Kanaflex

Kanaflex KanaPipe

High-Strength Steel Reinforced HDPE Pipe

Kanaflex®

MADE IN THE USA

High-Strength Steel Reinforced HDPE Pipe




Kanaflex Steel Reinforced Polyethylene Pipe (SRPE) Kanapipe for Storm and Sanitary Sewer Applications-12"-72"

Kanaflex Steel Reinforced Polyethylene Pipe (SRPE) is the sound solution for storm drainage, combined sewer overflow, retention/ detention, low head irrigation, culverts, slip lining, and sanitary sewer mainline applications.

Kanapipe combines the strength of steel and the long term durability of HDPE, utilizing quality virgin resin and high grade alloy steel. Kanapipe's composite structural design produces higher stiffness ratings and deeper burial allowances (over 50') than standard dual wall pipe products. Smooth wall interior (.010) for full flow rates, and chemical resistance to corrosive soils, discharges, and chemicals. Pressure resistant to both vertical and horizontal installations.

Specify Kanaflex Kanapipe with confidence, meeting or exceeding the requirements of ASTM F2435, D2321, D2412, D3212, F449, A1008, F2136, F477, and AASHTO M-294 standards.

Member:

Standard and Custom Lengths

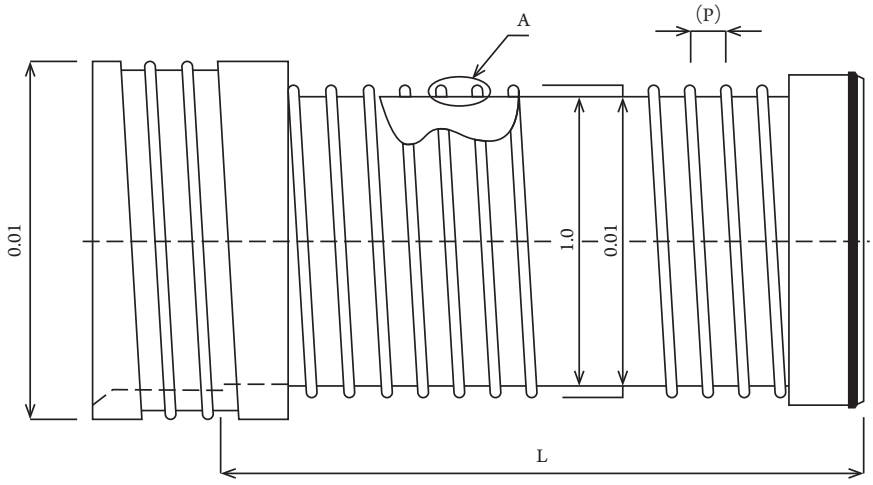
Kanaflex Kanapipe is available in standard lengths of 20' and 24' lengths as well custom lengths up to 40' in Bell x Spigot, PE x PE, or combination configurations. Ideal for culvert rehab, slip lining, and significantly reducing installed joints on storm and sanitary sewer layouts. Longer lengths improve the integrity of pipelines, eliminates waste, and reduces the cost of installation.

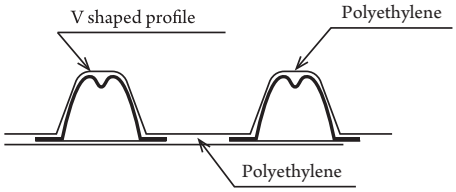
39 foot PE x PE 36" Kanapipe slip line Mendon, MA

Sanitary Sewer Joint

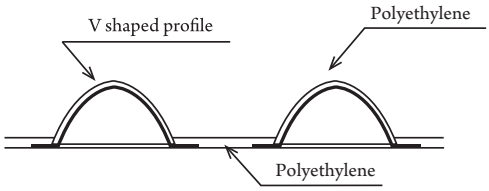
Kanapipe's engineered bell and spigot gasketed joint is a watertight, high performance connection with an enhanced leakage rating of 20 psi, significantly exceeding the ASTM D3212 minimum allowable leakage of 10.8 psi for sanitary sewers. Eliminates damage to roadway/parking lot pavements (cracking joint shifting, sinkhole depressions) due to infiltration/exfiltration commonly caused by using concrete pipe. Third party tested and certified, Kanapipe's joint is also internationally rated and certified to be earthquake resistant.

Pipe & Joint Dimensions





Enlarged View A
12”~42”



Enlarged View A
48”~60”

Nominal Diameter		Pipe Body						Pipe Joint	
		ID		OD_1		Pitch		OD_2	
inches	mm	inches	mm	inches	mm	inches	mm	inches	mm
12	300	12.0	305	13.3	338	2.36	60	15.9	405
15	375	15.0	381	16.3	413	2.36	60	18.9	480
18	450	18.0	457	19.3	489	2.44	62	22.0	560
24	600	24.0	610	25.7	653	2.76	70	28.5	725
30	750	30.0	762	32.2	817	3.54	90	35.0	890
36	900	36.0	915	38.2	970	3.94	100	41.1	1,045
42	1,050	42.0	1,067	44.4	1,128	3.94	100	47.4	1,205
48	1,200	48.0	1,220	52.0	1,320	6.30	160	57.7	1,465
60	1,500	60.0	1,524	65.2	1,656	7.68	195	70.9	1,801

* For pipe larger than 60" O.D., contact your Kanaflex representative

Allowable Burial

AASHTO — Allowable Burial Min/Max (ft)										
Diameter	Class I		Class II			Class III			Class IV	
(inches)	Compacted	Dumped	95%	90%	85%	95%	90%	85%	95%	90%
12	69	37	54	37	35	38	30	27	27	25
15	59	30	47	30	26	30	22	18	18	16
18	50	28	45	28	23	29	19	15	14	12
24	62	27	45	27	22	29	20	16	16	14
30	42	25	38	25	23	23	17	13	13	11
36	27	22	25	22	19	23	15	11	10	8
42	41	22	25	22	22	23	15	11	11	9
48	31	18	25	18	16	18	12	9	9	8
60	28	19	22	19	12	16	11	8	8	7

* For greater burial depth requirements, contact your Kanaflex representative.
** For 66" and 72" pipe requirements, contact your Kanaflex representative.

Minimum Pipe Stiffness

Minimum Pipe Stiffness Values Kanapipe Dual Wall SRPE															
Nominal Size		Inside Diameter		Outside Diameter		Pitch		Waterway Wall Thickness (min)		Minimum Steel Thickness		Minimum Pipe Stiffness		Minimum Pipe Stiffness (HS)	
inches	mm	inches	mm	inches	mm	inches	mm	inches	mm	inches	mm	MPa	psi	MPa	psi
12	300	12.0	305	13.3	338.0	2.36	60.0	0.059	1.5	0.0118	0.30	0.55	80	0.55	80
15	375	15.0	381	16.3	413.0	2.36	60.0	0.059	1.5	0.0118	0.30	0.55	80	0.45	65
18	450	18.0	457	19.3	489.0	2.44	62.0	0.059	1.5	0.0118	0.30	0.275	40	0.40	58
24	600	24.0	610	25.7	653.0	2.76	70.0	0.059	1.5	0.0118	0.30	0.235	34	0.40	58
30	750	30.0	762	32.2	817.0	3.54	90.0	0.079	2.0	0.0118	0.30	0.200	29	0.40	58
36	900	36.0	915	38.2	970.0	3.94	100.0	0.079	2.0	0.0118	0.30	0.155	22.5	0.40	58
42	1,050	42.0	1,067	44.4	1,128.0	3.94	100.0	0.079	2.0	0.0118	0.30	0.145	21	0.40	58
48	1,200	48.0	1,220	52.0	1,320.0	6.30	160.0	0.157	4.0	0.0118	0.30	0.135	20	0.40	58
60	1,500	60.0	1,524	65.2	1,656.0	7.68	195.0	0.157	4.0	0.0118	0.30	0.105	15	0.40	58

* Minimum stiffness values at 5% deflection. For greater stiffness requirements, contact your Kanaflex representative.
** For 66" and 72" pipe requirements, contact your Kanaflex representative.

Material Characteristics

Polyethylene Materials
The polyethylene compound satisfies the requirements of the cell class of 333430C as it prescribes it in the standard D3350.

Steel Materials
The steel material satisfies to standard A1008/A1008M or A653/A653M. Smallest zinc painting designation 20Z which the galvanizing painting is prescribed in the standard A591/A591M.

Chemical Resistance (Polyethylene)						
Chemical		Temperature		Chemical	Temperature	
		20°C °F	60°C °F		20°C °F	60°C °F
Sulfuric acid	10 - 50%	●	●	Sodium carbonate	●	●
Hydrochloric acid	10%	●	●	Calcium chloride	●	●
	35%	●	●	Methyl alcohol	●	▲
Nitric acid	10%	●	●	Ammonia water	●	●
	40%	●	▲	Hydrogen peroxide 30%	●	●
Hydrogen fluoride	75%	●	▲	Gasoline	▲	✖
Phosphoric acid	30%	●	●	Acetone	▲	✖
Formic acid	40%	●	●	Aniline	●	✖
Acetic acid	10%	●	●	Carbon tetrachloride	✖	✖
Glacial acetic acid		●	✖	Glycerin	●	▲
Caustic soda	50%	●	●	Benzene	✖	✖
Caustic potash	10%	●	●			

●... OK to Use ▲... Use with Caution ✖ ... Do Not Use

Pipe Weight (lbs/ft)		
Pipe Size (in)	PE x PE	B x S
12	3.32	3.86
15	4.12	4.76
18	4.80	5.70
24	8.78	10.06
30	11.86	13.71
36	20.23	22.90
42	28.0	31.59
48	39.52	45.37
60	51.15	60.30
66	57.24	
72	64.10	

Kanapipe Super A Maximum Flow Rate

Roughness coefficient n=0.010

Flow Velocity/Rate										
Nominal Diameter in (mm)	12 (300)		15 (375)		18 (450)		24 (600)		30” (750)	
Inside Diameter ft (m)	1.00 (0.305)		1.25 (0.381)		1.50 (0.457)		2.00 (0.610)		2.50 (0.762)	
Gradient	Flow Velocity ft/s (m/s)	Flow Rate ft^3/s (m^3/s)	Flow Velocity ft/s (m/s)	Flow Rate ft^3/s (m^3/s)	Flow Velocity ft/s (m/s)	Flow Rate ft^3/s (m^3/s)	Flow Velocity ft/s (m/s)	Flow Rate ft^3/s (m^3/s)	Flow Velocity ft/s (m/s)	Flow Rate ft^3/s (m^3/s)
1/10	18.62 (5.674)	14.62 (0.414)	21.60 (6.584)	26.52 (0.751)	24.39 (7.435)	43.05 (1.219)	29.68 (9.046)	93.27 (2.641)	34.41 (10.488)	168.91 (4.783)
1/20	13.16 (4.012)	10.35 (0.293)	15.28 (4.656)	18.75 (0.531)	17.25 (5.257)	30.44 (0.862)	20.99 (6.397)	65.97 (1.868)	24.33 (7.416)	119.43 (3.382)
1/30	10.75 (3.276)	8.44 (0.239)	12.47 (3.801)	15.29 (0.433)	14.08 (4.292)	24.86 (0.704)	17.14 (5.223)	53.85 (1.525)	19.87 (6.055)	97.50 (2.761)
1/40	9.31 (2.837)	7.31 (0.207)	10.80 (3.292)	13.24 (0.375)	12.19 (3.717)	21.54 (0.610)	14.84 (4.523)	46.65 (1.321)	17.20 (5.244)	84.44 (2.391)
1/50	8.32 (2.537)	6.53 (0.185)	9.66 (2.944)	11.87 (0.336)	10.91 (3.325)	19.25 (0.545)	13.27 (4.046)	41.71 (1.181)	15.39 (4.690)	75.54 (2.139)
1/100	5.89 (1.794)	4.63 (0.131)	6.83 (2.082)	8.37 (0.237)	7.72 (2.351)	13.63 (0.386)	9.39 (2.861)	29.49 (0.835)	10.88 (3.317)	53.43 (1.513)
1/200	4.16 (1.269)	3.28 (0.093)	4.83 (1.472)	5.93 (0.168)	5.45 (1.662)	9.64 (0.273)	6.64 (2.023)	20.87 (0.591)	7.69 (2.345)	37.75 (1.069)
1/300	3.40 (1.036)	2.68 (0.076)	3.94 (1.202)	4.84 (0.137)	4.45 (1.357)	7.88 (0.223)	5.42 (1.652)	17.02 (0.482)	6.28 (1.915)	30.83 (0.873)
1/400	2.94 (0.897)	2.30 (0.065)	3.42 (1.041)	4.20 (0.119)	3.86 (1.176)	6.82 (0.193)	4.69 (1.430)	14.76 (0.418)	5.44 (1.658)	26.70 (0.756)
1/500	2.63 (0.802)	2.08 (0.059)	3.05 (0.931)	3.74 (0.106)	3.45 (1.051)	(6.07 (0.172)	4.20 (1.279)	13.17 (0.373)	4.87 (1.483)	23.87 (0.676)
1/1000	1.86 (0.567)	1.45 (0.041)	2.16 (0.658)	2.65 (0.075)	2.44 (0.743)	4.31 (0.122)	2.97 (0.905)	9.32 (0.264)	3.44 (1.049)	16.88 (0.478)

Flow Velocity/Rate								
Nominal Diameter in (mm)	36 (900)		42 (1050)		48 (1200)		60 (1500)	
Inside Diameter ft (m)	3.00 (0.915)		3.50 (1.067)		4.00 (1.220)		5.00 (1.524)	
Gradient	Flow Velocity ft/s (m/s)	Flow Rate ft^3/s (m^3/s)	Flow Velocity ft/s (m/s)	Flow Rate ft^3/s (m^3/s)	Flow Velocity ft/s (m/s)	Flow Rate ft^3/s (m^3/s)	Flow Velocity ft/s (m/s)	Flow Rate ft^3/s (m^3/s)
1/10	38.84 (11.837)	275.07 (7.789)	43.02 (13.112)	413.96 (11.722)	47.01 (14.328)	591.49 (16.749)	54.52 (16.619)	1070.49 (30.313)
1/20	27.46 (8.370)	194.48 (5.507)	30.42 (9.272)	292.72 (8.289)	33.24 (10.132)	418.27 (11.844)	38.56 (11.752)	757.01 (21.436)
1/30	22.42 (6.834)	158.81 (4.497)	24.84 (7.570)	239.01 (6.768)	27.14 (8.273)	341.53 (9.671)	31.48 (9.595)	618.04 (17.501)
1/40	19.42 (5.918)	137.52 (3.894)	21.51 (6.556)	206.98 (5.861)	23.50 (7.164)	295.76 (8.375)	27.26 (8.310)	535.26 (15.157)
1/50	17.37 (5.293)	123.00 (3.483)	19.24 (5.864)	185.12 (5.242)	21.02 (6.408)	264.54 (7.491)	24.38 (7.432)	478.73 (13.556)
1/100	12.28 (3.743)	86.98 (2.463)	13.60 (4.146)	130.91 (3.707)	14.87 (4.531)	187.06 (5.297)	17.24 (5.256)	338.56 (9.587)
1/200	8.68 (2.647)	61.52 (1.742)	9.62 (2.932)	92.56 (2.621)	10.51 (3.204)	132.25 (3.745)	12.19 (3.716)	239.36 (6.778)
1/300	7.09 (2.161)	50.22 (1.422)	7.85 (2.394)	75.57 (2.140)	8.58 (2.616)	107.99 (3.058)	9.95 (3.034)	195.43 (5.534)
1/400	6.14 (1.872)	43.51 (1.232)	6.80 (2.073)	65.44 (1.853)	7.43 (2.266)	93.55 (2.649)	8.62 (2.628)	169.26 (4.793)
1/500	5.40 (1.674)	38.88 (1.101)	6.08 (1.854)	58.52 (1.657)	6.65 (2.026)	83.63 (2.368)	7.71 (2.350)	151.36 (4.286)
1/1000	3.88 (1.184)	27.51 (0.779)	4.30 (1.311)	41.39 (1.172)	4.70 (1.433)	59.15 (1.675)	5.45 (1.662)	107.04 (3.031)

For pipe specifications, please visit:
www.kanaflexcorp.com

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NATIONAL SALES (224) 545-2012

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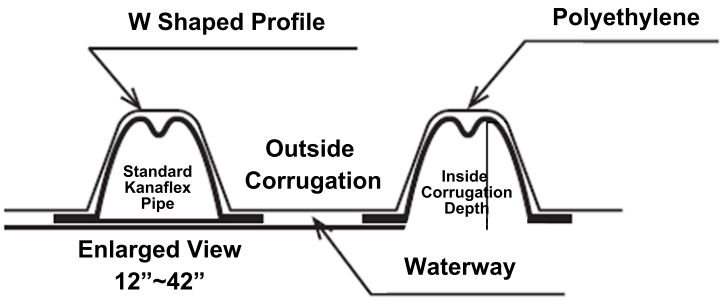
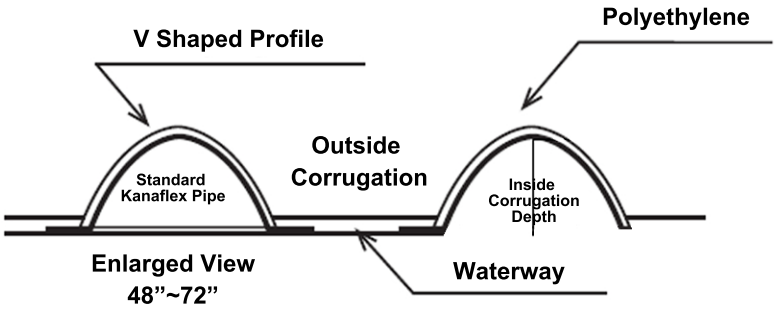
DUAL CORRUGATED SRHDPE

Pipe Specifications															
Nominal Size		Inside Diameter		Outside Diameter		Pitch		Minimum Waterway Wall Thickness		Minimum Steel Thickness		Inside Corrugation Depth		Minimum Pipe Strength	
Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Inches	mm	Mpa	psi
12	300	12	305	13.3	338	2.36	60	0.059	1.5	0.0118	0.3	0.3761	9.6	0.550	80.0
15	375	15	381	16.3	413	2.36	60	0.059	1.5	0.0118	0.3	0.3761	9.6	0.450	65.0
18	450	18	457	19.3	489	2.44	62	0.059	1.5	0.0118	0.3	0.6205	15.3	0.248	40.0
24	600	24	610	25.7	653	2.76	70	0.059	1.5	0.0118	0.3	0.8205	20.8	0.235	34.0
30	750	30	762	32.2	817	3.54	90	0.079	2.0	0.0118	0.3	1.0605	26.5	0.200	29.0
36	900	36	915	38.2	970	3.94	100	0.079	2.0	0.0118	0.3	1.0605	26.5	0.155	22.5
42	1050	42	1067	44.4	1128	3.94	100	0.079	2.0	0.0118	0.3	1.1605	29.5	0.145	21.0
48	1200	48	1220	52.0	1320	6.30	160	0.157	4.0	0.0118	0.3	1.9215	48.0	0.135	20.0
60	1500	60	1524	65.2	1656	7.68	195	0.157	4.0	0.0118	0.3	2.5215	64.0	0.105	15.0
72	1825	72	1829	77.2	1961	7.68	195	0.157	4.0	0.0118	0.3	2.5215	64.0	0.084	12.0





Pipe Technical Binder

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Pipe Division

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April 24, 2019

Kevin Cornell
C/o Kanaflex Corporation
800 Woodlands Parkway
Vernon Hills, Illinois 60061

Re: Large Diameter Kanaflex Pipe Production

Mr. Cornell:

It is my distinct pleasure to continue our professional relationship and I have very much enjoyed our recent phone calls and email conversations. Pursuant to those discussions, please let this letter serve as my professional endorsement of the Kanaflex KanaPipe product with regard to its use in civil infrastructure systems and installations.

