排水用 波狀튜브인 $3\frac{1}{2}''$ 外徑 "프라코프랙스"의 水理學的 特性에 關한 試驗

Tests of Hydraulic capacity of 3 1½""I.D. "PLACOFLEX" corrugated tubing for drainage.

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摘 要

本實驗은 카나다 매길 대학교의 農工學科 水理實驗室에서 R.S. Brougton教授와 함께 施行 한것으로 現今 歐美 諸國에서 濕地排水用으로 많이 使用하고 있는 內徑 3½" 波狀形 푸라스틱 튜브의 水理學的 特性을 調査硏究한 結果이다.

1. 0.060ft/100ft로 부터 2.630ft/100ft까지의 損失水頭의 範圍에서 2개의 튜브를 통한 流出量은 0.003 c.f.s.에서 0.188c.f.s.로 나타났으며

2. 單一 튜브에 있어서는 유출량을 0.162 c.f.s.로 부터 0.376 c.f.s.로 함으로써 손실 수두는 1.854 ft/100ft에서 9.964ft/100ft로 이들은 現地 施設에서 許容되는 범위이다.

3. 第1項의 유출량과 水頭損失에 있어서 맨닝의 마찰계수 n은 平均値가 0.0145인 0.012로 부터 0.052의 범위내 였다.

4. 유출량 0.030 c.f.s.로 부터 0.188 c.f.s.에 이르는 23번의 측정치와 0.162 c.f.s.로 부터 0.376 a.f.s에 이르는 7번의 측정치에 대한 全體的인 n 값의 平均値는 0.01453이었다.

5. 10ft/100ft의 現地勾配를 고려한 特別시험을 한 結果 비록 유속이나 레이놀드 남버는 높았지만 그림 2에서 보는바와 같이 맨닝의 n 값은 別로 증가되지 않았다. 故로 "PLACOFLEX"波狀形 푸라스틱 튜브에 있어서 n=0.0145가 훌륭한 설계치로써 천거될수 있다고 사료된다.

6. 그림 3의 무디 다이아 그램에서 Darcy-Wiesbach의 마찰 손실계수 f와 레이놀드수의 値 들은 거개가 相對 粗度 (E/D)0.03의 주위에 몰려 있음을 보여주고 있다. 이것은 이 튜브 相對 조도치(0.057)로써 波狀深의 最初의 大略的인 利用에 依하여 期待될수 있는것 보다 더 매끄러운 管이라는 것을 알 수있다. 그래서 波狀深을 相對粗度値얻는데 利用해서는 안될 것이다.

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1. INTRODUCTION

The first investigation of perforated plastic tubing for subsurface drainage were started as early as 1948 by the U.S. Corpssof Engineers and Iowa state university, the history of commercial tubing development and resultant interrest in Europe about a decade age. Production and extensive use of smoothed perforated drainage tubing did not begin until 1959 in Europe and 1964 in the united states, while corrugated drainage tubing was not introduced until about 1963 in Europe, 1966 in the United states and 1968 in Canada. There has been interest during this period in the development of standards for this drainage tubing. Before a standard for a new product is developed, resea rch and experience must be applied toward the development of suitable requirements and associated test methods that will constitute a specification. In this tests we attempted to acquire some hydraulic capacity of 3½" I.D. PLACOFLEX corrugated plastic tube which has been used in common as a drianage tube in the low lands.

2. Materials and Test procedure

Tube data are as follows:

outside diameter: 3.385 inches. Inside diameter: 3.501 inches ridge: 0.029 inches. valley: 0.035inches. web: 0.027 inches. depth of corrugations: 0.20 inches. pitch of corrugations: 0.50 inches. steel piezometer thimbles with 3 piezometer openings equally spaced circumferentially and 2 pipe diameters from the thimbles ends were installed at each end of two lengths of the 3½" I.D. PLACOFLEX corrugated tubing. The inside diameter of the thimbles was 3.625 inches approximately that of the mean flow diameter in the plastic tube to avoid acceleration or deceleration of the flow. The lengths were south tube 101.46 ft. and north tube 100.58ft. The head loses were converted to feet per 100ft. of tube by appropiate calculations. The corrugated plastic tube was aligned by placing it within 6 inch aluminium irriation tubes set in a strainght line. Water was supplied to the tubing by a laboratory pump. The discharge from the tube was measured by calibrated laboratory weir. The two tests lengths of measured by a calibrated laboratory weir. The two tests lenths of ltubing were connected in series so that one discharge setting gave duplicaet measurements of friction loss.

