
0+02.027205E+07	3.943	3.972	105.595	0.754	34.668	193.859	0.019	0.029	2.891	36.530
0+02.027041E+07	3.953	3.982	105.949	0.752	34.709	194.920	0.019	0.029	2.897	36.575
0+02.026851E+07	3.963	3.992	106.305	0.749	34.750	195.986	0.019	0.029	2.903	36.621
0+02.026625E+07	3.973	4.002	106.661	0.747	34.791	197.055	0.019	0.028	2.909	36.667
0+02.026347E+07	3.984	4.012	107.017	0.744	34.832	198.128	0.018	0.028	2.915	36.713
0+02.025987E+07	3.994	4.022	107.373	0.742	34.873	199.205	0.018	0.028	2.921	36.758
0+02.025478E+07	4.004	4.032	107.730	0.739	34.914	200.285	0.018	0.028	2.927	36.804
0+02.024609E+07	4.014	4.042	108.088	0.737	34.955	201.369	0.018	0.028	2.933	36.850
0+02.015629E+07	4.024	4.052	108.446	0.735	34.995	202.457	0.018	0.028	2.939	36.896

Fig. 3: Flow Pro computed water surface profile data and other parameters at tail end of the NSRC command area

The computed parameters like profile type, flow type, critical depth, critical area, velocity, wetted perimeter and hydraulic radius as shown in the Table 2 and Figure 4.

Table 2: Flowpro2.1 computed values at three levels

S No	Particulars	Head section	Middle	Tail end
1	Profile type	Mild, M-1	Mild, M-2	Mild, M-2
2	Flow type	Subcritical	Subcritical	Subcritical
3	Critical depth, m	3.017	1.190	1.168
4	Critical slope	0.00295	0.00634	0.00646
5	Critical area, m^2	58.37	34.045	24.799
6	Depth (normal), m	9.296	3.871	3.871
7	Velocity, m/s	3.05	0.85	0.719
8	Area, m^2	194.44	131.44	103.12
9	Wetted perimeter, m	37.757	43.525	36.209
10	Hydraulic radius, m	5.150	3.020	2.848

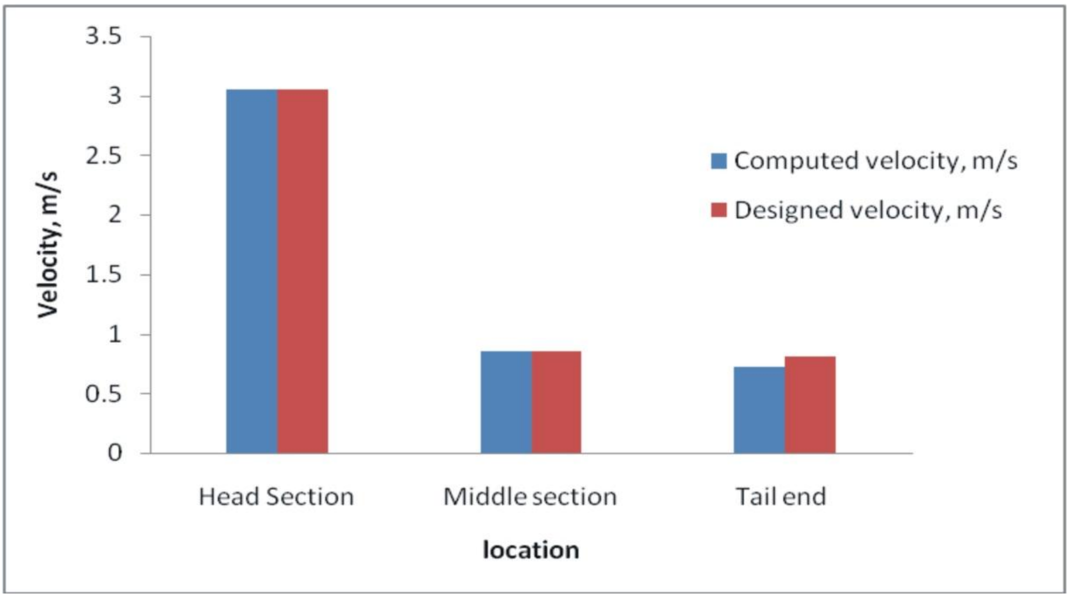


Fig. 4: Comparison of flowpro2.1 computed values with designed values at different locations of NSRJC

The computed values at head, middle and tail section s of the main canal were 3.05 m/s, 0.85 m/s and 0.719 m/s and as per the design 3.048 m/s, 0.85 m/s and 0.814 m/s respectively. The variation in values is also not more than 11%. Similarly, Addanki branch canal of NSRJC input data were tabulated in the following Table 3.