As you know, I have been intimately involved in the specialized use of large diameter plastic piping materials in the water and wastewater infrastructure markets for the past 10 years. During that time, I have worked with all of the major large diameter pipe vendors who service the North American markets and as a result of this experience, I have developed a very unique understanding of each of these companies and more importantly, their material offerings and material system capabilities. Given my intense focus on the utilization of larger diameter plastic pipe materials in the development of my own engineered solutions, I have acquired a tremendous knowledge and experience base with regard to profile wall plastic pipe and metal or steel reinforce polyethylene pipe materials. As a result of this experience, I clearly understand the material applications, material limitations, and material pricing characteristics that are the underlying evaluation and selection criteria used by many civil engineers who specify these materials and the products I have engineered that use the same.

I can confidently state that Kanaflex currently produces a composite large diameter piping material that I firmly believe reflects the best combination of material characteristics, fabrication capability, and feedstock pricing. I also know that the KanaPipe material has the long term potential to garner a dominant position in the current large diameter pipe market as it relates to the use of the material for typical piping systems as well as high valued engineered product systems.

Knowing that your current North American capability is limited to a 72—inch diameter material, I wanted to share with you some thoughts that may improve your understanding of where

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KanaPipe might effectively compete and increase its acceptance as a preferred material of choice. Please note the following remarks and comments based upon my professional understanding and experience:

Large Diameter Plastic Pipe Materials

Having been in the civil engineering profession for the past 27 years, and having worked as a specifying engineering consultant, I can confirm that the large diameter pipe world needs more plastic pipe material choices to overcome limitations related to precast concrete pipe (RCP), large diameter corrugated metal pipe (CMP), and the specialty fiberglass and concrete composite pipe materials (Hobas and similar). KanaPipe's unique combination of HDPE material and metal reinforcement results in a composite material that is structurally robust, corrosion and abrasion resistant, and most importantly, cost effective compared to other comparable material offerings. As a result, this positions KanaPipe to capture a tremendous share of the large diameter pipe market.

The Civil Engineering world is looking for this type of piping solution and for the most part doesn't know that it is available or how to properly engineer and implement the same into large civil infrastructure projects. This same lack of knowledge also applies to KanaFlex's competitors as I have seen and experienced this fundamental lack of knowledge in nearly every engineering office I have visited over the past ten years.

Utility and Infrastructure Systems

As you may know, the civil engineering world is driving the need for more intelligent and complex stormwater and wastewater infrastructure solutions. I am personally seeing a major year over year increase in infrastructure systems implementing large diameter plastic piping systems for CSO (Combined Sewer Overflow) systems, large diameter stormwater and irrigation projects, and for underground stormwater detention systems for reuse and reclamation purposes. I am also seeing strong interest in the use of large diameter composite plastic pipe materials as alternatives to conventional Hobas and T-Lock piping systems for wastewater interceptor and sewer main installations. As you already know, KanaPipe is a stronger material compared to pure plastic piping systems and is a far better material selection compared its only other North American SRPE counterpart (Duramaxx). Given KanaPipe's lighter weight and less expensive capital cost, it is readily understood that KanaPipe represents a much better first cost value compared to the more expensive and much heavier all-plastic large diameter pipe materials.

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Engineered Products & Engineered Solutions

As you probably understand, my professional interest and passion as it relates to KanaPipe, is its potential use in high valued engineered systems. As an innovator and patent holder on various wastewater treatment and pumping system, my focus has been primarily based on the use of large diameter plastic pipe materials as a core material that serves as the vessel or tankage component of my engineered products. My reliance upon these materials is centered on the efficiency in which the materials are manufactured (as a feedstock) and their ease of implementation in fabrication of high value infrastructure systems or engineered products. As stated previously, it is now possible to design, fabricate, and deliver large pump stations and wastewater treatment systems that use materials like Kanaflex as the vessel system……..because in this industry, it is always about the vessel……always has been, and always will be and to think otherwise is foolish.

Further to my point, it should be made abundantly clear that large diameter materials having diameters of 96-inches and larger are the preferred sizes as the material efficiencies drastically increase as a function of the final product retail price. Many of our competitors are attempting to drive higher value retail pricing for their engineered products which is counter intuitive to the market need and market desire. End Users and System owners do not have the luxury of spending large sums of money for routine every-day engineered solutions, especially for civil infrastructure components that are always out of sight and out of mind, but so terribly important in the day to day infrastructure needs of our modern world.

Consulting Engineers who evaluate and specify engineered products will often default to the solution that is the least expensive, even though it may not have the best overall life cycle cost. In this regard, cost unfortunately is given much more consideration as a final selection criteria which further reinforces my prior statements made in the above paragraph. As such, I do know that KanaPipe possesses the greatest future potential as its material capabilities and material pricing combine in a way that exceeds current all-plastic pipe products; this matter is further reinforced by the simple fact that the all-plastic pipe manufacturers have a much higher break even pricing threshold which unfortunately will limit their long term ability to compete on a price basis, meaning that when they get to that minimum threshold and can go no further lower in their pricing, KanaPipe can maintain its pricing position and remain viable in the market place.

This simple fact also applies to engineered products and engineered solutions that utilize large diameter plastic piping materials as a major material element in their final design. If our products are cost effective and generate a profit at the same time, as a function of the plastic pipe material choice, we are much more effective in driving or solutions into the market place which in turn generates larger revenue streams and higher profit margins.

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In closing, I hope that this letter further explains my sincere professional interest in using large diameter plastic pipe materials in our engineered products. I also want to express my earnest recommendation that KanaFlex give every consideration to investing in the expansion of its current North American manufacturing capability such that it can produce and sell 96-inch, 108-inch, 120-inch KanaPipe materials. Our current pipeline of opportunities and projects will need suppliers to furnish up to 2,000 linear feet of 96-inch ID and 120-inch ID material for use in our future product orders with the majority of this need in the next 12 to 18 months. As our market presence continues to grow, the need for more material in the same diameters will increase year over year such that I can easily forecast a time when Modular Water Systems may need as much as 10,000 linear feet of large diameter material in any given year.

Thank you again for considering my past experience and future goals as it relates to supporting our corporate material needs. If anyone should have any questions regarding this matter, please feel free to give me a call and I will be glad to discuss my thoughts and remarks in much greater detail.

Sincerely,
Modular Water Systems

Daniel M Early, PE
President & Senior Engineer

Cc: KanaFlex Vendor File

Standard Specification for

Steel-Reinforced Polyethylene (SRPE) Corrugated Pipe

AASHTO Designation: MP 42-20[1]

Technical Subcommittee: 4b, Flexible and Metallic Pipe

Release: Group 2 (June)

AASHTO

American Association of State Highway and Transportation Officials
555 12th Street NW, Suite 1000
Washington, DC 20004

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AASHTO

1. SCOPE

1.1. This specification covers the requirements and methods of tests for steel-reinforced polyethylene (SRPE) corrugated pipe, couplings, and fittings for use in surface and subsurface drainage applications.

1.1.1. Nominal sizes of 300 to 1800 mm (12 to 72 in.) are included.

1.1.2. Materials, workmanship, dimensions, pipe stiffness, impact resistance, joining systems, and form of markings are specified.

1.2. SRPE corrugated pipe is intended for surface and subsurface drainage applications where soil provides support to its flexible walls. Its major use is to collect or convey drainage water by open gravity flow as culverts, storm drains, etc.

Note 1—When SRPE corrugated pipe is to be used in locations where the ends may be exposed, above ground, consideration should be given to protection of the exposed portions due to combustibility of polyethylene and the effects of prolonged exposure to ultraviolet radiation, as well as corrosion of steel reinforcement.

1.3. This specification only deals with this pipe's materials requirements. The structural design of steel reinforced thermoplastic culverts and the proper installation procedures are given in the *AASHTO LRFD Bridge Design Specifications*, Section 12, and *AASHTO LRFD Bridge Construction Specifications*, Section 26, respectively. Upon request of the specifying agency or engineer, the manufacturer shall provide profile wall section detail required for a full engineering evaluation.

1.4. The values stated in SI units are to be regarded as standard. Within the text, the U.S. Customary units are shown in parentheses and may not be exact equivalents.

1.5. The following precautionary caveat pertains only to the test method portion, Section 9, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. REFERENCED STANDARDS

2.1. *AASHTO Standards*:

- M 288, Geosynthetic Specification for Highway Applications
- T 341, Determination of Compression Capacity for Profile Wall Plastic Pipe by Stub Compression Loading
- *AASHTO LRFD Bridge Design Specifications*, Section 12
- *AASHTO LRFD Bridge Construction Specifications*, Section 26

2.2. *ASTM Standards*:

- A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- A1008/A1008M Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
- D618, Standard Practice for Conditioning Plastics for Testing
- D883, Standard Terminology Relating to Plastics
- D2122, Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
- D2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
- D2444, Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)
- D3212, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
- D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
- D4703, Standard Practice for Compression Molding Thermoplastic Materials into Test Specimens, Plaques, or Sheets
- D7091, Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals
- F412, Standard Terminology Relating to Plastic Piping Systems
- F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- F2136, Standard Test Method for Notched, Constant Ligament-Stress (NCLS) Test to Determine Slow-Crack-Growth Resistance of HDPE Resins or HDPE Corrugated Pipe

3. TERMINOLOGY

3.1. The terminology used in this standard is in accordance with the definitions given in ASTM D883 and ASTM F412 unless otherwise specified.

3.2. *Definitions*:

3.2.1. *crack*—any break or split that extends through the pipe wall.

3.2.2. *crease*—a visible irrecoverable indentation.

3.2.3. *delamination*—a gap extending through the fused PE between two adjacent Corrugated Profiles.

3.2.4. *encapsulation thickness*—the thickness of the high density polyethylene (HDPE) bonded to either side of the steel reinforcement (see Figure 2).

3.2.5. *gravity flow*—a condition in which liquid flow through a piping system results from a downward pipeline slope, but flow is less than full, except during conditions when the system may become temporarily surcharged, in which case the system is subject to temporary internal hydrostatic pressure that is limited to 74 kPa [10.8 psi].

3.2.6. *polyethylene (PE) plastics*—plastics based on polymers made with ethylene as essentially the sole monomer (ASTM D883).

3.2.7. *reworked plastic*—a plastic from a processor's own production that has been reground, pelletized, or solvated after having been previously processed by molding, extrusion, etc. (ASTM D883).

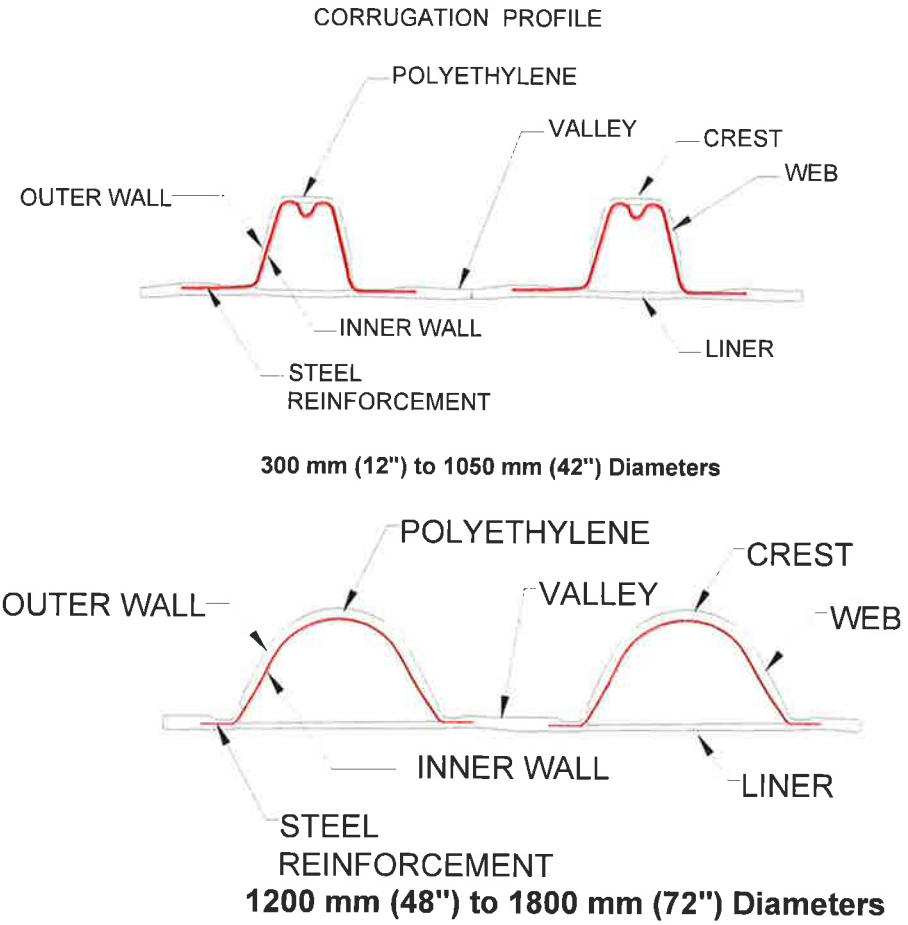

Figure 1—Cross Section of Corrugated Profile

3.2.8. *steel-reinforced polyethylene corrugated pipe*—Polyethylene pipe with a corrugated profile containing reinforcing steel (see Figure 1).

3.2.9. *slow crack growth*—A phenomenon by which a stress crack may form. A stress crack is an external or internal crack in plastic caused by tensile stresses less than its short-term mechanical strength.

3.2.10. *virgin polyethylene material*—PE plastic material in the form of pellets, granules, powder, floc, or liquid that has not been subject to use or processing other than required for initial manufacture.

4. CLASSIFICATION

4.1. *The SRPE corrugated pipe covered by this specification is classified as follows*:

4.1.1. *Type S*—This pipe shall have a full circular cross section with an essentially smooth inner wall.

4.1.2. *Type SP*—This pipe shall be Type S with perforations.

4.2. Perforations are described in Section 7.5.

5. ORDERING INFORMATION

5.1. *Orders using this specification shall include the following information as necessary to adequately describe the desired product*:

5.1.1. AASHTO MP zzz;

5.1.2. Perforation, if applicable (Section 7.5);

5.1.3. Diameter and length required, either total length or length of each piece and number of pieces;

5.1.4. Certification, if desired (Section 12.1); and

5.1.5. Type of pipe joint (Section 7.11.1).

6. MATERIALS

6.1. *Polyethylene Materials*:

6.1.1. *Pipe and Fittings*—Pipe and fittings shall be made of virgin PE, conforming to the requirements of ASTM D3350 and having a cell classification of 334452C or E. Resins that have higher cell classifications in one or more properties are acceptable provided the product requirements are met.

6.1.2. *Rotational Molded Fittings and Couplings*—Fittings and couplings shall be made of virgin PE, conforming to the requirements of ASTM D3350 and having a cell classification of 213320C or E. Resins that have higher cell classifications in one or more properties are acceptable provided product requirements are met. For slow crack resistance, acceptance of resins shall be determined by using notched, constant ligament-stress (NCLS) test according to the procedure described in Section 9.4. The average failure time of the five test specimens must exceed 24 h with no single specimen's failure time less than 17 h.

6.1.3. *Injection Molding Fittings and Couplings*—Fittings and couplings shall be made of virgin PE, conforming to the requirements of ASTM D3350 and having a cell classification of 324452C or E. Resins that have higher cell classifications in one or more properties are acceptable provided product requirements are met.

6.1.4. *Carbon Black Content*—The carbon black content shall not exceed 4.0 percent of the total PE compound weight.

6.1.5. *Other Materials*—It is permissible to use materials other than the cell classification in Section 6.1.1 as part of the pipe manufacturing, for example to weld pipe joints, provided these materials have higher cell classifications in one or more properties and in no way compromise the performance of the pipe products in the intended use.

6.1.6. *Reworked Plastics*—In lieu of virgin PE, it is permissible to use clean, reworked plastic generated from the manufacturer's own pipe production, provided that it meets the cell classification requirements as described in Section 6.1.1.

6.2. *Steel Materials*:

6.2.1. *Steel Dimensions and Properties*—The minimum thickness of the steel sheet shall be as listed in Table 1. The steel substrate shall conform to Specification ASTM A1008/A1008M or ASTM A653/A653M, and the minimum yield strength of the steel sheet shall not be less than 358 MPa [52 ksi]. All steel materials shall be galvanized per the requirements of ASTM A653/A653M with a G40 minimum coating weight.

6.2.2. *Steel Content*—The steel content shall not exceed 75 percent of the total weight of the pipe. The steel material shall be fully encapsulated by the polyethylene material with a minimum thickness of the polyethylene as shown in Table 1and Figure 2.

6.3. *Gaskets*—Elastomeric gaskets shall meet the requirements of ASTM F477.

6.4. *Industrial Sealant*—Sealants, such as moisture cure urethane or asphalt-based sealant materials used for repairs, cut pipe end or assembly of coupling joints, as recommended by the manufacturer may be used.

7. REQUIREMENTS

7.1. *Workmanship*—The pipe and fittings shall be free of foreign inclusions and visible defects as defined herein. Visible defects shall not affect the wall integrity or the encapsulation of the steel reinforcement. The steel reinforcing materials shall not be exposed.

7.2. *Visible Defects*—Cracks, creases, delaminations, and unpigmented or non-uniformly pigmented pipe that are visible by the unaided eye are not permissible in the pipe or fittings.

7.3. There shall be no evidence of delamination when tested in accordance with Section 9.2.

7.4. *Pipe Dimensions and Tolerances*:

7.4.1. *Inside Diameter*—The tolerance on the inside diameter shall be ±2.0 percent, when measured in accordance with Section 9.6.1. Pipe dimensions (for both perforated and nonperforated pipe) shall comply with Table 1.

7.4.1.1. Other diameters that are within the range of pipe sizes shown in Table 1 are permissible. The minimum wall thickness and other properties shall be interpolated from the adjacent values given in Table 1.