For discharge up to 0.126 cfs. water-air manometers were used. For discharge from 0.120 to 0.376 cfs. water mercury manometers were used. The lenth and diameter of the test pipe was checked periodically during the tests as the flow rate and head losses wera increased. When the flow rate was adjusted to a value higher than 0.188 cfs, the south pipe was noticed to begin elongating at its high pressure end. Since a good range of head losses covering perhaps 95% of field slope drain tube applica ion onditions had been reached by this time the, tests were stopped.

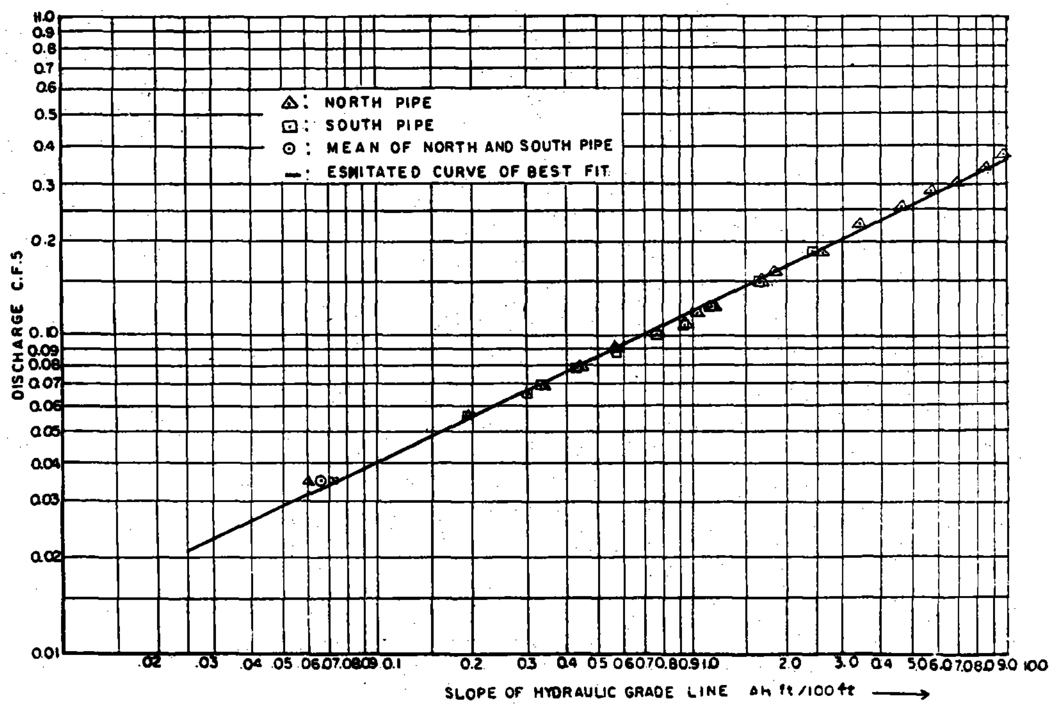

Fig 1.

The south lenth of tubing was then rreeplaced by an irrigation pipe and water was supplied to the high elevation end of the north tube. Since this arrangement reduced the internal pressure in the tube, it was possible to carry the flows to head loses up to 10 ft/100ft. of tube without changing the dimensions of the tube without changing the dimensions of the tube.

3. Results and Discussion.

With full pipe flow conditions, for a range of head losses from 0.060 ft 100/ft. to 2.630 ft/100 ft., the flow through the two tubes ranged from 0.003 cfs to 0.188 cfs. (Fig 1) This covers the head losses involved in the majority of field inst allations. The manning friction coefficient varied from 0.012 to 0.0152 with an average 12 flow rates from valve settings 4 to 15 used on each of the two 100 ft. lenths of pipe were between 0.0139 and 0.015 as we can see at Table 2. The one value of 0.012 was obtained at the lowest flow rate. Small errors in piezometer readings such as could be introduced by meniscus effects and pressure fluctuations would have proportion-atelly larger effects on the value of n at the low head loss end of the scale than would the same experimental errors at higher head losses and flow rates.