Table 3: Data input for Addanki branch canal of NSRJC

S No	Particulars	Head section	Middle	Tail end
1	Start Station, m	30700+00.000	43721+00.000	199616+00.000
2	End station, m	38025+00.000	50006+00.000	202796+00.000
3	Flow rate, m^3/s	51.578	41.680	79.65
4	Width, m	22.555	18.288	18.8976
5	Manning's	0.025	0.025	0.025
6	Bottom slope	0.0005152	0.0005152	0.0005152
7	Control depth, m	2.438	2.438	2.286
8	Side slope	1.5:1	1.5:1	1.5:1

The computed values at head, middle and tail sections of the Addanki branch canal was shown in following Table 4and Figure 5 as 0.807 m/s, 0.782 m/s and 0.73 m/s and as per the design 0.889 m/s, 0.87 m/s and 0.805 m/s respectively. The maximum variation is even not more than 10%.

Table 4: Computed values at three levels of Addanki branch canal of NSRJC

S No	Particulars	Head section	Middle	Tail end
1	Profile type	Mild, M-1	Mild, M-2	Mild, M-1
2	Flow type	Subcritical	Subcritical	Subcritical
3	Critical depth, m	0.796	0.791	0.731
4	Critical slope	0.00691	0.00698	0.00718
5	Critical area, m^2	18.915	15.412	12.393
6	Depth (normal), m	2.438	2.438	2.286
7	**Velocity, m/s**	**0.807**	**0.782**	**0.73**
8	Area, m^2	63.905	53.297	44.072
9	Wetted perimeter, m	31.345	27.049	24.092
10	Hydraulic radius, m	2.039	1.97	1.829

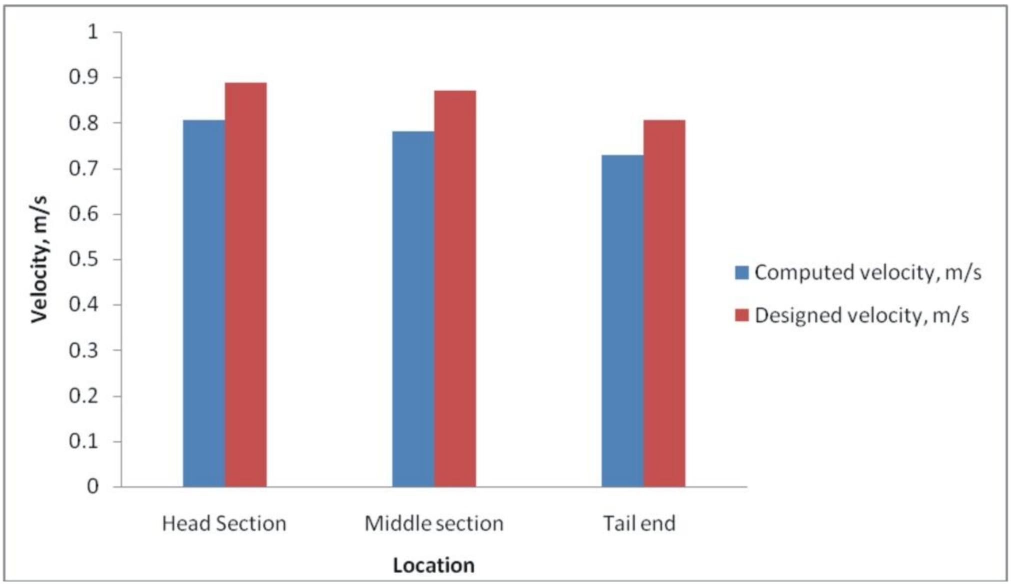


Fig. 5: Comparison of computed values with designed values at different locations of Addanki branch canal of NSRJC

Similarly, Darsi branch canal of NSRJC input data were tabulated in the following Table 5.