Table 1—Pipe Sizes, Diameters, Steel Thickness and Minimum Valley Wall Thicknesses[a]

Nominal Pipe Size, mm (in.)	Inside Diameter, mm [in.]	Outside Diameter, mm [in.]	Minimum Steel Thickness mm [in.]	Minimum Valley Wall Thickness mm [in.]	Minimum Encapsulation Thickness mm [in.]	Minimum Inner Wall Thickness mm [in]
300 (12)	305 [12.01]	338 [13.31]	0.30 [0.012]	3.3 [0.13]	0.9 [0.035]	2.3 [0.09]
375 (15)	381 [15.00]	413 [16.26]	0.30 [0.012]	3.3 [0.13]	1.0 [0.039]	2.3 [0.09]
450 (18)	457 [17.99]	489 [19.25]	0.30 [0.012]	4.2 [0.17]	1.3 [0.051]	2.9 [0.11]
600 (24)	610 [24.02]	653 [25.71]	0.30 [0.012]	4.2 [0.17]	1.5 [0.059]	2.9 [0.11]
750 (30)	762 [30.00]	817 [32.17]	0.30 [0.012]	5.2 [0.20]	1.5 [0.059]	3.6 [0.14]
900 (36)	915 [36.02]	970 [38.19]	0.30 [0.012]	6.9 [0.27]	1.7 [0.067]	4.8 [0.19]
1050 (42)	1067 [42.01]	1128 [44.41]	0.30 [0.012]	9.7 [0.38]	1.8 [0.071]	6.8 [0.27]
1200 (48)	1220 [48.03]	1320 [51.97]	0.30 [0.012]	10.8 [0.43]	1.8 [0.071]	7.6 [0.30]
1500 (60)	1524 [60.00]	1656 [65.20]	0.30 [0.012]	11.9 [0.47]	2.0 [0.079]	8.3 [0.33]
1800 (72)	1842 [72.52]	1982 [78.03]	0.30 [0.012]	13.0 [051]	2.0 [0.079]	9.1 [0.36]

[a] Conversions of SI units to U.S. Customary units in this table are "soft" conversions; i.e., the metric measurement is mathematically converted to its exact (or nearly exact) equivalent in inch–pound measurement.

7.4.2. *Valley Wall*—Minimum wall thickness shall be as required in Table 1 and measured in accordance with Section 9.6.2.

7.4.3. *Length*—The pipe shall be sold in any length agreeable to the user. Length shall not be less than 99 percent of the specified length, when measured in accordance with Section 9.6.3.

7.4.4. *Encapsulation Thickness*—The minimum thickness of the PE encapsulation of steel reinforcement, measured at any location, shall be as specified in Table 1. Factory cut pipe ends shall have the cut corrugation ends encapsulated with PE material meeting the requirements of Section 6.1, to maintain the requirements of Table 1. Encapsulation thicknesses shall be measured in accordance with Section 9.6.4. Field cut pipe ends shall have the cut corrugation ends encapsulated with industrial sealant meeting the requirements of Section 6.4.

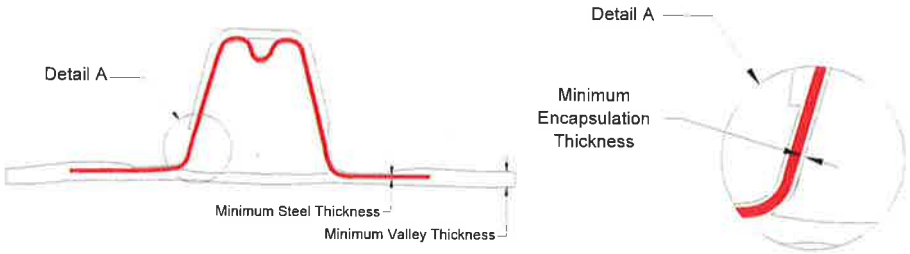

Figure 2—Encapsulation and Wall Thickness

7.5. *Perforations*—When perforated pipe is specified, the perforations shall be cleanly cut and uniformly spaced along the length and circumference of the pipe. Circular perforations shall be a minimum of 5 mm (0.2 in.) and shall not exceed 10 mm (0.4 in.) in diameter. The water inlet area shall be a minimum of 30 cm^2/m (1.5 $in.^2/ft$) for pipe sizes 300 to 450 mm (12 to 18 in.) and 40 cm^2/m (2.0 $in.^2/ft$) for pipe sizes larger than 450 mm (18 in.). All measurements shall be made in accordance with Section 9.6.5. The perforations shall be cleanly cut so as not to restrict the inflow of water. Perforations shall be located in the valley portion of the pipe between the corrugations. The reinforcing steel material shall not be exposed by these perforations.

7.6. *Pipe Stiffness*—The pipe shall have minimum pipe stiffness at 5 percent deflection as listed in Table 2. Pipe stiffness shall be tested in accordance with Section 9.1.

Table 2—Pipe Stiffness

Nominal Pipe Size, mm (in.)	Pipe Stiffness, kPa [psi] [a]
300 (12)	400 [58]
375 (15)	400 [58]
450 (18)	275 [40]
600 (24)	235 [34]
750 (30)	200 [29]
900 (36)	155 [22.5]
1050 (42)	145 [21]
1200 (48)	140 [20]
1500 (60)	105 [15]
1800 (72)	105 [15]

Note 2—The 5 percent deflection criterion was selected for testing convenience and should not be considered as a limitation with respect to in-use deflection.

7.7. *Pipe Flattening*—There shall be no evidence of splitting, cracking, or breaking when tested in accordance with Section 9.2. Additionally, there shall be no downturn of the load-deflection curve prior to 20 percent vertical deflection.

7.8. *Bonding of the Steel to the Polyethylene*—The mechanical bond between the steel reinforcement and the polyethylene shall be greater than the tensile strength of the polyethylene resin required for this standard. It shall not be possible to separate any two layers with a probe or with the point of a knife blade so that the layers separate cleanly, or the probe or knife moves freely between the layers. There shall be no separation of the polyethylene from the steel reinforcing plate, when the pipe is deflected 40 percent, in accordance with Section 9.2.

7.9. *Impact*—There shall be no evidence of splitting, cracking, or breaking when tested in accordance with Section 9.3.

7.10. *Fitting Requirements*:

7.10.1. Only fittings supplied or recommended by the manufacturer shall be used. Fabricated fittings shall be supplied with joints compatible with the overall system requirements.

7.10.2. All fittings shall be within an overall length dimensional tolerance ±12 mm (±0.5 in.) of the manufacturer's specified dimensions when measured in accordance with Section 9.6.3.

7.10.3. The fittings shall not impair the overall integrity or function of the pipe.

7.10.4. Common fittings include in-line joint fittings, reducers, and branch or complementary assembly fittings such as tees and wyes. These fittings shall be installed or coupled to the pipe by split couplers or other methods meeting the requirements of Section 7.11.

7.10.5. Fittings shall not reduce the inside diameter of the pipe being joined by more than 12 mm (0.5 in.). Reducer fittings shall not reduce the cross-sectional area of the small size diameter by more than 3 percent.

7.11. *Jointing Requirements*:

7.11.1. Pipe joints and couplings shall be split-collar bands or screw-on collars meeting the material requirements of Section 6.1. Split-collar bands or screw-on collars shall be corrugated to match the pipe corrugations and shall provide sufficient longitudinal strength to preserve pipe alignment and prevent separation at the joints. If required, the pipe joint shall incorporate a flat, O-ring, or profile

gasket. Split-collar bands or screw-on collars shall engage at least two full corrugations of each pipe section. The two ends of the split-collar band shall overlap a minimum of 50.8 mm (2.0 in.). Split-collar bands or screw-on collars shall meet the soil-tight requirements of Section 7.11.2.1 or the silt-tight requirements of Section 7.11.2.2.

7.11.1.1. Other types of couplings or fastening devices that are equally effective as one of those described in Section 7.11.2 may be used when approved by the purchaser.

7.11.1.2. *Internal Coupling, Sealant Type*—Joint seal is affected by applying an industrial sealant between the external surface of the coupling and the internal surface of the pipe. This jointing system may be used when approved by the purchaser.

7.11.1.3. Other types of jointing methods such as flanging, internal coupling (gasket type), extrusion welding, electro-fusion, butt fusion, and others may be used when approved by the purchaser.

7.11.2. *Joint Tightness*—The pipe or fitting joint shall meet the requirements defined as one of the following types:

7.11.2.1. *Soil-Tight Joints*—Soil-tight joints are specified as a function of opening size (maximum dimension normal to the direction that soil may infiltrate), channel length (length of the path along which the soil may infiltrate), and backfill particle size. If the size of the opening exceeds 3 mm ($^1/_8$ in.), the length of the channel must be at least four times the size of the opening. No opening may exceed 25 mm (1 in.). Backfill material containing a high percentage of fine-graded soils requires investigation for the specific type of joint to be used to guard against soil infiltration.

7.11.2.2. *Silt-Tight Joints*—A silt-tight joint is resistant to infiltration of particles that pass the No. 200 sieve. Silt-tight joints are specified to provide protection against infiltration of backfill material containing a high percentage of fines, and typically utilize some type of filtering or sealing component, such as a geotextile wrap or an elastomeric rubber seal.

7.11.2.2.1. Geotextile wraps are manufactured to tolerances that assure silt will not pass through them. The successful performance of these wraps in the field is dependent on their installation. If a geotextile wrap is specified for use, the material specified should meet the requirements of M 288, with an apparent opening size (AOS) greater than 70.

7.11.2.2.2. For joints that utilize an elastomeric rubber seal, silt-tight performance shall have been demonstrated in a laboratory test to meet the hydrostatic requirements of ASTM D3212, with the exception that the hydrostatic test pressure shall be a minimum of 14 kPa (2 psi).

7.11.2.3. *Leak-Resistant Joints*—Leak-resistant joints shall be bell and spigot and utilize an elastomeric rubber seal meeting the requirements of ASTM F477. Alternative methods of joining (e.g., external joint wraps) shall be allowed provided the requirements of Section 7.11.2.3.1 are achieved.

7.11.2.3.1. Leak resistance shall be verified in the lab by meeting all of the requirements of ASTM D3212. The hydrostatic test pressure and vacuum specified in the test method shall be 74 kPa (10.8 psi).

7.11.3. *Special Design Joints*—Special design joints shall include joints requiring special strength in bending or shear, pull-apart capabilities, or unusual features such as restrained joints placed on severe slopes, welded joints, flanged and bolted joints for high pressures, high heads, or velocities. Watertight joints that provide zero leakage for a specified head or pressure application are included in this type of joint.

7.12. *Stub Compression Test*—Profile compression capacity in any specimen in the stub compression test shall not be less than 50 percent of the gross cross section of the steel reinforcing area times the minimum specified yield strength of the steel when tested in accordance with Section 9.7. The stub compression test, T 341, shall be a material and wall design qualification test conducted twice a year or whenever there are changes in wall design or material distribution. Computing the minimum capacity requires determining the cross-sectional area of the pipe wall. This can be accomplished conveniently by optically scanning the profile and determining the section properties using a computer drafting program.

8. CONDITIONING

8.1. Condition the specimen prior to test at 21 to 25°C (70 to 77°F) for not less than 24 h in accordance with Procedure A in ASTM D618 for those tests where conditioning is required, and unless otherwise specified.

8.2. Conduct all tests at a laboratory temperature of 21 to 25°C (70 to 77°F) unless otherwise specified herein.

9. TEST METHODS

9.1. *Pipe Stiffness*—Select a minimum of three pipe specimens from the pipe and test for pipe stiffness $F/\Delta y$, as described in ASTM D2412, except for the following conditions:

9.1.1. Specimens shall be cut mid valley to mid valley along the corrugation, and then cut across the corrugation.

9.1.2. Specimens shall exceed 457 mm (18 in.) in length.

9.1.3. Locate the first specimen in the loading machine with the imaginary line between two corrugations parallel to the loading plates. The specimen must lie flat on the plate within 3 mm (⅛ in.) . Use the first location as a reference point for rotation of the other two specimens. Rotate the second specimen 45 degrees and the third specimen 90 degrees. Test each specimen in one position only.

9.1.4. Testing speed of the specimens shall be 12.7 mm (0.5 in.) per min for testing up to 5 percent deflection. For testing beyond 5 percent deflection, test at a speed of 127 mm (5 in.) per min.

9.1.5. The deflection indicator shall be readable and accurate to +0.02 mm (+0.001 in.) .

9.1.6. The parallel plates must exceed the samples in length.

9.2. *Pipe Flattening*—Flatten the three pipe samples from Section 9.1 until the vertical inside diameter is reduced by 40 percent. The length of the test specimen and the rate of loading shall be the same as in Section 9.1. Examine the specimen with the unaided eye for cracking, splitting, or delamination.

9.3. *Pipe Impact*—Test pipe specimens in accordance with ASTM D2444 except that six specimens shall be tested. Specimens shall be at least 457 mm (18 in.) in length and impact points shall be at least 152 mm (6 in.) from the end of the specimen. Impact resistance shall not be less than 136 J. Tup B and a flat plate specimen holder shall be used. Condition the specimens for 24 h (± 0.25 h) at a temperature of 0 ± 1°C (32 ± 2°F), and conduct all tests within 60 s of removal from this atmosphere.

9.4. *Slow Crack Growth Resistance of HDPE Resin Compounds*—Test basic resin compounds for stress crack resistance in accordance with ASTM F2136, the NCLS test, except for the following modifications:

9.5. The applied stress for the NCLS test shall be 4100 kPa (600 psi).

9.6. The specimens shall be prepared from pieces of the pipe liner that have been compression molded into a plaque in accordance with ASTM D4703, Procedure C.

Note 3—The notched depth of 20 percent of the nominal thickness of the specimen is critical to this procedure.

9.7. *Delamination*—Test the fusion of the bond between the inner and outer wall of the corrugated profile width (see Figure 2) with a probe or knife point. It shall not be possible to cleanly separate the two walls. Test samples at eight equally spaced points around its circumference.

9.8. *Dimensions*:

9.8.1. *Inside Diameter*—Measure the inside diameter of three specimens, each a minimum of 300 mm (12 in.) long with any suitable device accurate to 0.8 mm (0.03 in.), at two positions, namely, at any point in the circumferential direction and at 90 degrees from this point, and average the six measurements. The inside diameter shall meet the requirements of Section 7.4.1.

9.8.2. *Valley Wall*—Locate and measure the wall thickness between the corrugations at four equally spaced locations around the circumference of the pipe, in accordance with ASTM D2122.

9.8.3. *Length*—Measure pipe with any suitable device accurate to ±6.0 mm in 3 m (±0.25 in. in 10 ft). Make all measurements on the pipe while it is resting on a relatively flat surface, in a straight line, with no external tensile or compressive forces exerted on the pipe. These measurements may be taken at ambient temperatures.

9.8.4. *Encapsulation Thickness*—Locate and measure the encapsulation thickness by cutting a minimum of two equally spaced cross sections. Pipe specimens shall be cleanly cut and burrs removed. A flat-anvil micrometer or Vernier calipers, accurate to ±0.02 mm (±0.001 in) shall be used to measure the encapsulation thickness at eight equally spaced locations around the pipe circumference. Encapsulation thickness shall be measured for inner wall and outer wall.

Note 4—Alternatively, direct measurements may be used. To measure inner wall encapsulation thickness, remove HDPE from outer wall. Measure the combined thickness of the steel and inner wall. Care should be taken to avoid misalignment of the anvil or Vernier calipers with the longitudinal axis of the specimen. Remove the HDPE from the inner wall. Measure the thickness of the steel reinforcement. Subtract the steel reinforcement thickness from combined thickness of the steel and inner wall thickness to obtain the inner wall encapsulation thickness. To measure the outer wall, repeat this process by interchanging the outer and inner wall thickness described above. Care should be taken to avoid removing steel thickness when removing the HDPE.

9.8.5. *Perforations*—Measure dimensions of perforations on a straight profile specimen with no external forces applied. Make linear measurements with instruments accurate to 0.2 mm (0.08 in.).

9.9. *Stub Compression Capacity*:

9.9.1. Determine the stub compression capacity of the pipe section in accordance with T 341. Conduct four tests on specimens cut from the same ring of pipe at 90-degree intervals around the circumference.

10. INSPECTION AND RETEST

10.1. *Inspection*—Inspection of the material shall be made as agreed on by the purchaser and the seller as part of the purchase contract.

10.2. *Retest and Rejection*—Retesting in the event of a test failure shall be conducted on samples from the failed lot only under an agreement between purchaser and seller. There shall be no changes to the test procedures or the requirements.

11. MARKING

11.1. *All pipe shall be clearly marked at intervals of no more than 3 m (10.0 ft) as follows*:

11.1.1. Manufacturer's name or trademark.

11.1.2. AASHTO MP zzz.

11.1.3. Nominal pipe size.

11.1.4. The plant designation code.

11.1.5. The date of manufacture or an appropriate code. If a date code is used, a durable manufacturer sticker that identifies the actual date of manufacture shall be adhered to the inside of each length of pipe.

Note 5—A durable sticker is one that is substantial enough to remain in place and be legible through installation of the pipe.

11.2. Fittings shall be marked with the standard number of this specification and with the manufacturer's identification symbol.

12. QUALITY ASSURANCE

12.1. A manufacturer's certificate that the product was manufactured, tested, and supplied in accordance with this specification, together with a report of the test results and the date each test was completed shall be furnished on request. Each certification so furnished shall be signed by a person authorized by the manufacturer.

13. KEYWORDS

13.1. Crack; crease; delamination; gravity flow; SRPE.

APPENDIX

(Nonmandatory Information)

X1. QUALITY CONTROL/QUALITY ASSURANCE PROGRAM

X1.1. *Scope*:

X1.1.1. As required in Sections 10 and 12, the acceptance of these products relies on the adequate inspection and certification agreed to between the buyer and the seller/manufacturer. This appendix should serve as a guide for both the manufacturer and the specifying agency. It places the responsibility on the manufacturer to control the quality of the material they produce and to provide the quality control.

X1.2. *Program Requirements*:

X1.2.1. The manufacturing company must have a quality control plan, as described in Section X1.3 that has been approved by the specifying agency.

X1.2.2. The manufacturing plant must have a quality control plan, as described in Section X1.3, and in X1.7, which has been approved by the specifying agency.

X1.2.3. The plant must use a specifying agency-approved laboratory, either within the company or an independent laboratory as noted in Section X1.4.

X1.2.4. The manufacturing plant(s) must have a designated quality control technician.

X1.3. *Quality Control Plan*:

X1.3.1. The manufacturer must supply to the specifying agency a written quality control plan that shows how the producer will control the equipment, materials, and production methods to ensure that the specified products are supplied. The following information must be included in the plan:

X1.3.1.1. Titles of the personnel responsible for production quality at the plant(s).

X1.3.1.2. The physical location of the plant(s).

X1.3.1.3. The methods of identification of each lot of material during manufacturing, testing, storage, and shipment. The method of identification shall allow the specifying agency to trace the finished product to the material provider.

X1.3.1.4. The method of sampling and testing of raw materials and of finished product, including lot sizes and types of tests performed.

X1.3.1.5. A plan for dealing with nonconforming product, including how the manufacturer plans to initiate immediate investigation and how corrective action will be implemented to remedy the cause of the problem.

X1.4. *Approved Laboratory*:

X1.4.1. All tests must be conducted at laboratories approved by the specifier. Each manufacturer may establish and maintain its own laboratory for performance of quality control testing or may utilize an approved independent laboratory. Records of instrument calibration and maintenance and of sample collection and analysis must be maintained at the laboratory.