The overall average valve of Manning'sn for the 23 measurements between flow rates of 0.30 cfs and 0.188 cfs and the 7 measurements betwe-en 0.162 cfs and 0.376 cfs was n=0.1453.

Table 1 Discharges, piezometee's readings and slopes in the low presure.

Valve Position	Weir Head (mm)	Q (cfs)	Piezometers(H_2O. Low Pressure) South pipe H_1 (in)	H_2 (in)	$\triangle H_{12}$ (H_1-H_2)	Mean $\triangle H_{12}$	North pipe H_3 (in)	H_4 (in)	$\triangle H_{34}$ (H_3-H_4)	Mean $\triangle H_{34}$	Water Temp-(°F)	$\triangle H_{12}$/100ft (south)	$\triangle H_{34}$/100ft (north)
1	0	0	19.30 19.30 19.30	19.30 19.30 19.30	0 0 0	0	19.25 19.20 19.20	19.35 19.40 19.40	—0.10 —0.20 —0.20	—0.166	72°	0	—
2	23.0	0.003	19.60 19.60 19.60	19.55 19.55 19.55	0.05 0.05 0.05	0.05	19.50 19.50 19.50	19.60 19.60 19.60	—0.10 —0.10 —0.10	—0.10	—	0.00412	—
3	25.5	0.0035	19.70 19.70 19.40	19.70 19.70 19.40	0 0 0.30	0.100		19.70 19.70 19.70	—0.10 —0.10 —0.10	—0.10	—	0.009	—
4	74.0	0.0360	23.05 23.05 23.05	22.15 22.15 22.15	0.90 0.90 0.90	0.900	21.80 21.80 21.80	21.03 21.03 21.03	0.77 0.77 0.77	0.77	—	0.074	0.0606
5	96.4	0.0560	28.05 28.10 28.10	25.60 25.60 25.60	2.45 2.50 2.50	2.483	24.60 24.60 24.60	22.20 22.90 22.90	3.55 3.55 3.55	3.55	—	0.204	0.198
6	106.3	0.0660	31.70 31.70 31.70	28.00 28.00 28.00	3.70 3.70 3.70	3.70	26.45 26.45 26.45	22.90 22.90 22.90	3.55 3.55 3.55	3.55	—	0.304	0.294
7	109.5	0.0710	32.80 32.80 32.80	28.70 28.70 28.70	4.10 4.10 4.10	4.10	27.00 27.00 27.00	22.90 22.90 22.90	4.10 4.10 4.10	4.10	—	0.337	0.340
8	116.5	0.080	35.80 35.70 35.70	30.40 30.40 30.40	5.40 5.30 5.30	5.33	28.20 28.10 28.10	22.70 22.70 22.70	5.50 5.40 5.40	5.43	—	0.439	0.450
9	122.8	0.090	40.50 40.70 40.40	33.60 33.60 33.70	6.90 7.10 6.70	6.90	30.70 30.65 30.78	23.90 23.80 23.85	6.80 6.85 6.85	6.83	—	0.568	0.566
10	131.3	0.102	47.50 47.40 47.50	38.05 38.10 38.05	9.45 9.30 9.45	9.40	34.40 34.40 34.40	25.05 25.05 25.05	9.35 9.35 9.35	9.35	—	0.772	0.774