Table 5: Data input for Darsi branch canal of NSRJC

S No	Particulars	Head section	Middle	Tail end
1	Start Station, m	30700+00.000	43721+00.000	199616+00.000
2	End station, m	38025+00.000	50006+00.000	202796+00.000
3	Flow rate, m^3/s	51.578	41.680	79.65
4	Width, m	22.555	18.288	18.8976
5	Manning’s	0.025	0.025	0.025
6	Bottom slope	0.0005152	0.0005152	0.0005152
7	Control depth, m	2.438	2.438	2.286
8	Side slope	1.5:1	1.5:1	1.5:1

The computed values at head, middle and tail sections of the Darsi branch canal were shown in following Table 6 and Figure 6.

Table 6: Flow pro2.1 computed values at three levels of Darsi branch canal of NSRJC

S No	Particulars	Head section	Middle	Tail end
1	Profile type	Mild, M-1	Mild, M-2	Mild, M-1
2	Flow type	Subcritical	Subcritical	Subcritical
3	Critical depth, m	1.149	1.022	0.054
4	Critical slope	0.00516	0.00513	0.01349
5	Critical area, m^2	39.396	33.224	0.619
6	Depth (normal), m	3.871	3.871	1.829
7	Velocity, m/s	0.832	0.802	0.155
8	Area, m^2	153.84	127.149	2.908
9	Wetted perimeter, m	49.312	45.726	12.383
10	Hydraulic radius, m	3.12	2.781	0.235

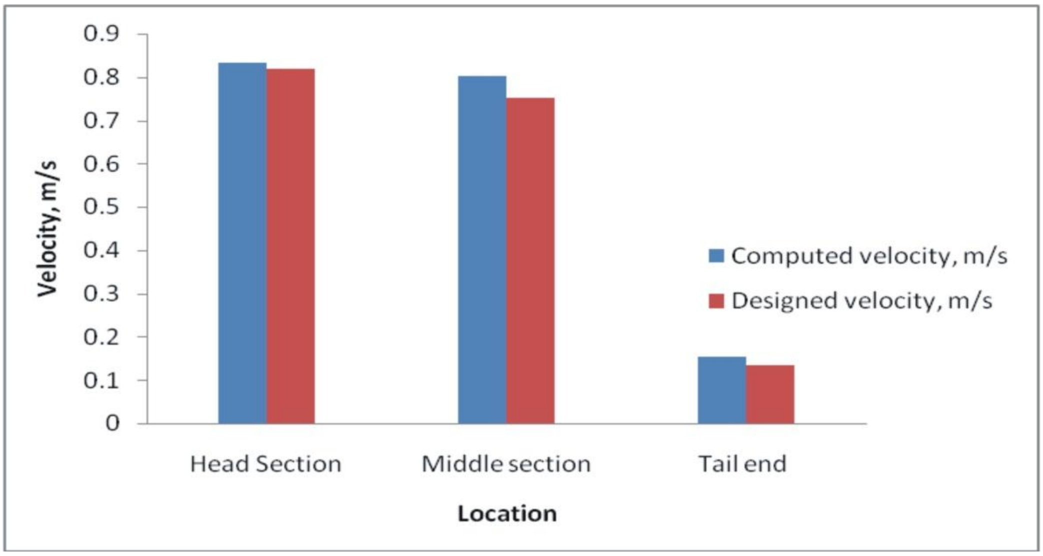


Fig. 6: Comparison of computed values with designed values at different locations of Darsi branch canal of NSRJC

From the above data Darsi branch canal were 0.832 m/s, 0.802 m/s and 0.155 m/s and as per the design 0.82m/s, 0.753 m/s and 0.135 m/s respectively. The maximum variation is even not more than 14%.

Hence, the simulated discharges of flow pro2.1 software compared with designed discharges and velocities and there is no much variation in flow. The maximum variation is occurred only 10%.

CONCLUSIONS

The computed values at head, middle and tail section s of the main canal were 3.05 m/s, 0.85 m/s and 0.719 m/s and as per the design 3.048 m/s, 0.85 m/s and 0.814 m/s respectively. Similarly, Addanki and Darsi branch canals were also computed using Flowpro2.1 software. Hence, flow pro2.1 software simulated discharges compared with designed discharges and velocities and there is no much variation in flow.

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