X1.5. *Quality Control Technician*:

X1.5.1. All samples must be taken and tested by quality control technicians designated by the manufacturer. The designated quality control technicians will be responsible for overall quality control at the manufacturing plant.

X1.6. *Annual Update*:

X1.6.1. An annual update may be required. The annual update may be submitted by the manufacturer to the specifying agency by December 31st of each calendar year.

X1.7. *Plant Approval*:

X1.7.1. The plant approval process requires the manufacturer to submit an annual update to the specifying agency. The update must identify the specific product manufactured at the plant.

X1.7.2. The specifying agency will review the manufacturer's written quality control plan, and a plant inspection may be scheduled. This inspection will verify that the quality control plan has been implemented and is being followed and that at least one designated quality control technician is on site and will be present when material is being produced under this program. The laboratory will be inspected and approved if it meets the requirements.

X1.8. *Sampling and Testing*:

X1.8.1. The quality assurance plan approved for each manufacturer, or manufacturer's location, or both, shall detail the methods and frequency of sampling and testing for all raw materials and products purchased or manufactured at that location. All testing shall be in accordance with current specifications and procedures referenced in Sections 6, 7, and 9.

X1.8.2. Samples of materials and pipe may be taken by the specifying agency.

X1.8.3. The specifying agency may require an annual third-party independent assurance test.

X1.9. *Sample Identification and Record Keeping*:

X1.9.1. Manufacturer's quality control samples are to be uniquely identified by the producing plant.

X1.9.2. Quality control and quality assurance data are to be retained by the manufacturer for 2 y and made available to the specifying agency on request.

X1.9.3. Quality control test reports shall include the lot identification.

X1.9.4. Unless requested at the time of ordering, test reports do not have to be filed for specific projects.

X1.9.5. Reports shall indicate the action taken to resolve nonconforming product.

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[1] This provisional standard was first published in 2020.

Designation: F2435 – 15

Standard Specification for Steel Reinforced Polyethylene (PE) Corrugated Pipe[1]

This standard is issued under the fixed designation F2435; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification covers requirements and test methods for materials, dimensions, workmanship, elongation, impact resistance, pipe stiffness, perforations, and markings for steel reinforced corrugated polyethylene (PE) piping systems of nominal sizes 8 in. (200 mm), through 80 in. (2000 mm). The steel reinforced polyethylene pipes governed by this standard are intended for use in underground applications where soil provides support for their flexible walls. The steel reinforced polyethylene corrugated pipes governed by this standard are intended for use in non-pressure applications for sanitary sewers, storm sewers and drainage pipes.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 There is no similar or equivalent ISO standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A591/A591M Specification for Steel Sheet, Electrolytic Zinc-Coated, for Light Coating Weight [Mass] Applications (Withdrawn 2005)[3]

A653/A653M Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

A1008/A1008M Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable

D618 Practice for Conditioning Plastics for Testing

D2122 Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings

D2321 Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications

D2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading

D3212 Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals

D3350 Specification for Polyethylene Plastics Pipe and Fittings Materials

F412 Terminology Relating to Plastic Piping Systems

F449 Practice for Subsurface Installation of Corrugated Polyethylene Pipe for Agricultural Drainage or Water Table Control

F477 Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

F2136 Test Method for Notched, Constant Ligament-Stress (NCLS) Test to Determine Slow-Crack-Growth Resistance of HDPE Resins or HDPE Corrugated Pipe

2.2 *AASHO Standard*[4]

Standard Specification for Highway Bridges, Division II, Section 30, "Metal Culverts."

2.3 *Federal Standards:*[5]

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

2.4 *Military Standards:*[5]

MIL-STD-129 Marking for Shipment and Storage

3. Terminology

3.1 *Definitions*—Definitions used in this specification are in accordance with Terminology F412, unless otherwise noted.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *double-wall steel reinforced polyethylene corrugated pipe, n*—polyethylene corrugated pipe with steel reinforcing

[1] This specification is under the jurisdiction of ASTM Committee F17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.11 on Composite.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001. http://www.transportation.org

[5] DLA Document Services Building 4/D 700 Robbins Avenue Philadelphia, PA 19111-5094 http://quicksearch.dla.mil/

***A Summary of Changes section appears at the end of this standard**

helical V-shaped profile encapsulated within the corrugations and with a closed channel on the inside of the pipe (See Fig. 2).

3.2.2 *single-wall steel reinforced polyethylene corrugated pipe, n*—polyethylene corrugated pipe with steel reinforcing helical V-shaped profile encapsulated within the corrugations and with an open channel on the inside of the pipe (See Fig. 1).

3.2.3 *triple-wall, adj*—polyethylene corrugated pipe with steel reinforcing profiles either helical V-shaped profiles or U-shaped profiles encapsulated within the corrugations and with steel reinforcing helical flat profiles encapsulated within the exterior polyethylene layer and with a closed channel (polyethylene layer) on the inside of the pipe (See Fig. 3 and Fig. 4).

3.2.4 *Steel Reinforced Polyethylene Corrugated Pipe (SRPCP), n*—single wall, double wall or triple wall, helical (spiral) corrugated pipe with steel reinforcing ribs, either V-shaped or U-shaped, encapsulated within polyethylene.

4. Significance and Use

4.1 Steel reinforced corrugated PE pipes are used for underground applications where soil provides support to their flexible walls. Their major use is to collect or convey storm water run-off for sewers and drains, or both.

4.2 Exclusions from recommended use:

4.2.1 Permanent exposure to sunlight and exposure to chemicals whose compatibility with the pipe and fittings is not known.

5. Materials

5.1 *Polyethylene Materials:*

5.1.1 Polyethylene compounds used in the manufacture of steel reinforced corrugated PE drainage pipe shall meet or exceed the requirements of cell classification of 333430C as defined and described in Specification D3350.

5.1.2 Slow crack growth resistance of the polyethylene compound shall be determined by testing in accordance with Test Method F2136. The applied stress shall be 600 psi (4100 kPa). The test specimens must exceed 41 h with no failures. Testing shall be done on polyethylene material taken from the finished pipe.

5.1.3 *Carbon Black Content*—Minimum 2.0 wt. % to a maximum 3.0 wt. % of the total of the polyethylene compound.

5.2 *Steel Materials:*

5.2.1 The minimum thickness of the steel sheet shall be as listed in Tables 1-4. The steel substrate shall conform to Specification A1008/A1008M or A653/A653M, and the minimum yield strength of the steel sheet shall not be less than 24.66 ksi (170 MPa). The zinc-galvanized coating shall have a minimum zinc coating designation of 20Z (intermediate coating) as defined in Specification A591/A591M.

5.2.2 *Steel Material Content*—Maximum 75% (±2 %) of the total weight of the pipe. The steel material is fully encapsulated by the polyethylene material with a minimum thickness of the polyethylene at its thinnest point of 0.012 in. (0.3 mm).

5.3 *Rework Material*—Rework material is not to be used in the manufacture of this product.

5.4 *Gaskets*—Elastomeric gaskets shall comply with the requirements specified in Specification F477.

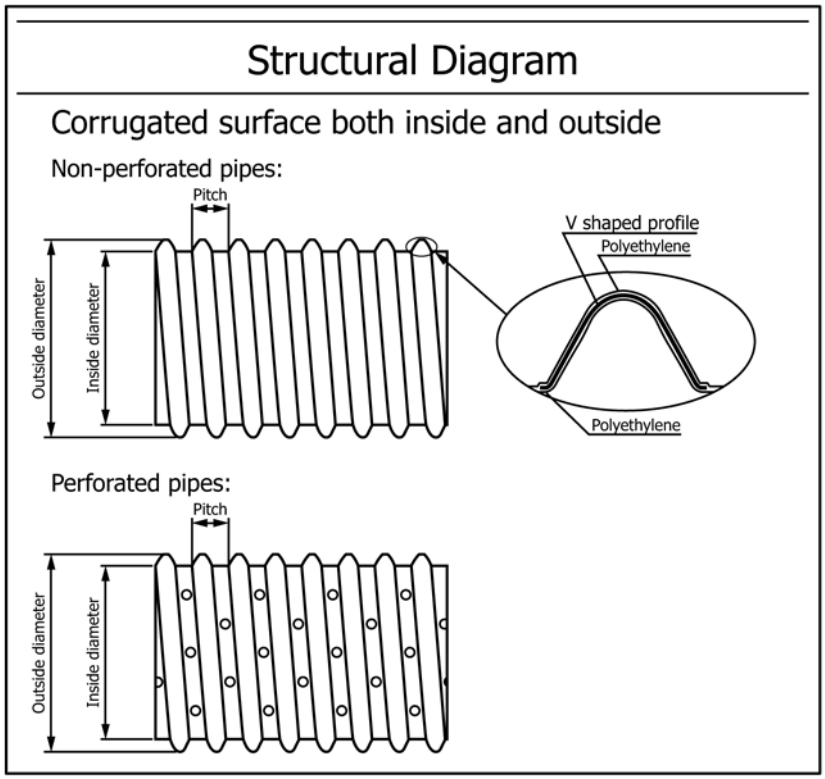

FIG. 1 Single-Wall Steel Reinforced Corrugated Polyethylene Pipe – Types I, III and IV

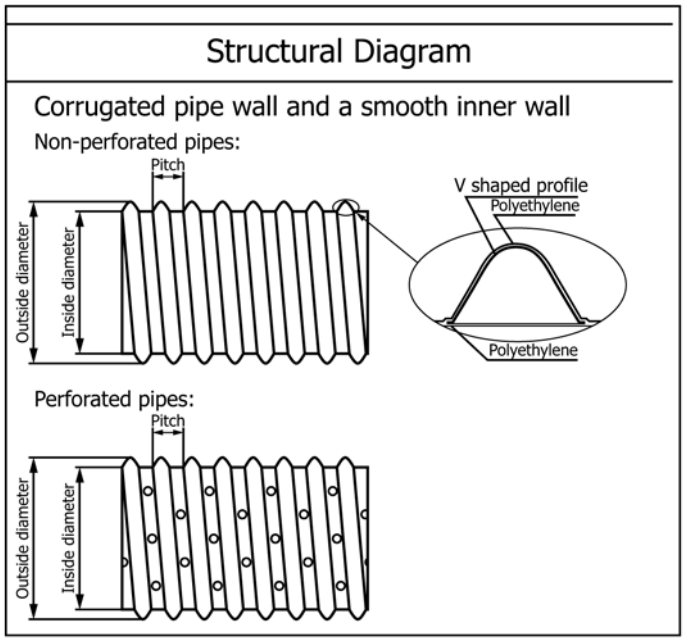

FIG. 2 Double-Wall Steel Reinforced Corrugated Polyethylene Pipe – Types I, III and IV

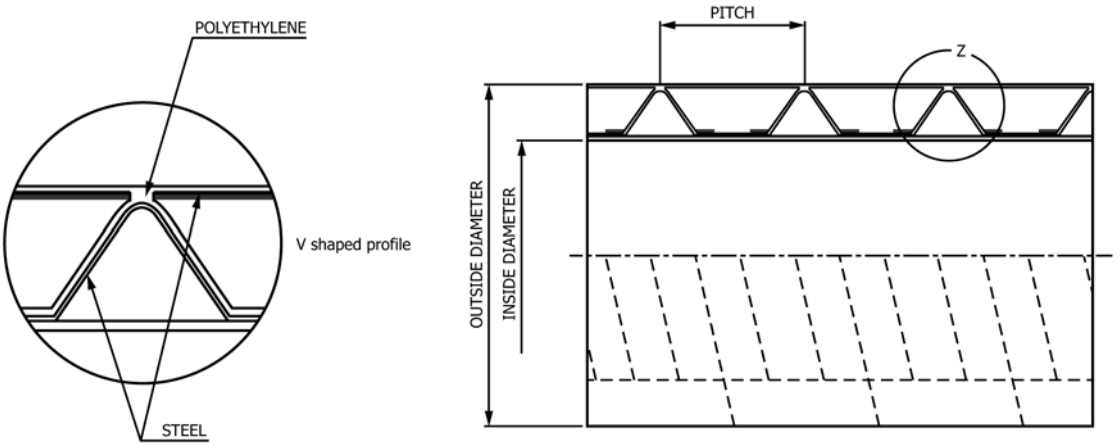

FIG. 3 Triple-Wall Steel Reinforced Corrugated Polyethylene Pipe – Type IIA

5.5 *Lubricant*—The lubricant used for assembly of gasketed joints shall have no detrimental effect on the gasket or on the pipe.

NOTE 1—The purpose of the HDPE encapsulation of the steel is to attain bonding between the steel and PE to form a composite structure. The PE encapsulation is not for protecting the steel from corrosion damage. The minimum PE thickness of 0.012 in. at the thinnest point still maintains the bond between the steel and PE. The pipe is designed to combine pipe stiffness and buckling performance. The thickness of the HDPE encapsulation does not affect product performance.

6. Requirements

6.1 *Workmanship*—The inside and outside surfaces of the pipe shall be semi-matte or glossy in appearance and free of chalking, sticky, or tacky materials. The pipe wall shall not have cracks, holes, blisters, voids, foreign inclusions or other defects that are visible to the naked eye and that can affect the wall integrity or the bonding to the steel reinforcement. Holes deliberately placed in perforated pipe are permitted. The surface shall be free of bloom.

6.2 *Pipe Dimensions and Tolerances:*

6.2.1 Pipe Dimensions (for both perforated and non-perforated pipe) shall comply with Table 1, Table 3, and Table 4 for single-wall and double-wall pipe and Table 2 for triple-wall pipe, when measured in accordance with Test Method D2122.

6.2.2 *Inside Diameter*—The tolerance on the nominal inside diameter shall be ±2.0 %, when measured in accordance with section 8.3.

6.2.3 *Outside Diameter*—The tolerance on the nominal outside diameter shall be ±2.0 %, when measured in accordance with section 8.4.

6.2.4 *Wall Thickness*—The tolerance of the minimum wall thickness of the waterway of the pipe (see Tables 1-4) shall be +35 % when measured in accordance with 8.5.

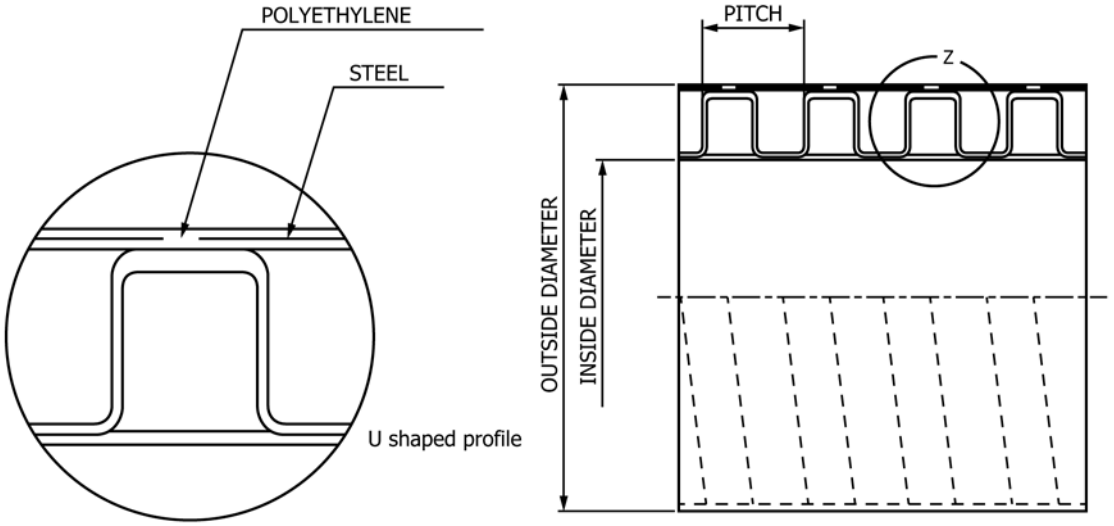

FIG. 4 Triple-Wall Steel Reinforced Corrugated Polyethylene Pipe – Type IIB

TABLE 1 Dimensions and Pipe Stiffness for Single-Wall Pipe and Double-Wall Pipe – Type I (V-shaped profile)

Nominal Size		Inside Diameter		Outside Diameter		Pitch		Waterway Wall Thickness (min)		Minimum Steel Thickness		Minimum Pipe Stiffness	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	psi	MPa
8	200	8.0	203	9.1	231.1	2.16	54.9	0.13	3.3	0.0118	0.30	58	0.40
10	250	10.0	254	10.95	278.1	2.16	54.9	0.13	3.3	0.0118	0.30	58	0.40
12	300	12.0	305	13.12	333.2	2.16	54.9	0.13	3.3	0.0118	0.30	58	0.40
18	450	18.0	457	19.58	497.3	2.63	66.8	0.165	4.2	0.0157	0.40	58	0.40
24	600	24.0	610	26.56	674.6	3.42	86.9	0.165	4.2	0.0157	0.40	58	0.40
28	700	28.0	711	30.85	783.6	3.85	97.8	0.204	5.2	0.0157	0.40	58	0.40
32	800	32.0	813	35.11	891.8	4.25	108.0	0.212	5.4	0.0157	0.40	58	0.40
36	900	36.0	914	39.4	1000.8	4.88	124.0	0.272	6.9	0.0157	0.40	58	0.40
40	1000	40.0	1016	47.2	1198.9	6.69	169.9	0.382	9.7	0.0157	0.40	58	0.40
45	1125	44.0	1118	51.73	1313.9	7.48	190.0	0.402	10.2	0.0157	0.40	58	0.40
48	1200	48.0	1219	56.42	1432.1	8.07	205.0	0.425	10.8	0.0157	0.40	58	0.40
54	1375	54.0	1372	63.12	1603.2	8.85	224.8	0.449	11.4	0.0157	0.40	58	0.40
61	1525	61.0	1524	70.41	1788.4	9.25	235.0	0.469	11.9	0.0157	0.40	58	0.40
67	1675	67.0	1676	76.4	1940.6	9.25	235.0	0.492	12.5	0.0157	0.40	58	0.40
73	1825	73.0	1829	82.98	2107.7	9.25	235.0	0.512	13.0	0.0157	0.40	58	0.40
80	2000	80.0	2032	91.25	2317.8	9.25	235.0	0.512	13.0	0.0157	0.40	58	0.40

6.2.5 *Length*—The pipe shall be sold in any length agreeable to the user. Length shall not be less than 99 % of the specified length when measured in accordance with section 8.6.

6.3 *Perforations:*

6.3.1 *Drainage Pipe*—When perforations are necessary they shall be cleanly cut and uniformly spaced along the length and circumference of the pipe in a size, shape, and pattern suited to the needs of the user. Perforations shall be in the valley portion of the pipe. The reinforcing steel material shall not be exposed by these perforations.

6.3.2 The inlet area of the perforations shall be a minimum of 1 $in.^2$/ft (21 cm^2/m) of pipe.

6.4 *Pipe Stiffness*—The pipe shall have a minimum pipe stiffness as shown in Tables 1-4 at 5 % deflection, when tested in accordance with section 8.7.

NOTE 2—The 5 % deflection criteria was selected for testing convenience and should not be considered as a limitation with respect to in-use deflection.

NOTE 3—Figs. 1-4 are meant to be representative of the reinforced PE composite pipes described in this standard.