11	137.0	0.112	53.80 53.50 53.40	42.20 42.20 42.20	11.60 11.30 11.20	11.36	37.70 37.75 37.60	26.40 26.40 26.05	11.30 11.35 11.25	11.30		0.930	0.936
12	142.5	0.126	60.50 60.60 60.50	46.80 46.90 46.80	13.70 42.40 42.40	13.70	42.40 42.40 42.40	27.80 27.80 27.80	14.60 14.60 14.60	14.60	73°	1.140	1.209
13	139.7	0.120	29.90 29.90 29.90	30.95 30.95 30.95	1.05 1.05 1.05	1.05 (Hg) 13.18 (H_2O)	30.70 30.70 30.70	31.75 31.75 31.75	1.05 1.05 1.05	1.05 (Hg) 13.18 (H_2O)	70°	1.082	1.019
14	154.3	0.150	29.60 29.62 29.58	31.20 31.20 31.20	1.60 1.58 1.52	1.60 20.08	30.40 30.41 30.39	32.00 31.98 32.01	1.60 1.57 1.62	1.60 20.08	—	1.649	1.663
15	171.3	0.188	29.20 29.18 29.22	31.55 31.50 31.60	2.35 2.32 2.38	2.35 29.49	29.95 29.92 29.92	32.45 32.45 32.45	2.50 2.53 2.53	2.52 31.75	—	2.422	2.63
16	185.5	0.228	—	—	—	—	—	—	—	—	—	—	—
17	159.4	0.162	—	—	—	—	30.10 30.15 30.13	31.90 31.88 31.92	1.80 1.73 1.79	1.773 22.25	66.5°	—	1.854
18	184.4	0.225	—	—	—	—	29.25 29.20 29.30	32.65 32.70 32.60	3.40 3.50 3.30	3.40 42.67	—	—	3.535
19	195.6	0.258	—	—	—	—	28.70 28.67 28.72	33.15 33.20 33.18	4.45 4.53 4.46	4.48 56.22	—	—	4.658
20	204.5	0.286	—	—	—	—	28.20 28.15 28.22	33.60 33.65 33.68	5.40 5.50 5.36	5.42 68.02	—	—	5.636
21	213.1	0.316	—	—	—	—	27.50 27.55 27.55	34.20 34.20 34.20	6.70 6.65 6.65	6.66 83.67	—	—	6.932
22	222.7	0.348	—	—	—	—	26.75 26.80 26.70	34.95 34.90 35.00	8.20 8.10 8.30	8.20 102.9	—	—	8.526
23	230.2	0.376	—	—	—	—	26.00 26.05 25.95	35.60 35.55 35.60	9.60 9.50 9.65	9.58 120.26	—	—	9.964

※ For these lests ⑰～㉓ Temp of water was 66.5° F $v=1.14\times10^{-5}$ ft^2/sec

Even for higher velocites and higher Reynolds numbers the Mannings n value did not increase.

For the 7 flow rates from valve position 17 to 32 Mannings n was very stable ranging only from 0.045 to 0.0147 with a mean value of 0.0146 as you can see at Table 2. A change from the laboratory water temperature of about 72° F. to a field water condition of 40° F would cause an increase in kinematic viscosity from 1.04×10 to 1.66×0 ft/sec., a 1.6 fold increase.

Table 2. Velocity, Reynold's number, friction factor and manning's n.

Valve Position	Q cfs	V (ft/sec)	$\frac{H_L}{L}$ South	$\frac{H_L}{L}$ North	Re (ft^2/sec)	South pipe		North pipe	
						f	n	f	n
1	0	0	—	0	0	0	0	—	—
2	0.0030	0.0449	0.000041	—	0.1277×10^4	0.385	0.0374	—	—

3	0.0035	0.0524	0.000091	—	0.1490×10^4	0.6191	0.0475	—	—
4	0.0300	0.4492	0.00074	0.00061	0.1532×10^5	0.0688	0.0132	0.0564	0.01200
5	0.0560	0.8386	0.00204	0.00198	0.2380×10^5	0.05450	0.0141	0.0507	0.01391
6	0.0660	0.9883	0.00304	0.00294	0.2810×10^5	0.05847	0.0146	0.0564	0.01438
7	0.0710	1.0632	0.00337	0.00340	0.3023×10^5	0.05602	0.0143	0.0565	0.01439
8	0.0800	1.1980	0.00459	0.00450	0.3406×10^5	0.05747	0.0145	0.0583	0.01469
9	0.0900	1.3477	0.00568	0.00566	0.3832×10^5	0.05875	0.0147	0.0585	0.01464
10	0.1020	1.5274	0.00772	0.00774	0.4343×10^5	0.06216	0.0151	0.0623	0.01510
11	0.7720	1.6772	0.00930	0.00936	0.4768×10^5	0.06211	0.0151	0.0625	0.01518
12	0.1260	1.8868	0.0110	0.01209	0.5364×10^5	0.06016	0.0148	0.0638	0.01522
13	0.1200	1.7970	0.01082	0.01019	0.4950×10^5	0.06295	0.0152	0.0593	0.01473
14	0.1500	2.2462	0.01949	0.01663	0.6187×10^5	0.06140	0.0150	0.0620	0.01505
15	0.1880	2.8152	0.02422	0.02630	0.7754×10^5	0.05741	0.0135	0.0623	0.01509
16	0.2280	3.4142							