NOTE 4—Tables 1-4 describe four different types of pipes identified as Types I, II, III and IV which are different as to structure (single and double wall and triple wall structure), profile shape (U-shaped or V-shaped), waterway wall thicknesses and steel thicknesses. These differences are detailed in the Tables.

6.5 *Bonding of the Steel to the Polyethylene*—The mechanical bond between the steel reinforcement and the polyethylene shall be greater than the tensile strength of the polyethylene resin required for this standard. It shall not be possible to separate any two layers with a probe or with the point of a knife blade so that the layers separate cleanly, or the probe or knife moves freely between the layers. There shall be no separation of the polyethylene from the steel reinforcing plate, when the pipe is deflected 40 %, in accordance with Test Method D2412.

6.6 *Fitting Requirements:*

6.6.1 The fittings shall not reduce or impair the overall integrity or function of the pipeline.

6.6.2 Fittings shall be supplied with joints compatible with the overall system. All joints for watertight gravity flow sewer systems shall meet the requirements of 6.6.3.1. All other joints

TABLE 2 Nominal Pipe Sizes, Dimensions, and Pipe Stiffness for Triple-Wall Pipe – Type IIA and IIB

Nominal Size		Inside Diameter		Outside Diameter		Pitch		Minimum Waterway Wall		Minimum Steel Thickness		Minimum Pipe Stiffness Type IIA		Minimum Pipe Stiffness Type IIB	
inch	mm	inch	mm	Inch	mm	inch	mm	inch	mm	Inch	mm	psi	MPa	psi	MPa
12	300	11.89	302	13.46	342	1.18	30	0.039	1.0	0.0118	0.30			50.75	0.35
14	350	13.66	347	15.55	395	1.38	35	0.047	1.2	0.0118	0.30			50.75	0.35
15	375	14.76	375	16.73	425	1.50	38	0.055	1.4	0.0118	0.30			43.50	0.30
16	400	15.75	400	17.72	450	1.50	38	0.055	1.4	0.0118	0.30			40.60	0.28
18	450	18.07	459	20.31	518	1.57	40	0.055	1.4	0.0118	0.30			40.60	0.28
20	500	19.69	500	22.24	565	1.77	45	0.059	1.5	0.0118	0.30			40.60	0.28
21	525	20.67	525	23.23	590	1.77	45	0.059	1.5	0.0118	0.30			40.60	0.28
24	600	24.02	610	26.85	682	2.17	55	0.059	1.5	0.0118	0.30			39.15	0.27
27	675	26.57	675	30.51	775	2.60	66	0.067	1.7	0.0118	0.30			39.15	0.27
28	700	27.72	704	31.50	800	2.60	66	0.083	2.1	0.0118	0.30			39.15	0.27
30	750	29.53	750	33.31	846	2.60	66	0.083	2.1	0.0118	0.30			39.15	0.27
32	800	31.50	800	35.83	910	2.91	74	0.083	2.1	0.0118	0.30			39.15	0.27
36	900	35.43	900	40.39	1026	3.15	80	0.118	3.0	0.0118	0.30			39.15	0.27
40	1000	39.37	1000	45.28	1150	3.39	86	0.122	3.1	0.0118	0.30			39.15	0.27
42	1050	41.34	1050	47.24	1200	3.39	86	0.122	3.1	0.0118	0.30			39.15	0.27
44	1100	43.31	1100	50.98	1295	7.48	190	0.157	4.0	0.0118	0.30	58	0.40		
48	1200	47.24	1200	54.92	1395	7.48	190	0.157	4.0	0.0118	0.30	58	0.40		
54	1375	53.15	1350	60.83	1545	7.48	190	0.177	4.5	0.0118	0.30	58	0.40		
60	1524	59.06	1500	67.44	1713	8.07	205	0.177	4.5	0.0118	0.30	58	0.40		
66	1650	64.96	1650	73.35	1863	8.07	205	0.177	4.5	0.0118	0.30	58	0.40		
71	1800	70.87	1800	79.25	2013	8.07	205	0.177	4.5	0.0118	0.30	58	0.40		
80	2000	78.74	2000	87.13	2213	8.07	205	0.177	4.5	0.0118	0.30	58	0.40		

TABLE 3 Dimensions and Pipe Stiffness for Single-Wall Pipe and Double-Wall Pipe – Type III (V-shaped profile)

Nominal Size		Inside Diameter		Outside Diameter		Pitch		Waterway Wall Thickness (min)		Minimum Steel Thickness		Minimum Pipe Stiffness	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	MPa	psi
8	200	8.0	203	9.1	231.1	2.36	60.0	0.059	1.5	0.0118	0.30	0.55	80
10	250	10.0	254	10.95	278.1	2.36	60.0	0.059	1.5	0.0118	0.30	0.55	80
12	300	12.0	305	13.3	338.0	2.36	60.0	0.059	1.5	0.0118	0.30	0.55	80
15	375	15.0	381	16.3	413.0	2.36	60.0	0.059	1.5	0.0118	0.30	0.45	65
18	450	18.0	457	19.3	489.0	2.44	62.0	0.059	1.5	0.0157	0.40	0.40	58
24	600	24.0	610	25.7	653.0	2.76	70.0	0.059	1.5	0.0157	0.40	0.40	58
30	750	30.0	762	32.2	817.0	3.54	90.0	0.079	2.0	0.0157	0.40	0.40	58
36	900	36.0	915	38.2	970.0	3.94	100.0	0.079	2.0	0.0157	0.40	0.40	58
42	1050	42.0	1067	44.4	1128.0	3.94	100.0	0.079	2.0	0.0157	0.40	0.40	58
48	1200	48.0	1220	52.0	1320.0	6.30	160.0	0.157	4.0	0.0157	0.40	0.40	58
60	1500	60.0	1524	65.2	1656.0	7.68	195.0	0.157	4.0	0.0157	0.40	0.40	58

TABLE 4 Dimensions and Pipe Stiffness for Single-Wall Pipe and Double-Wall Pipe – Type IV (V-shaped profile)

Nominal Size		Inside Diameter		Outside Diameter		Pitch		Waterway Wall Thickness (min)		Minimum Steel Thickness		Minimum Pipe Stiffness	
inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	MPa	psi
8	200	8.0	203	9.1	231.1	2.36	60.0	0.059	1.5	0.0118	0.30	0.40	58
10	250	10.0	254	10.95	278.1	2.36	60.0	0.059	1.5	0.0118	0.30	0.40	58
12	300	12.0	305	13.3	338.0	2.36	60.0	0.059	1.5	0.0118	0.30	0.40	58
15	375	15.0	381	16.3	413.0	2.36	60.0	0.059	1.5	0.0118	0.30	0.40	58
18	450	18.0	457	19.3	489.0	2.44	62.0	0.059	1.5	0.0118	0.30	0.275	40
24	600	24.0	610	25.7	653.0	2.76	70.0	0.059	1.5	0.0118	0.30	0.235	34
30	750	30.0	762	32.2	817.0	3.54	90.0	0.079	2.0	0.0118	0.30	0.200	29
36	900	36.0	915	38.2	970.0	3.94	100.0	0.079	2.0	0.0118	0.30	0.155	22.5
42	1050	42.0	1067	44.4	1128.0	3.94	100.0	0.079	2.0	0.0118	0.30	0.145	21
48	1200	48.0	1220	52.0	1320.0	6.30	160.0	0.157	4.0	0.0118	0.30	0.135	20
60	1500	60.0	1524	65.2	1656.0	7.68	195.0	0.157	4.0	0.0118	0.30	0.105	15

shall meet the requirements of a soil tight joint unless otherwise specified by the manufacturer.

6.6.3 *Joint Tightness:*

6.6.3.1 *Watertight Joints*—Gasketed watertight joints, when utilized, shall meet the requirements of Specification using a pressure of a 10.8 psi (74 kPa) and a vacuum of 10.8 psi (74 kPa).

6.6.3.2 *Soil-tight Joints*—Soil tight joints are specified as a function of opening size, channel length and backfill particle size. If the size of the opening exceeds 3 mm, the length of the channel shall be at least four times the size of the opening. A backfill material containing a high percentage of fine-graded soils requires investigation for the specific type of joint to be used to guard against soil infiltration. Information regarding joint soil tightness criteria can be found in AASHTO's Standard Specification for Highway Bridges, Division II, Section 30, "Metal Culverts".

6.6.3.3 *Silt-tight joints*—Silt tight joints shall be used where the backfill material has a high percentage of fines. Silt tight joints shall meet laboratory tests in accordance with Test Method except that the joint shall be tested using 2.0 psi (14 kPa).

6.6.4 Where these connections are not practical or undesirable because of space, layout, or other requirements, joining methods such as external snap couplers, split couplers, and so forth that are equally effective are to be used.

NOTE 5—Only fittings and couplers supplied or recommended by the pipe manufacturer shall be used.

7. Sampling and Retest

7.1 *Sampling*—Samples of pipe and fittings sufficient to determine conformance with this specification shall be taken at random from stock by the testing agency. Samples shall be representative of the product type under consideration.

7.2 *Retest and Rejection.*—Retesting in the event of a test failure shall be conducted on samples from the failed lot only under an agreement between purchaser and seller. There shall be no changes to the test procedures or the requirements.

8. Test Methods

8.1 *Conditioning Test Specimens*—Condition the specimen prior to test at 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity for not less than 24 h prior to the test, in accordance with Procedure A in Practice for those tests where conditioning is required, unless otherwise specified.

8.2 *Test Conditions*—Conduct tests in a laboratory atmosphere of 73.4 ± 3.6°F (23 ± 2°C) and 50 ± 5 % relative humidity, unless otherwise specified.

8.3 *Inside Diameter*—Measure the inside diameter of three 1-ft (300-mm) long specimens, with any suitable device accurate to ± 1⁄32 in. (0.8 mm), at two positions, namely, any point in the circumferential direction and 90° from this point, and average the six measurements.

8.4 *Outside Diameter*—Measure the outside diameter of three, 1-ft (300-mm) long specimens, with any suitable device accurate to ± 1⁄32 in. (0.8 mm), at two positions, namely, any point in the circumferential direction and 90° from this point, and average the six measurements.

8.5 *Pipe wall*—measure the wall thickness, in the waterway, in the gaps between the profile.

8.6 *Length*—Measure the pipe with any suitable device accurate to ± 1⁄32 in. (0.8 mm) in 10 ft. (3 m). Make all measurements on the pipe while it is resting on a relatively flat surface, in a straight line, with no external tensile or compressive forces exerted on the pipe.

8.7 *Pipe Stiffness*—Select a minimum of three pipe specimens and test for pipe stiffness F/Δy, as described in Test Method D2412, except for the following conditions for single-wall pipe, double-wall pipe, and triple-wall pipe: (*1*) Specimens shall be cut vertically starting parallel to the corrugation, cut mid valley to mid valley along the corrugation, and then cut across the corrugation, or the pipe shall be cut vertically. (*2*) Specimens shall be longer than 18 inches (457 mm) in length. (*3*) Locate the first specimen in the loading machine with the imaginary line between two corrugations parallel to the loading plates. The specimen must lie flat on the plate within 1⁄8 in. (3 mm). Use the first location as a reference point for rotation of the other two specimens. Rotate the second specimen 45° and the third specimen 90°. Test each specimen in one position only. (*4*) Testing speed of the specimens shall be 0.5 inches (12.7 mm) per minute for testing up to 5 % deflection. For testing beyond 5 % deflection, test at a speed of 5 in./min. (*5*) The deflection indicator shall be readable and accurate to +0.001 in. (+0.02 mm). (*6*) The parallel plates must exceed the samples in length.

8.8 *Joint Tightness*—Test for Joint tightness for watertight joints in accordance with Specification D3212.

9. Installation

9.1 It is recommended that pipe used in sub drain applications shall be installed in accordance with Practice F449, pipe used in storm sewer and other applications shall be installed in accordance with Practice D2321.

10. Certification

10.1 Upon request of the user, the manufacturer shall provide certification that the product was manufactured and tested in accordance with this specification. This certification shall be furnished at the time of shipment.

11. Marking

11.1 *Quality of Marking*—The marking shall be applied to the pipe in such a manner that it remains legible (easily read) after installation and inspection. It shall be placed, at least, at the end of each length of pipe or spaced at intervals of not more than 10 ft (3.0 m).

11.2 *Markings*—Each standard and random length of pipe in compliance with this specification shall be clearly marked by the producer with the following information: this designation, (ASTM F2435), the nominal pipe size, the legend SRPCP, the manufacturer's name, trade name, or trademark, the manufacturer's production code, identifying plant location, machine, and date of manufacture.

12. Report

12.1 The report shall include the following:

12.1.1 Date or dates of tests;

12.1.2 Complete identification of the product tested, including size, nomenclature, manufacturer, lot number, previous history, if any, and so forth;

12.1.3 Description of manufacturer's product marking;

12.1.4 Conditioning method;

12.1.5 Details of sampling;

12.1.6 Individual test results, and the average test results;

12.1.7 Notation describing any retests due to previous test failure; and

12.1.8 Description of terms.

13. Packaging

13.1 All pipe, unless otherwise specified, shall be packed or loaded onto a carrier, for standard commercial shipment.

14. Quality Assurance

14.1 When the product is marked with the designation, Specification F2435, the manufacturer affirms that the product was manufactured, inspected, sampled, and tested in accordance with this specification and has been found to meet the requirements of this specification.

15. Keywords

15.1 Corrugated; perforated; polyethylene; steel reinforced; pipe

SUPPLEMENTARY REQUIREMENTS

GOVERNMENT/MILITARY PROCUREMENT

These requirements apply only to Federal/Military procurement, not domestic sales or transfers.

S1. *Responsibility for Inspection*—Unless otherwise specified in the contract or purchase order, the producer is responsible for the performance of all inspections and test requirements specified herein. The producer may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless the purchaser disapproves. The purchaser shall have the right to perform any of the inspections and tests set forth in this specification where such inspections are deemed necessary to ensure that material conforms to prescribed requirements.

NOTE S1.1—In U.S. federal contracts, the contractor is responsible for inspection.

S2. *Packaging and Marking for U.S. Government Procurement:*

S2.1 *Packaging*—Unless otherwise specified in the contract, the materials shall be packaged in accordance with the supplier's standard practice in a manner ensuring arrival at destination in satisfactory condition and which will be acceptable to the carrier at lowest rates. Containers and packaging shall comply with Uniform Freight Classification rules or National Motor Freight Classification rules.

S2.2 *Marking*—Marking for shipment shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military agencies.

NOTE S2.1—The inclusion of U.S. Government procurement requirements should not be construed as an indication that the U.S. Government uses or endorses the products described in this specification.

APPENDIXES

(Nonmandatory Information)

X1. COUPLINGS

X1.1 The couplings should not reduce or impair the overall integrity or function of the pipe.

X1.2 Couplings should not reduce the capacity of the pipe being joined.

X2. AUTHORITIES

X2.1 Since this product has a wide variety of uses, approval for its use rests with various agencies. The installer should contact the relevant authority to obtain local installation guidelines. A partial list of authorities, according to product usage is as follows:

X2.1.1 *Farm Drainage*—U.S. Department of Agriculture, Soil Conservation Service, local office: reference, Engineering Standard 606.

X2.1.2 *Roadway Drainage*—Federal, state, county, or local highway authority.

SUMMARY OF CHANGES

Committee F17 has identified the location of selected changes to this standard since the last issue (F2435–12) that may impact the use of this standard.

(1) 1.1 was revised

ASTM C655	Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe
ASTM C1433	Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culvers, Storm Drains, and Sewers
ASTM D1056	Standard Specification for Flexible Cellular Materials Sponge or Expanded Rubber
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride)(PVC) Sewer Pipe and Fittings
ASTM D3212	Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D6690	Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F667	Standard Specification for 3” through 24” Corrugated Polyethylene Pipe and Fittings
ASTM F714	Standard Specification for Polyethylene (PE) Plastic Pipe (DR PR) Based on Outside Diameter
ASTM F794	Standard Specification for Poly (Vinyl Chloride)(PVC)Profile Gravity Sewer Pipe & Fittings Based on Controlled Inside Diameter
ASTM F894	Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F949	Standard Specification for Poly (Vinyl Chloride)(PVC) Corrugated Sewer Pipe With a Smooth interior and Fittings
ASTM F2435	**Standard Specification for Steel Reinforced Polyethylene (PE) Corrugated Pipe**
ASTM F2562	Standard Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewage
ASTM F2736	Standard Specification for 6” to 30” (152mm to 762mm) Polypropylene (PP) Corrugated Single and Double Wall Pipe
ASTM F2764	Standard Specification for 30” to 60” (750mm to 1500mm) Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications
ASTM F2881	Standard Specification for 12” to 60” (300 to 1500mm) Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications

END ITEM D-701

Model Specification

Steel Reinforced High Density Polyethylene Pipe (SRHDPE)

KanaPipe

Table of Contents

1. Intent

The intent of this document is to specify the appropriate pipe material and installation methods for ball and spigot steel reinforced high density polyethylene pipe (SRHDPE).

2. Reference Specifications

This document references the following specifications, including ASTM, that are made part hereof by such reference and shall be the latest edition and revision.

ASTM F2435	Standard Specification for Steel Reinforced Polyethylene (PE) Corrugated Pipe
ASTM A591/A591M	Specification for Steel Sheet, Electrolytic Zinc-Coated, for Light Coating Weight (Mass) Applications
ASTM A653/A653M	Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
ASTM 1008/1008M	Specifications for Steel, Sheet, Cold-Rolled Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
ASTM D618	Practice for Conditioning Plastics for Testing
ASTM D2122	Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings
ASTM D2321	Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2412	Test Method for Determination of External Loading Characteristic of Plastic Pipe by Parallel-Plate Loading
ASTM D3212	Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3350	Specification for Polyethylene Plastics Pipe and Fittings Materials
ASTM F412	Terminology Relating to Plastic Piping Systems

ASTM F449	Practice for Subsurface Installation of Corrugated Polyethylene Pipe for Agricultural Drainage or Water Table Control
ASTM F477	Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F2136	Test Method for Notched, Constant Ligament-Stress (NCLS) Test to Determine Slow-Crack-Growth Resistance of HDPE Resins or HDPE Corrugated Pipe
FED. STD. No. 123	Marking for Shipment (Civil Agencies)
MIL-STD-129	Marking for Shipment and Storage

3. Pipe and Gasket Material Requirements

3.1 Polyethylene Materials

3.1.1 Polyethylene compounds used in steel reinforced corrugated PE pipe shall meet or exceed the cell classification of 333430C as defined by ASTM D3350.

3.1.2 Slow crack growth resistance of Polyethylene shall be determined in accordance with ASTM F2136.

3.1.3 Carbon black content of polyethylene shall be a minimum 2.0% to a maximum 3.0% by weight of carbon black.

3.2 Steel Materials

3.2.1 The minimum thickness shall be according to ASTM F2435. The steel substrate shall conform to ASTM A1008/A1008M or A653/A653M. The minimum yield strength of the steel shall not be less than 24.66 ksi. The zinc-galvanized coating shall have a minimum zinc coating designation of 20Z as defined in ASTM A591/A591M.

3.2.2 The Steel material content shall be a maximum 75% (±2%) of the total weight of the pipe. Steel shall be fully encapsulated by polyethylene material with a minimum thickness of 0.012 in. at the thinnest point.

3.3 Gasket

3.3.1 Elastomeric gaskets shall comply with the requirements specified in ASTM F477.

3.4 Lubricant

3.4.1 The lubricant used for the assembly of the gasketed joints shall have no detrimental effect on the gasket or on the pipe.

3.5 Rework Material

3.5.1 Rework material is not to be used in the manufacture of this product.

4. Pipe Requirements

4.1 The pipe shall be KanaPipe Type IV LS manufactured by Kanaflex Corporation.

4.2 The pipe shall be double-wall steel reinforced polyethylene corrugated pipe as defined in ASTM F2435.

4.3 The pipe be shall be manufactured per ASTM F2435 specifications with regards to inside diameter, outside diameter, wall thickness, and length.

4.4 Pipe minimum stiffness shall be as shown in ASTM F2435 at 5% deflection when tested in accordance with ASTM D2412.

4.5 The mechanical bond between steel and polyethylene shall be greater than the tensile strength of the polyethylene resin required for this standard. There shall be no separation of the polyethylene from the reinforcing steel up to 40% deflection when tested in accordance with ASTM D2412.

4.6 The pipe shall be homogenous throughout and free from visible holes, crack or other injurious defects. The pipe shall be as uniform as commercially practical in color, opacity, density and other physical properties.

5. Installation Procedures

5.1 Gravity or low pressure pipe installations to be installed in accordance with ASTM D2321.

5.2 Field joining to be performed per manufacturer's recommendations.

Kanapipe Installation Guide

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INTRODUCTION

This installation guide provides a brief explanation for proper installation of Kanapipe. Additional install guidance can be found in the following industry practices and standards:

1. ASTM F449-02 (or later) “Practice for Subsurface Installation of Corrugated Polyethylene Pipe for Agricultural Drainage or Water Table Control.”
2. ASTM F1417-05 (or later) “Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air.”
3. ASTM F1668-96 (2002) (or later) “Construction of Buried Plastic Pipe.”
4. ASTM D2321-05 (or later) “Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.”
5. ASTM F2435 -12 (or later) “Standard Specification for Steal Reinforced Polyethylene (PE) corrugated pipe”

Any discrepancies between this installation guide and the above referenced standards and practices should be brought to the attention of Kanaflex Corporation prior to proceeding with installation. It is noted that this installation guide is not intended to supersede the procedures established by the design engineer for a specific project or site condition.

Kanapipe Features and Benefits

Kanapipe is intelligently designed to combine the durability characteristics of corrugated high density polyethylene (HDPE) and the strength of corrugated steel pipe. This composite of two highly successful pipe materials results in:

1. **Chemical and abrasion resistance** - Kanapipe HDPE and exclusive bell and spigot design encapsulates the steel components creating a highly durable pipe

product resistant to corrosion and deterioration caused by stormwater, industrial wastewater, and sanitary sewer. The hot spring water, etc. The pipe wall is also resistant to abrasion caused by soil and dirt mixed into wastewater.

2. **Hydraulics** - Hydraulically efficient pipe product with the Mannings “n” coefficient ranging from 0.011 to 0.013, depending on flow velocity
3. **Bell and Spigot** - Patented bell and spigot water tight joint technology exceeds the pipe joint test requirements of ASTM D3212. Kanapipe pipe joints are all certified to meet a minimum of 20 psi pressure. The Kanapipe joints have been certified as Earthquake resistant by the XXXXXXX which is an international certification agency.
4. **Composite Structure** - Kanapipe steel reinforcing provides superior structural properties for traffic and deep burial applications. Steel reinforcing eliminates the temperature effect on the strength of HDPE. Traditional black HDPE products can reach up to 165°F when stored in the sun and loose approximately 30% of its strength. Kanapipe’s steel reinforcing does not loose strength, which results in a user friendly installation in all environmental conditions.
5. **Handling** – Lighter weight and longer pipe lengths results in a contractor friendly pipe which reduces size requirement of construction equipment, transportation cost and related installation time. The economic benefits of the longer pipe lengths, lighter weight, quick bell and spigot joint assembly and greater structural characteristics of steel reinforcing reduce labor cost when installing in accordance with ASTM D2321.
6. **High Performance Applications** – Kanapipe’s steel reinforcing, high performance bell and spigot joints and inert HDPE pipe walls create a high performances composite structure suitable for deep burials and corrosive environments of sanitary sewer and industrial waste.

In addition to the features described above general pipe dimensions are shown in Figure 1 and Table 1 below.

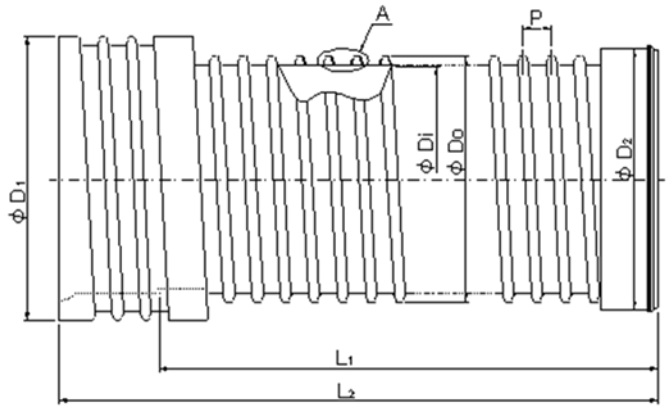


Figure 1 – General Pipe Dimensions

Nominal diameter in (mm)	Pipe Dimensions (1)			Bell and Spigot Joint(1)		Length(1)	
	Pipe OD (Do) in (mm)	Pipe ID (Di) in (mm)	Pitch (P) in (mm)	Bell OD (D_1) in (mm)	Spigot OD (D_2) in (mm)	Lay Length (L_1) ft (mm)	Total Length (L_2) ft (mm)
12" (300)	13.3 (338)	12.0 (305)	2.36 (60)	15.94 (405)	14.09 (358)	20 (6100)	20.5 (6248)
15" (375)	16.3 (413)	15.0 (381)	2.36 (60)	18.90 (480)	17.05 (433)	20 (6100)	20.5 (6248)
18" (450)	19.3 (489)	18.0 (457)	2.44 (62)	22.05 (560)	20.04 (509)	20 (6100)	20.5 (6248)
24" (600)	25.7 (653)	24.0 (610)	2.76 (70)	28.54 (725)	26.50 (673)	20 (6100)	20.5 (6258)
30" (750)	32.2 (817)	30.0 (762)	3.54 (90)	35.04 (890)	33.11 (841)	20 (6100)	20.6 (6268)
36" (900)	38.2 (970)	36.0 (915)	3.94 (100)	41.14 (1045)	39.13 (994)	20 (6100)	20.6 (6278)
42" (1050)	44.4 (1128)	42.0 (1067)	3.94 (100)	47.44 (1205)	45.35 (1152)	20 (6100)	20.7 (6303)
48" (1200)	52.0 (1320)	48.0 (1220)	6.30 (160)	57.68 (1465)	53.39 (1356)	20 (6100)	20.8 (6345)
60" (1500)	65.2 (1656)	60.0 (1524)	7.68 (195)	70.91 (1801)	66.54 (1690)	20 (6100)	21.0 (6405)

Note: 1. See Figure 1, above.

Table 1 – General Pipe and Joint Dimension

Job Site Receiving, Handling and Storage

Upon pipe shipment arrival, the pipe shipment should be inspected for any damage that might have occurred by the shipper and to ensure the accuracy of the shipment. All shipments will include a bill of lading and an adequate amount of pipe joint lubrication. The bill of lading should be compared to the shipped pipe, gaskets and fitting. Any discrepancies should be immediately reported to the transportation company representative at the time of delivery.

Unloading Kanapipe and fittings should be performed in accordance with all OSHA safety requirements. The method of unloading pipe is ultimately the responsibility and decision of the customer. Equipment such as forklifts, cranes, cherry pickers or fount-end loaders equipped with forks are traditionally used. All operators should be adequately trained for safe operation of the equipment and handling the load.

When removing cargo restraints, such as tiedown straps, ropes or chains, extreme caution must be used. The load may have shifted, which could result in pipe falling from the truck. If a forklift is used to remove pipe, the operator should exercise care to avoid running the forks too far under the pipe, since the forks may strike adjacent of pipe or push pipe off the opposite side of the truck. If a crane or front end loader is used, it is recommended using a spreader bar with nylon (or synthetic) straps or protected cables to avoid damage to the pipe. When lifting the pipe, straps should be placed approximately 8 feet apart as shown in Figure 2 below:

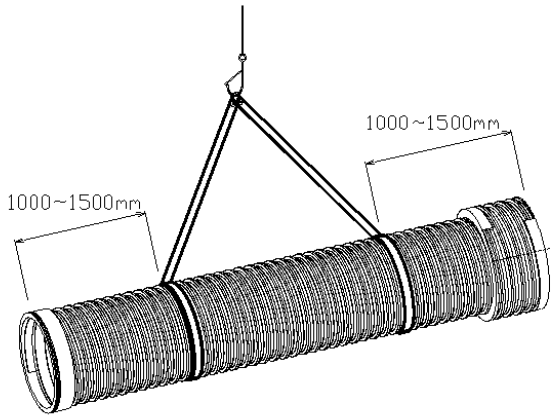


Figure 2 – Recommended Lifting Configuration

Dragging or dropping pipe from the truck, handling with a single chain or cable, or using forks directly on the inside of the pipe is not recommended and doing so will void any warranties.

Pipe should be stored on a flat surface Job site storage of pipe should be in a location that is out of the way of construction equipment. Palletized pipe should not be stacked over two pallets in height. Storage of individual pipe lengths should not be stacked in piles not greater than 5 feet high. The individual pipe lengths should be stacked in alternating directions to prevent bell and spigots from coming in contact with each other. Chock blocks or other suitable method should be used to prevent the stacked pipe from rolling.

WARNING

Not adhering to these instructions may result in serious injury to pipe and/or people. Do not stand or climb on stacked pipe. Stand clear of pipe during unloading. Always follow project, local, state and OSHA safety requirements and rules.

TRENCH CONSTRUCTION

The trench width is determined based on the pipe diameter, backfill material, compaction equipment an in-situ soils. If the in-situ (or native) soils are unstable a trench box or other approved bracing should be used for worker safety. The width of the trench needs to be wide enough for a person to work safely within the trench. The minimum clear width between the pipe springline and the trench should be 1 foot. ASTM D2321 provides guidance for the proper use and movement of trench boxes. It is noted that improper movement of the trench box may disturb the compacted back fill and adversely affect pipe performance. Minimum trench widths are as shown in Table 2 below.

It is noted that these minimum trench widths shown in Table 2 are recommendations only and the does not supersede requirements specified by the project engineer. However trench widths should be kept to a minimum to avoid excessive excavation cost. If the pipe is installed in a compacted embankment, pipe embedment should be compacted at least 2.5 pipe diameters from the pipe on both sides of the pipe or to the trench walls, whichever is less.

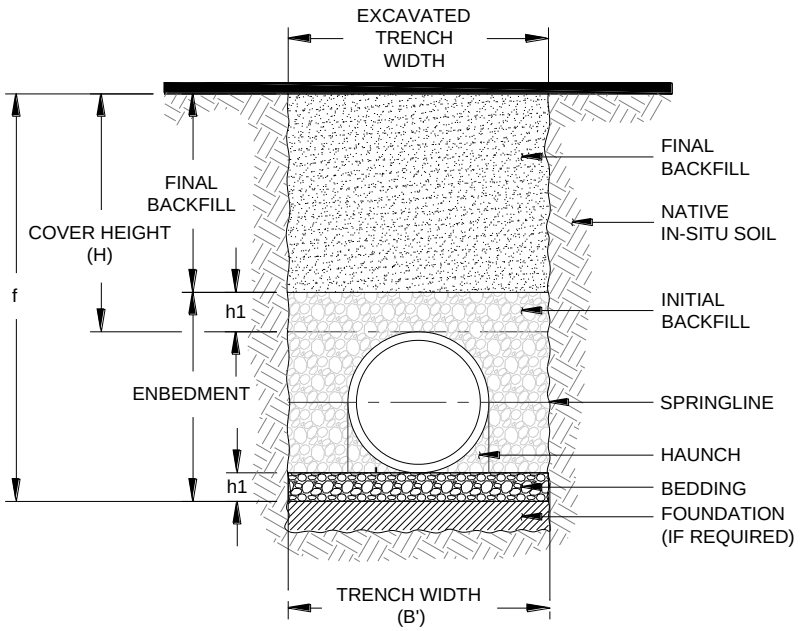


Figure 3 – General Trench and Embedment Terminology

Critical Dimensions for Trench Installation		
Nominal diameter in (mm)	Trench Width B' in (m)	Bedding height h1 in (m)
8 (200)	25 (0.6)*	6 (0.15)*
10 (250)	27 (0.7)*	6 (0.15)*
12 (300)	29 (0.7)*	6 (0.15)*
15 (375)	33 (0.8)	6 (0.15)
18 (450)	36 (0.9)	6 (0.15)
24 (600)	44 (1.1)	8 (0.20)
30 (750)	52 (1.3)	8 (0.20)
36 (900)	60 (1.5)	8 (0.20)
42 (1050)	68 (1.7)	12 (0.30)
48 (1200)	77 (2.0)	12 (0.30)
60 (1500)	94 (2.4)	12 (0.30)

Table 2 – Minimum Critical Dimensions for Trench Installation

Embankment Installations

It is noted that the backfill envelope for embankment installations requires design parameters and dimensions for the construction of a structural sound embedment of the pipe. Recommended critical dimensions are shown in Figure 4 and Table 3 below.

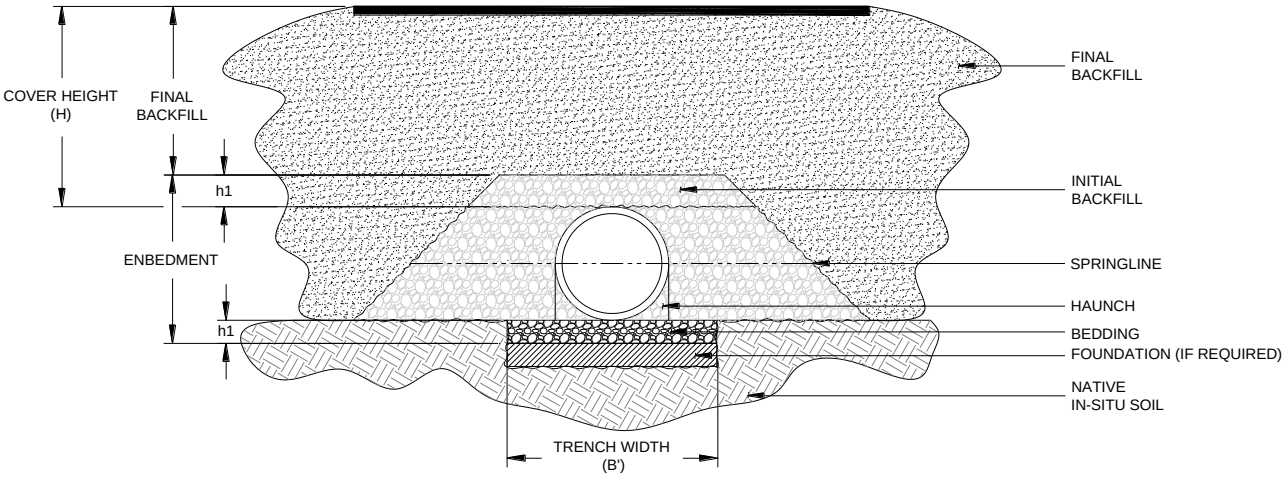


Figure 4 – General Embankment and Embedment Terminology

Critical Dimensions for Embankment Installation		
Nominal diameter in(mm)	Trench Width B' in (m)	Bedding height h1 in (m)
8 (200)	25 (0.6)*	6 (0.15)*
10 (250)	27 (0.7)*	6 (0.15)*
12 (300)	29 (0.7)*	6 (0.15)*
15 (375)	35 (0.9)	6 (0.15)
18 (450)	39 (1.0)	6 (0.15)
24 (600)	51 (1.3)	8 (0.20)
30 (750)	59 (1.5)	8 (0.20)
36 (900)	63 (1.6)	8 (0.20)
42 (1050)	71 (1.8)	12 (0.30)
48 (1200)	87 (2.2)	12 (0.30)
60 (1500)	102 (2.6)	12 (0.30)

Table 3 – Minimum Critical Dimensions for Embankment Installation

Backfill Envelope

Backfill envelope design for trench installations (which includes the foundation, bedding and embedment) should be determined as part of the structural design for Kanaflex pipe materials. ASTM D2321 is the recommended basis for installation recommendations in trafficked installations, with the exception the minimum allowable cover is 12-inches for 48-inch diameter and smaller and a minimum of 24-inches for 60-inch diameter. Figure 3 below illustrates general trench and embedment terminology used in this guide.

Foundations

The foundation material must be stable and capable of supporting the pipe installation. Unstable trench bottoms must be stabilized as directed by the engineer. If soft soil, such as peat or muck, is encountered, typical corrective measures are to remove and replace the soil in question with suitable bedding material. Additionally, if rock or unyielding foundation material is found, that material should be over excavated to

approximately 12” and replaced with suitable foundation material, as directed by the engineer.

Bedding

The bedding material is placed in the bottom of the trench, to provide uniform support to maintain line and grade for the pipe. A loosely placed zone of bedding is placed in the middle 1/3 of the trench bottom whereas the outer 1/3 of the bedding is compacted. The bedding should be placed so that Kanapipe is at the correct grade when backfilled. The minimum recommended bedding thickness is four inches for 8”-36” diameter pipe and a minimum of six inches for 42”-60” diameter pipe. Recommended bedding material is a class I, class II or class III material as defined in ASTM D2321 and Table 4 below.

Table 4 – Recommended Pipe Embedment Materials

PIPE EMBEDMENT MATERIALS						
Class	**ASTM D2321[1] Description**	**ASTM D2487 Notation**	**Description**	**AASHTO M43 Notation**	**Min. Std. Proctor Density[2] (%)**	**Lift Placement Depth**
IA	Open-graded, clean manufactured aggregates	N/A	Angular crushed stone or rock, crushed gravel, crushed slag; large voids with little or no fines	5 56	Dumped	18” (0.5m)
IB	Dense-graded, clean manufactured, processed aggregates	N/A	Angular crushed stone or other Class IA material and stone/sand mixtures; little or no fines			
II	Clean, coarse-grained soils	GW	Well-graded gravel, gravel/sand mixtures; little or no fines	57 6 67	85%	12" (0.3m)
		GP	Poorly-graded gravels, gravel/sand mixtures; little or no fines			
		SW	Well-graded sands, gravelly sands; little or no fines			
		SP	Poorly-graded sands, gravelly sands; little or no fines			
III	Coarse-grained soils with fines	GM	Silty gravels, gravel/sand/silt mixtures	Gravel and sand with <10% fines	90%	9" (0.2m)
		GC	Clayey gravels, gravel/sand/clay mixtures			
		SM	Silty sands, sand/silt mixtures			
		SC	Clayey sands, sand/clay mixtures			
IVA	Inorganic fine-grained soils	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, silts with slight plasticity		NR	
		CL	Inorganic clays of low to medium plasticity; gravelly, sandy, or silty clays; lean clays			
IVB	Inorganic fine-grained soils	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		NR	
		CH	Inorganic clays of high plasticity, fat clays			
V	Organic or highly organic soils	OL	Organic silts and organic silty clays of low plasticity		NR	
		OH	Organic clays of medium to high plasticity, organic silts			
		PT	Peat and other high organic soils			

Note:

(1) Class III material should only be used in dry trench conditions where minimum densities can be achieved. Maximum particle size should not exceed 1.5".
(2) Higher densities may be required as specified by the engineer.
(3) NR – Not recommended embedment material.