Valve position	Q (cfs)	V (ft/sec)	$\frac{H_L}{L}$ (North)	Re (ft^2/sec)	North pipe f	North pipe n
17	0.162	2.425	0.01854	0.6205×10^5	0.0592	0.0147
18	0.225	3.368	0.03535	0.8620×10^5	0.0585	0.0146
19	0.258	3.862	0.04658	0.9884×10^5	0.0578	0.0147
20	0.286	4.281	0.05636	1.0656×10	0.0581	0.0145
21	0.316	4.731	0.06932	1.2106×10^5	0.0560	0.0146
22	0.035	5.209	0.08526	1.3332×10^5	0.0590	0.0147
23	0.376	5.629	0.09964	1.4404×10^5	0.0590	0.0147

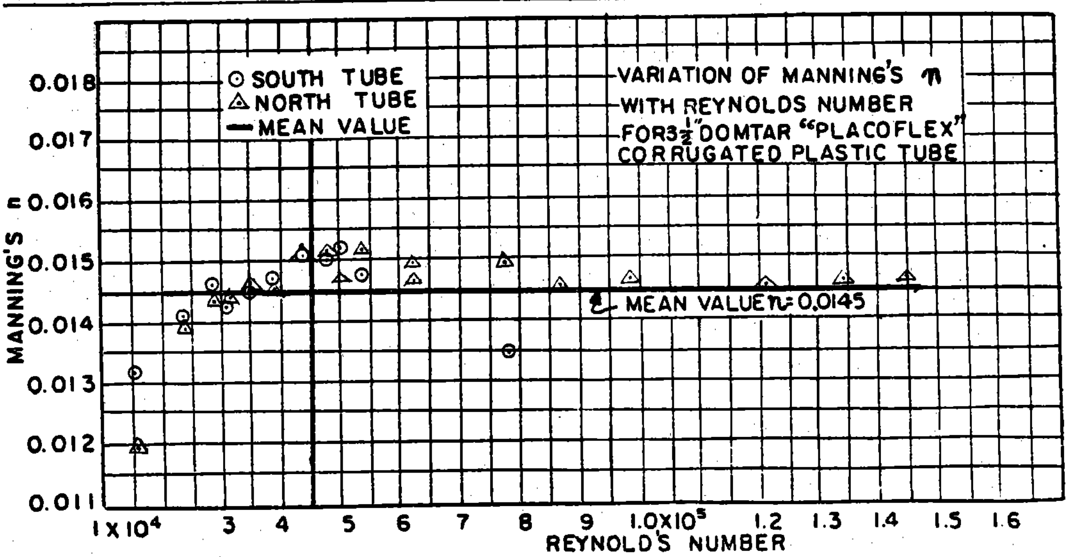

Fig. 2

Thus for the same flow velocity in the field as in the labolatory the field Reynolds number could be 1.6 times less than the laboratory Reynolds number. since the mannings n has remained relatively constant over a range of test Reynolds numbers from 0.1532x 10 to 1.440×10, a 9.4 fold increase in Reynolds numqers, there seems little point in trying to adjust the Mannings n to be used for field design flows from that obtained in the laboratory.