Haunching

The haunch is the area of embedment that extends from the bedding up to the spring line of the pipe. Getting adequate material into the haunch area, and compacting as necessary, provides a major portion of the pipe's support against the soil and traffic loads. Poor placement and compaction of embedment workmanship, especially in the haunch area, will lead to excessive pipe deflection and grade and alignment problems. Haunching materials can be Class I, II, or III per ASTM D2321. Maximum lifts and compaction are shown in Table 4 above. As previously mentioned special care must be taken to avoid disturbing the backfill in the haunch area when moving trench boxes.

When beginning the backfilling process, the embedment material should be distributed and compacted in lifts evenly on each side of the pipe to ensure that lateral loads on the pipe do not pushed out of alignment. Dumping or "raining" embedment material with the backhoe bucket in the center of the pipe and allowing it to fall evenly on each side of the pipe results in evenly distributes backfill loads, which maintains pipe alignment in the trench.

Initial Backfill

Initial backfill extends from the spring line to a minimum of six inches (0.15 m) above the crown of the pipe. Initial backfill should be placed in lifts or layers. The maximum lift height is determined by the type of backfill material and pipe diameter. Lift heights should not to exceed one half the pipe diameter or those as shown in Table 4 above. When using a material that requires compaction it is important not to use mechanical compaction equipment directly on the pipe itself.

Clean crushed stone, may not require compaction but using a shovel to “knifing” the crushed stone under and around the pipe in the haunch area to eliminate any voids provides critical support for the pipe. Other backfill materials require a greater level of compaction. Table 4 specifies the minimum level compaction, however depending upon the burial depth and the engineer’s design the required level of compaction may exceed the minimum compaction listed in Table 4. The specific degree of compaction should be determined by the project engineer or a geotechnical engineer based on the soil properties and burial depth.

Final Backfill

Final backfill extends from the initial backfill layer to the finished grade. For 8- to 48-inch (200mm-1,200mm) diameters the final backfill shall be a minimum of six inches (0.15 m) and shall be a minimum of eighteen inches (0.5 m) for 60-inch (1500 mm) diameter. This minimum depth of final backfill shall be measured from the top of the pipe to:

1. the bottom of flexible pavement; or
2. the top of rigid pavement.

When no pavement will be installed, but vehicle traffic is expected (e.g. gravel driveway), a minimum cover of 18” for 4- to 48-inch diameters and 30” for 60-inch diameters is recommended to minimize rutting. In non-trafficked applications native or in-situ material is suitable for final backfill.

COMPACTION OF BACKFILL

The level of compaction will vary depending on the material and installation requirements. Proper selection of compaction equipment depends on the backfill

materials. Compaction methods will depend primarily on the amount of compaction, or modulus of soil reaction, required and the moisture level of the material. At optimum moisture levels, some Class II and III soils can be compacted to minimum recommended levels simply by walking on each backfill lift. While this technique may not be acceptable for all installations, the point is that compaction need not always require a great deal of extra effort or mechanical equipment. If, however, mechanical compaction equipment is needed in the backfill envelope or elsewhere on the site, the subsequent paragraphs provide guidance on compaction equipment and the soils for which they are most appropriate.

Relative Compaction Effort for Backfill				
Soil Classification[(1)]	Compaction Effort	Compaction Method or Equipment	Moisture Control	Maximum Lift
Class I	Low	Hand Knifing, Vibratory, or Impact	None	18”
Class II	Moderate	Vibratory or Impact	Remove standing water from trench	12”
Class III	High	Impact	Near optimum to minimize compaction effort	6”
Class IV	Very High	Impact	Near optimum to achieve required density	NA

Table 5 –Relative Compaction Effort for Backfill

Vibration compactors, as shown, are recommended for non-cohesive soils. Care should be taken to avoid contacting the pipe when using compaction equipment.

Impact compactors, as shown, are recommended for cohesive soils and non-cohesive materials. Impact compactors are most effective for use with cohesive backfill materials. Care should be taken to avoid contacting the pipe when using compaction equipment.

Vibration roller, as shown, are recommended for cohesive soils and non-cohesive materials. Care should be taken to maintain a minimum separation distance from pipe. Minimum separation distances will vary from 1-foot to 3-feet, depending upon the size and weight of the equipment. Contact Kanaflex for specific guidance.

Caution should be used for other compaction equipment such as hydraulic rammers and sheepsfoot rollers. These types of equipment must have separation distances of 4 feet or more. Contact Kanaflex for guidance for specific equipment.

LAYING PIPE

Prior to laying pipe the pipe should be inspected to ensure the pipe has not been damaged and that it is the correct type and size for the project. If the pipe is to be distributed along the trench alignment, the following precautions should be observed:

1. Lay pipe along the trench with the spigot in the direction of the lower or downstream direction. (Note: Pipe should always be assembled with the spigot pushed into the bell. Never push the bell onto the spigot.)
2. Place pipe opposite of the side of the trench the excavated spoils will be stored.
3. Place pipe to protect it from traffic and heavy equipment. Additionally if blasting is required for the project the pipe should be protected from blasts.

When lifting and lowering pipe onto the bedding, utilize a crane with two lifting points. A wide nylon sling is recommended (see Figure 1). Lifting the pipe by a

single point may damage the pipe and is not recommended. Dragging the pipe into place should be avoided. Dragging can damage the pipe and void the warranty.

JOINT ASSEMBLY

The Kanaflex pipe has one of the most robust joint designs in the industry, however proper joint assembly is critical to achieving the desired field performance. The following steps are necessary for proper joint performance:

1. Prior to lowering the pipe the bell and spigot should be cleaned with a rag and inspected for any damage. Additionally the protective film covering the gasket should be removed.
2. Place a home mark on the spigot of the pipe. The home mark should be placed a distance “L” from the end of the spigot. See Table 6 below.
3. Dig a bell hole in the bedding as shown in Figure 6 below. It is noted that the bell hole depth “h” should be 4-inches (100 mm) for 12” to 42” diameter and 6-inches (150mm) for pipe 48” and larger.
4. Once the pipe is lowered in to the trench (as previously described), the inside of the bell and spigot gasket should be lubricated. Special attention should be paid to avoid letting the lubricated spigot come in contact with the bedding material. Bedding material may stick to the spigot, be dragged into the pipe joint and adversely affect the joint performance.
5. Assemble the joint by pushing the spigot into the bell. Never push the bell onto the spigot. Pushing the bell onto the spigot may scoop bedding material into the pipe joint and adversely affect the pipe joint performance.
6. Joint assembly should be accomplished using a come-along or other device to provide a controlled loading during the assembly process. A strap on the bell and spigot ends should be looped around the pipe and the come-along should be used to bring the two ends together. See Figure 6 below for an illustration of the come-along and strap configuration.
7. Once the pipe is joined come-along assembly is removed, the pipe joint must be inspected to ensure the pipe is completely homed.

8. Bell holes must be filled and compacted. Special attention must be given to placement and compaction of bedding material under and around the bell and spigot bell.

Homing Mark Location (L)	
Nominal Diameter	in (mm)
12"—18"	5.8” (148)
24"	6.2” (158)
30"	6.6” (168)
36"	7.0” (178)
42"	8.9” (203)
48"	9.6” (245)
60"	12” (305)

Table 6 – Homing Mark Location

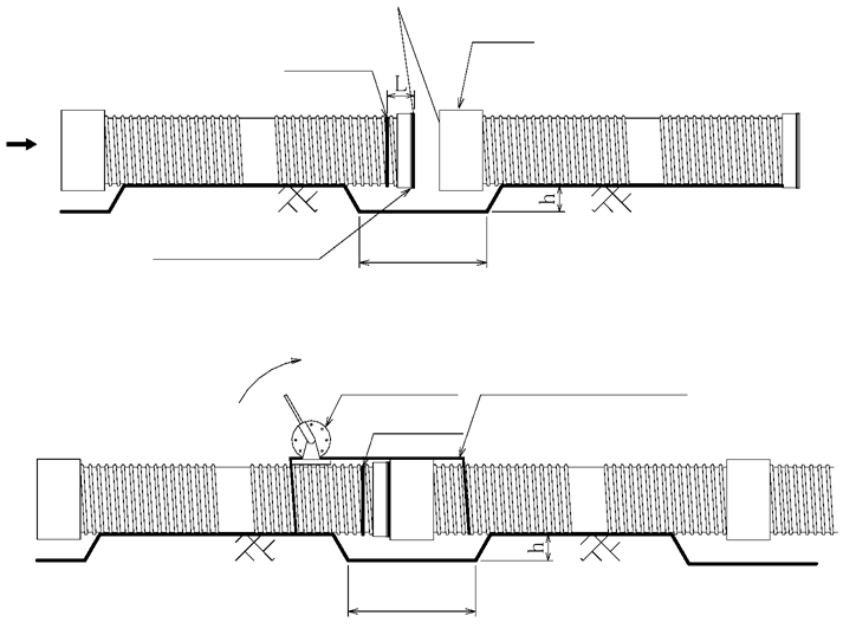


Figure 6 – Bell Holes and Pipe Joint Assembly

Maximum Cover Height

Design calculations for installed Kanapipe are summarized in the Table 7 below.

Table 7 - Maximum Cover for KanaPipe Installed in Trench, ft (m)

	Class 1		Class 2			Class 3		
Diameter	**Compacted**	**Uncompacted**	**95%**	**90%**	**85%**	**95%**	**90%**	**85%**
8”	65		65	30		30		
(200)	(20)		(20)	(9)		(9)		
10”	65		65	30		30		
(250)	(20)		(20)	(9)		(9)		
12”	65		65	30		30		
(300)	(20)		(20)	(9)		(9)		
15”	62		62	30		30		
(375)	(19)		(19)	(9)		(9)		
18”	62		62	17		17		
(450)	(19)		(19)	(8)		(8)		
24”	62		62	26		26		
(600)	(19)		(19)	(8)		(8)		
30”	62		62	26		26		
(750)	(19)		(19)	(8)		(8)		
36”	59		59	23		23		
(900)	(18)		(18)	(7)		(7)		
42”	56		56	23		23		
(1050)	(17)		(17)	(7)		(7)		
48”	56		56	23		23		
(1200)	(17)		(17)	(7)		(7)		
60”	56		56	20		20		
(1500)	(17)		(17)	(6)		(6)		
72”	42		42	20		20		
(1800)								

Notes:

1. Calculations assume no hydrostatic pressure and a density of 112 pcf (1926 kg/m^3) for overburden material.
2. Backfill materials and compaction levels not shown in the table may also be acceptable
3. For projects where cover exceeds the maximum values listed above, contact Kanaflex for specific design considerations.

Groundwater

Where groundwater is present in the trench, it is necessary to dewater in order to maintain stability of the in-situ and imported materials. In order to insure a stable trench bottom, the water level in the trench shall remain below the bedding during the installation procedure.

Kanaflex

Notes for Handling

Thank you for purchasing Kanaflex pipe.
Please follow the instructions below in the loading and unloading, transportation, and handling of the pipe.

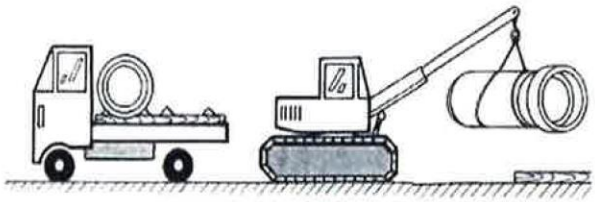
1. Use Fig. 1

   Don't drop, throw, roll, or drag the pipe.

2. Careful handling of the pipe, especially the bell and spigot, is very important. A small damage could cause a large leak.
3. For handling pipe 18" and smaller, please unload by hand.
4. Use Fig. 2

   For handling pipe 24" and larger, please unload with a crane. Do not use a steel cable. Please use a wide nylon belt suspending the pipe from 2 points as shown. Do not loop the belt through the pipe to lift.

Fig. 1



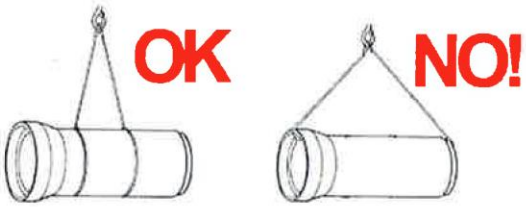


Fig. 2

5. Use Fig. 3

   Please store and transport horizontally. Please strap with a wide nylon belt when transporting. Please use UV sheet to protect from the sun.

6. Use Fig. 4

   During transport, please place the pipe as flat as possible and do not let the pipe come into contact with any objects, including other pieces of pipe.

7. Please store the pipe where it will not come into contact with oil or any chemicals.

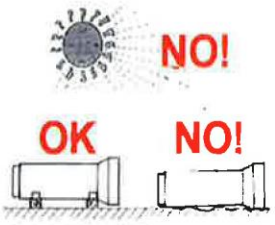


Fig. 3

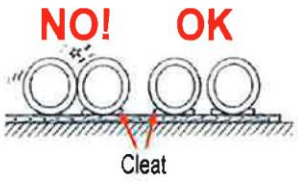


Fig. 4

8. Use Fig. 5

   Please store the pipe flat. Alternate the pipe so adjacent pipe has the bell in opposite directions. Please store the pipe securely. Please consider safety when storing. Do not let the stored pipe collapse.

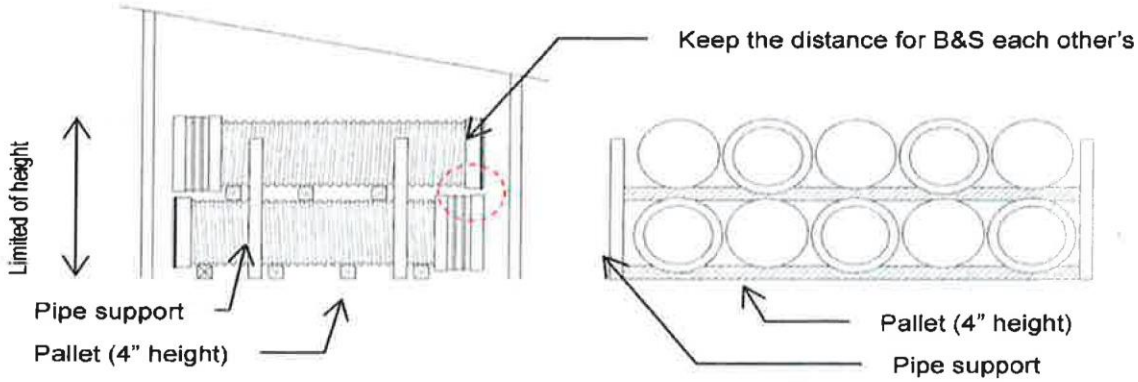


Fig. 5

Kanaflex

Kana Pipe Coupler Installation Manual

Thank you for purchasing Kanapipe Coupler.
Please follow the installation instruction below:

e ITEM# **KPC12 (Kana Pipe Coupler size 12)**

Coupler with Cut and use with Cable Tie

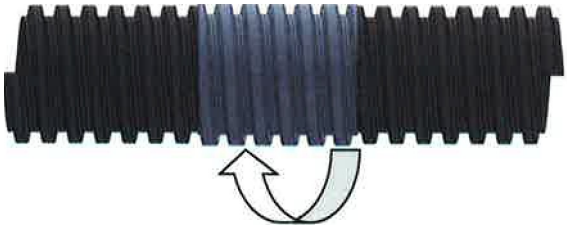
- Connecting Method

1. Screw the KPC Coupler completely into Pipe A

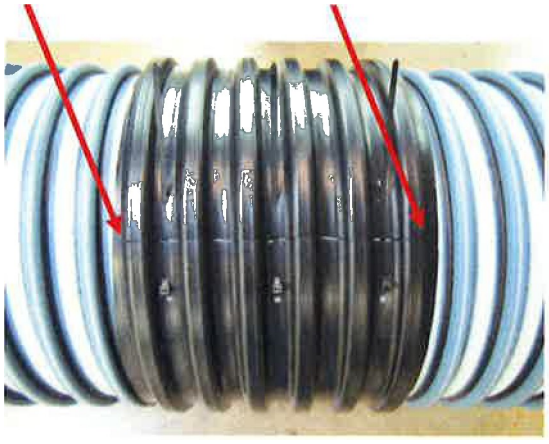
2. Butt the pipe B to pipe A

OOC=>

3. Reverse rotation of the KPC coupler to the center, the seam of pipe A and B falls in the middle of KPC coupler.



4. Cut edge with Knife



5. Tied with provided cable ties come with KPC after cut both edges.

REV-B

INSERTA TEE®

THE LATERAL CONNECTION SOLUTION®

INSERTA TEE® DESCRIPTION

INSERTA TEE is a three piece service connection consisting of a PVC Hub, Rubber Sleeve and Stainless Steel Band. INSERTA TEE is compression fit into the cored wall of a mainline and requires no special tooling. INSERTA TEEs are designed to connect 2” (51 mm) through 30” (750 mm) laterals to all known solidwall, profile, closed profile, corrugated pipe and manhole structures manufactured today.