A few of farm drain tubes are laid on slopes as steep as /10ft 100ft. for special purposes, It is seen from the data and Figure 2 that there was only small fluctuation in Mannings n around a mean value of 0.0145 for the tests conducted over this range of slopse. From the plotting of the calculated Darcy-Wiesbach friction factor f is Reynolds number on a print of the Moody diagram, Figure 3, it is seen that the data points are mostly clustered around a relative roughness line E/D of 0.03. This is smoother than might be predicted by a first usage of the corrugation depth as a relative roughness (0,20/3,50=0,0570)

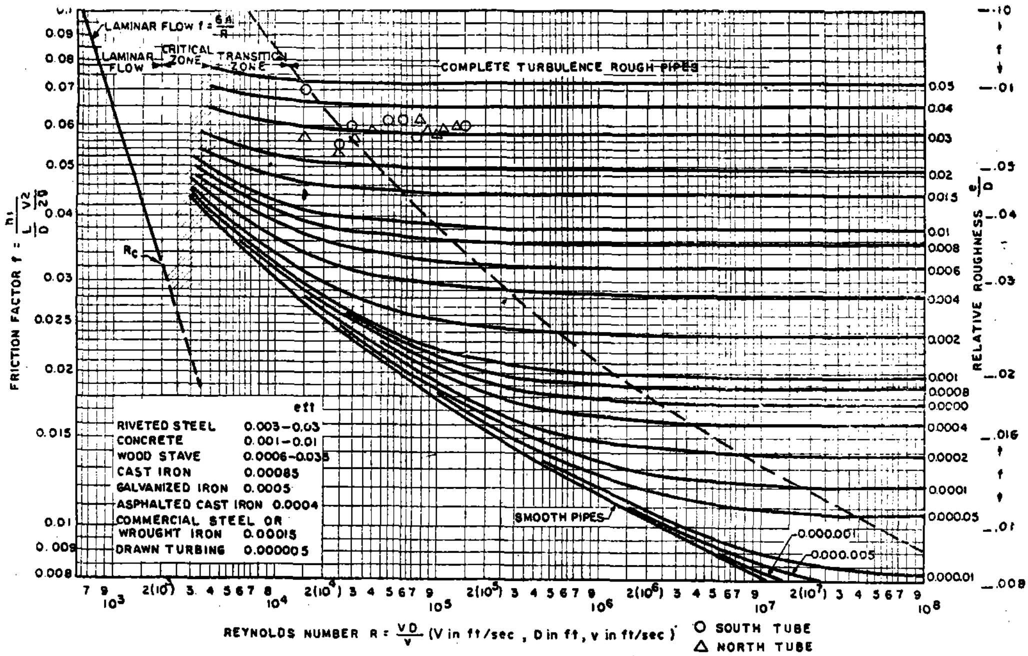

Fig. 3

4. CONCLUSIONS

1. For a single tube head losses were carried over a range from 1.854 ft/100ft. to 9.964 ft/100ft. with discharges rangings from 0.162 cfs to 0.376cfs.
2. For the head losses and discharges covered with the two lengths of pipe, the Mannings friction coefficient was found to vary from 0.012 to with an average value of 0.0145.
3. The special test carried out to extend the data toan extreme case of field slope of 10ft /100ft. showed that even for higher velocites and higher Reynolds numbers the mannings n value did not incre.ase. for the 7 flow rates from valve position 17 to 23 mannings n was very stable ranging only from 0.0145 to 0.0147 with a mean value of 0.0146.
4. Since the majority of farm drain tubes are laid on slopes from 0.1 ft/ 100ft. to 1.0ft/100ft. and a few are laid on slopes of 10ft/100 ft. for special purposes, and since it is seen from the data and Figure 2 that there was only a small fluctuation in mannings n value, it is recommended that n=0.0145 be treated as a good design value for the PLACOFLEX corrugated plastic tube.

5. At the Darcy-Wiesbach friction factor f is Reynolds number on a print of the moody diagram, Figure3, they are clustered around a relative roughness line E/D of 0.03. This is smoother than might be predicted by a first approximation usage of the corrugation depth as a relative roughness value. This plotting does show however, that the flow is essentially in the complete turblence region and that a relatively constant value of f and Mannings n can be expected over the range of Reynolds numbers likely to occur in the field.

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博 士 學 位

當學會 會員이 年初에 名譽로운 博士學位를 받은바 이會員에 對하여 全會員과 더불어 祝賀드리며 앞으로 農工技術開發에 계속 이바지 하실줄 믿습니다.

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學位名 農 學 博 士

學位論文 흙의 粒度分布가 다짐 効果와 壓縮強度 및 透水係數에 주는 影響에 關한 硏究

學位授與年月日 1972. 2. 25

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最終出身學校 서울大學校農科大學院修了

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