INSERTA TEE for NEW & REHAB installations allows:

- Reduction in labor hours and pipe materials
- Services to be connected where needed
- Easier grading of mainline
- Matching of the internal radius of your pipe or structure for minimal penetration

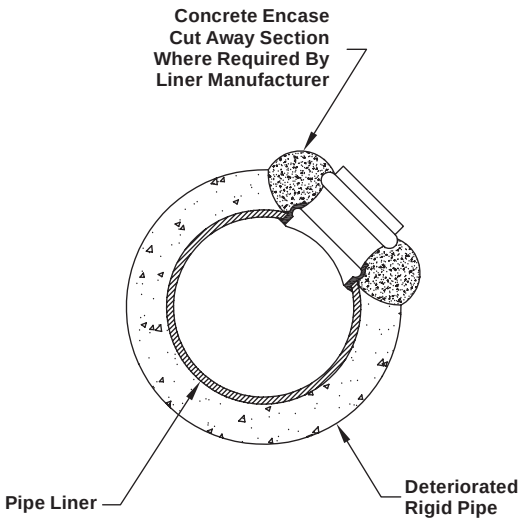
INSERTA TEE for TAPPING EXISTING LINES without disturbing the bedding while eliminating:

- Glues, epoxies and grout
- Tightening and retightening of bands around mainline
- Awkward gaskets

When Sliplining, Pipe Bursting and Relining, INSERTA TEE allows the following:

- Simple installation with no special equipment required
- For Pipe Bursting the connection is made directly into solid wall PE and PVC pipe

Detail for coring—directly into the liner



Applications:

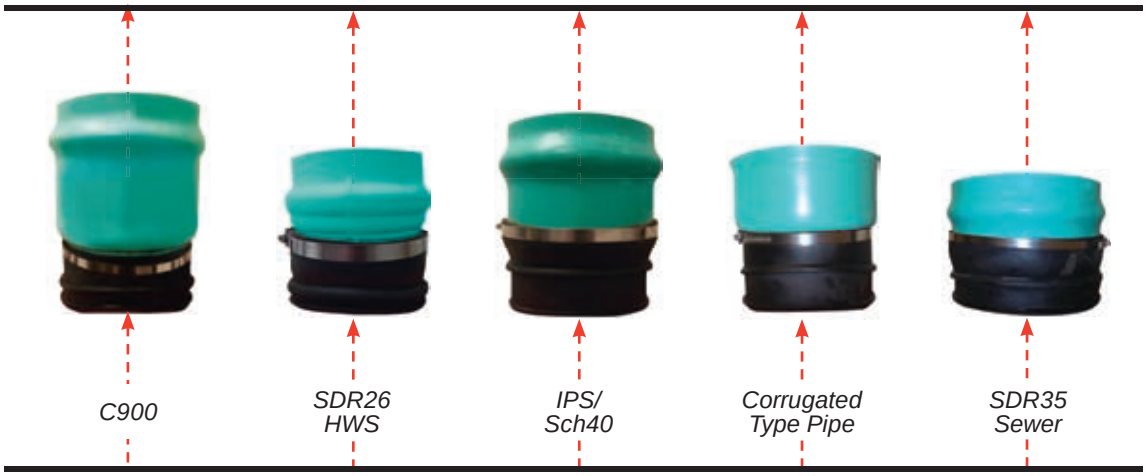
- Sanitary Sewers
- Pipe Bursting (HDPE/PVC)
- Fold-and-Formed Products
- Manholes
- Drainage
- Catch Basins
- Storm Sewers
- Sliplining
- Cured-In-Place Products
- Wet Wells
- Irrigation
- Electrical Vaults

FITS ANY MAINLINE OR STRUCTURE

SPECIFICATIONS

Rubber Sleeve . . . . . .ASTM F477
Band . . . . . .301 SS
Screw . . . . . .305 SS
Housing . . . . . .301 SS
Gasket . . . . . .ASTM F477

Any Mainline or Structure



Lateral

Allow longer lead times for custom fittings such as cast iron or ductile iron.

INSERTA TEE fittings for all gravity flow pipe and manholes

Ductile Iron	Spirolite	Ultra Rib™	Pro 21®
Fiberglass	Hi Q®/Sure-Lok®	PermaLok®	Polyethylene
PVC	Vylon®	Corrugated Metal	Truss®
Ultra Corr™	N-12®	Solflo® Max	A2000®
GOLDFLO®	Kor-Flo™	Concrete	Clay
Weholite®	Asbestos Cement	N-12® HP	SaniTite® HP
DuroMaxx®			

INSERTA TEE construction varies with pipe type and size.
For pipe not listed, contact our engineering department.

EASY, FAST & WATERTIGHT

Coring Machine

INSERTA FITTING's electric coring machine is designed for fast and efficient operation for coring hole sizes up to 30" (750 mm) in any type of pipe.

Recommended for all concrete, clay, fiberglass, ductile iron and also works well with plastic pipe connections over 10".

Coring Machine

Diamond Bits

Our diamond bits are of the highest quality to ensure maximum holes per bit.

Diamond bits are recommended for concrete, clay, fiberglass and ductile iron.

Hole Saws

Our unique designed hole saws allow the user to core fast, smooth and clean holes.

For more detailed information on hole saws, refer to the INSERTA TEE Hole Saws Brochure (#10791).

Handheld Drills

Hole Saw Sizing Chart

INSERTA TEE Size	Hole Saw Size
2" (51 mm)	2 5/8" (67 mm)
4" (100 mm)	4 1/2" (114 mm)
6" (150 mm)	6 1/2" (165 mm)
8" (200 mm)	8 3/4" (222 mm)
10" (250 mm)	10 7/8" (276 mm)
12" (300 mm)	12 7/8" (327 mm)
15" (375 mm)	15 13/16" (402 mm)
18" (450 mm)	19 3/16" (503 mm)
21" (525 mm)	22 9/16" (573 mm)
24" (600 mm)	25 5/16" (643 mm)
27" (675 mm)	28 1/2" (724 mm)
30" (750 mm)	32 17/32" (826 mm)

TESTING INFORMATION*

Northwest Testing Laboratory; Portland, Oregon

Reference Document: ASTM D3212

A 4” INSERTA TEE was installed into an 8” profile pipe with the following results:

- Pressure @16.5 psig for 10 minutes
- Vacuum to 22” Hg for 10 minutes
- Back to room pressure
- Vacuum to 22” Hg for 10 minutes
- No leakage
  - Pipe Deflected 5%
  - Pressure @ 10.8 psig for 10 minutes
  - No leakage

A 4” INSERTA TEE was installed into an 8” smooth wall PVC pipe with the following results:

- Pressure @ 28 psig for 5 minutes
- No leakage

INSERTA TEEs were installed into smooth wall PVC and concrete pipe with the following results:

- Pressure @ 13 psig for 10 minutes
- No leakage

Independent Testing by Major Pipe Manufacturers

Reference Document: ASTM D3212

A 4” INSERTA TEE was installed into a 10” profile pipe with the following results:

- Pressure @ 12 psig for 50 hours
- No leakage

A 6” INSERTA TEE was installed into a 12” profile pipe with the following results:

- Pressure @ 12 psig for 24 hours
- No leakage

A 4” INSERTA TEE installed in 6”–12” solid wall PVC, a 6” INSERTA TEE installed in 8”–12” solid wall PVC and an 8” INSERTA TEE installed in 10”–12” solid wall PVC with the following results:

- Pressure @ 10.8 psig for 10 minutes
- No leakage

INSERTA TEEs (4”, 6” and 8”) installed in SaniTite HP pipe with the following results:

- Pressure @ 10.8 psig for 10 minutes
- No leakage

**This is highlighted testing on common sizes. Testing on additional size combinations available on request.*

INSERTA TEE® PRODUCT SPECIFICATION

Scope

This specification describes 2- through 30-inch (51 to 750 mm) INSERTA TEE service connections for use in gravity-flow sewer and drainage applications.

Product Requirements

INSERTA TEE service connections shall consist of a PVC hub, rubber sleeve and stainless steel band. Connection shall be a compression fit into the cored wall of a mainline pipe. Hub shall be made from heavy-duty PVC material. Stainless steel clamping assembly shall be made from minimum 301 grade steel. Rubber sleeve and gasket, when applicable, shall meet the requirements of ASTM F477. Gaskets shall be installed by the manufacturer. The water-based solution provided by the manufacturer shall be used during assembly. *Do not use pipe lube*.

The INSERTA TEE can be installed into any mainline pipe or structure. Connection hubs are available to connect to: corrugated polyethylene, corrugated polypropylene, PVC C900, SDR 26 HWS, SDR 35 (gasketed bell, SWR spigot & solvent weld bell), IPS/Sch 40 (gasketed bell & solvent weld bell) and corrugated PVC. Custom pipe types available.

Joint Performance

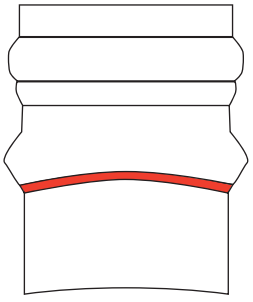
INSERTA TEE product includes a watertight bell connection meeting the requirements of ASTM D3212.

Field Pipe and Joint Performance

To assure watertightness, field performance verification may be accomplished by testing in accordance with ASTM F2487, ASTM C969 or ASTM F1417. Appropriate safety precautions must be used when field-testing any pipe material. Contact the manufacturer for recommended leakage rates.

Installation

Installation shall be in accordance with manufacturer's recommended installation guidelines. The use of installation methods or hole saws not purchased from Inserta Fittings will void the performance warranty of the product. Backfill around the INSERTA TEE service connection shall be of the same material type and compaction level as specified for the mainline pipe installation. Contact your local representative or visit the website at ***www.insertatee.com*** for a copy of the latest installation guidelines.



Product configuration & availability subject to change without notice. Product detail may differ slightly from actual product appearance.

Inserta Fittings Co. p 503.357.2110 | f 503.359.5417 | sales@insertatee.com | insertatee.com

BRO #10790 08/12

TECHNICAL BULLETIN 6.1 Alternate Trench Details

Introduction

Kanaflex Steel Reinforced HDPE pipe has a ring stiffness much greater than most traditional flexible pipe products. As a result of this greater stiffness, the trench and associated embedment requirements may be different that traditional corrugated plastic products. This bulletin is intended for trench installations applications only and provides an alternative trench detail for the use of Kanaflex pipe (see Figure 1 below). As shown in Figure 1, a composite embedment is available for Kanaflex pipe. Additional install guidance can be found in the following industry practices and standards:

1. ASTM F449-02 (or later) “Practice for Subsurface Installation of Corrugated Polyethylene Pipe for Agricultural Drainage or Water Table Control.”
2. ASTM F1417-05 (or later) “Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air.”
3. ASTM F1668-96 (2002) (or later) “Construction of Buried Plastic Pipe.”
4. ASTM D2321-05 (or later) “Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.”
5. ASTM F2435 -12 (or later) “Standard Specification for Steal Reinforced Polyethylene (PE) corrugated pipe”

Any discrepancies between this Technical Bulletin and the above referenced standards and practices should be brought to the attention of Kanaflex Corporation prior to proceeding with installation. It is noted that this Technical Bulletin is not intended to supersede the procedures established by the design engineer for a specific project or site condition. Additionally refer to the Kanaflex Installation Guide for comprehensive installation information which includes job site storage, handling, installation backfill compaction and pipe joint handling guidance.

This document is to be used as a reference for trench detail not as a comprehensive installation guide. Always follow project, local, state and OSHA safety requirements and rules.

TRENCH & BACKFILL CONSTRUCTION

Figure 1 below illustrates the typical composite embedment which transitions from one embedment material to a second embedment material at the springline of the pipe. The composite embedment is comprised of the stronger backfill below the spring line and typically a weaker backfill above the springline. Because of these composite materials it is necessary to identify backfill composite by Composite Embedment Soil Group Numbers shown in the Table 1 below. These group numbers are used to determine the maximum allowable burial depth shown in Table 3.

Table 1 – Composite Embedment Soil Group Numbers

Composite Embedment Soil Group Numbers										
Top Half[1] / Bottom Half[2]	Class I		Class II			Class III			Class IV	
	Compacted	Dumped	95%	90%	85%	95%	90%	85%	95%	90%
Class I Compacted	1	2	3	3	4	5	5	7	8	9
Class I Dumped	NR[4]	2	2	2	2	2	2	7	8	9
Class II 95%	NR	NR	3	4	4	4	5	7	7	9
Class II 90%	NR	NR	NR	4	4	4	5	7	8	9
Class II 85%	NR	NR	NR	NR	5	5	5	7	7	9
Class III 95%	NR	NR	NR	NR	NR	6	7	7	7	9
Class III 90%	NR	NR	NR	NR	NR	NR	7	7	8	9
Class III 85%	NR	NR	NR	NR	NR	NR	NR	8	8	9
Class IV 95%	NR	NR	NR	NR	NR	NR	NR	NR	8	9
Class IV 90%	NR	NR	NR	NR	NR	NR	NR	NR	NR	10

Notes:

1. Top half is defined as the backfill material used above the springline in the embedment shown in Figure 1 below.
2. Bottom half is defined as the backfill material used below the springline in the embedment shown in Figure 1 below.
3. Class I, II, III and IV soils are defined in ASTM D2321. Percent compactions are based on standard proctor density.
4. NR is defined as Not Recommended.

The trench width is determined based on the pipe diameter, backfill material, compaction equipment an in-situ soils. If the in-situ (or native) soils are unstable a trench box or other approved bracing should be used for worker safety. The width of the trench needs to be wide enough for a person to work safely within the trench. The minimum clear width between the pipe springline and the trench should be 1 foot. ASTM D2321 provides guidance for the proper use and movement of trench boxes. It is noted that improper movement of the trench box may disturb the compacted backfill and adversely affect pipe performance. Minimum trench widths are as shown in Table 1 below.

It is noted that these minimum trench widths shown in Table 2 are recommendations only and the does not supersede requirements specified by the project engineer. However trench widths should be kept to a minimum to avoid excessive excavation cost. If the pipe is installed in a compacted embankment, pipe embedment should be compacted at least 2.5 pipe diameters from the pipe on both sides of the pipe or to the trench walls, whichever is less.

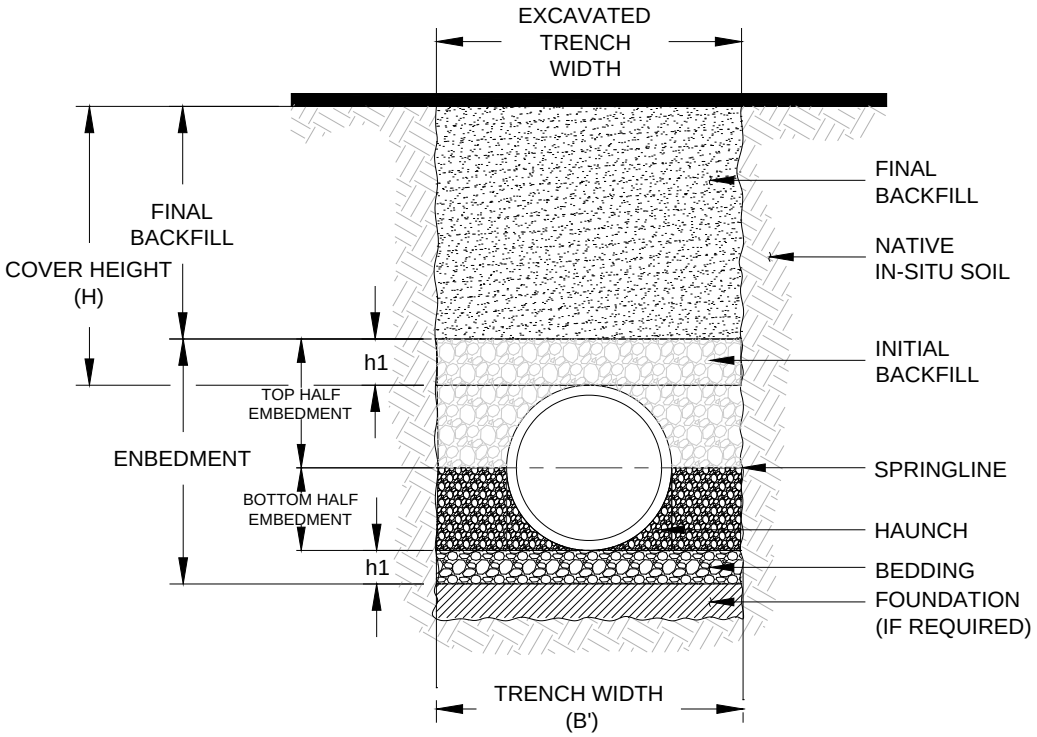


Figure 1 – General Trench and Embedment Terminology

Critical Dimensions for Trench Installation		
Nominal diameter in (mm)	Trench Width B' in (m)	Bedding height h1 in (m)
8 (200)	25 (0.6)*	6 (0.15)*
10 (250)	27 (0.7)*	6 (0.15)*
12 (300)	29 (0.7)*	6 (0.15)*
15 (375)	33 (0.8)	6 (0.15)
18 (450)	36 (0.9)	6 (0.15)
24 (600)	44 (1.1)	8 (0.20)
30 (750)	52 (1.3)	8 (0.20)
36 (900)	60 (1.5)	8 (0.20)
42 (1050)	68 (1.7)	8 (0.20)
48 (1200)	77 (2.0)	8 (0.20)
60 (1500)	94 (2.4)	8 (0.20)

Table 2 – Minimum Critical Dimensions for Trench Installation

For detailed instructions regarding backfill, foundations, bedding, hauching, initial

Maximum Cover Height

Design calculations for installed Kanapipe are summarized in the Table 3 below.

The results of the structural analysis indicate the pipe can be safely installed for the burial depths show in table below when installed in accordance with the manufacturer's recommendation and in accordance with ASTM D2321. Table 3 specifies he table list the specific diameters of the Kanaflex SRPE pipe and the associated maximum recommended burial depth for each composite soil group defined in Table 1.

Allowable Burial Depth (feet)										
Diameter (in)	Composite Soil Group (see Table 1)									
	1	2	3	4	5	6	7	8	9	10
12	67	37	54	37	35	38	30	27	27	25
15	59	30	47	30	26	30	22	18	18	16
18	50	28	45	28	23	29	19	15	14	12
24	64	27	45	27	22	29	20	16	16	14
30	42	25	38	25	23	26	17	13	13	11
36	27	22	25	22	19	23	15	11	10	8
42	41	22	36	22	22	23	15	11	11	9
48	31	18	27	18	16	18	12	9	9	8
60	28	19	22	19	12	16	11	8	8	7

Note: Composite soil group materials and density are defined in Table 1.

Table 3 - Maximum Cover for KanaPipe Installed in Trench, ft

Summary
Greater ring stiffness of Kanaflex pipe allows for the use of composite embedment. The burial depths shown in Table 3 are conservative. Contact Kanaflex for guidance to achieve deeper burial depths with composite embedment.

Design Method to Determine Maximum Burial Depth for Kanaflex Pipe

Introduction

This goal of this report is to documents the design method used to (1) determine the maximum allowable burial depth of Kanaflex pipe buried in embankment conditions, (2) explain major assumptions used for the CANDE modeling of the Kanaflex pipe structure (3) provide a summary burial depth table for the maximum allowable burial depth in an embankment conditions and (4) provide detailed summary tables of the analysis for each burial depth in an attachment. Kanaflex pipe is a steel reinforced polyethylene pipe (SRPE pipe) manufactured in accordance with ASTM F2435. This report summarizes the results of an analysis to determine the maximum allowable burial depth for 12", 15" 18" 24", 30", 36", 42", 48" and 60" diameters. The maximum allowable burial depth was determined for different diameters with four different soil embedment materials and up to three compaction density.

The design method presented in this report is based on the American Association of Highway Transportation Official (AASHTO) Load and Resistance Factor Design (LRFD) Section 12 design criteria. With the assumption that the Kanaflex pipe is installed in an embankment. This analysis is based on Finite Element Analysis using the **C**ulvert **An**alysis and **De**sign (CANDE - 2013) software developed for AASHTO. Additionally the CANDE-2013 finite element analysis is supplemented with analytical mechanics of material analysis.

Kanaflex Pipe and Corrugations

The Kanaflex pipe is a composite of HDPE plastic and steel as shown in the cross-sectional photograph below. It is evident that the steel wave forms are imbedded in the HDPE plastic. Figure 1 illustrates a typical composite steel/plastic cross section.

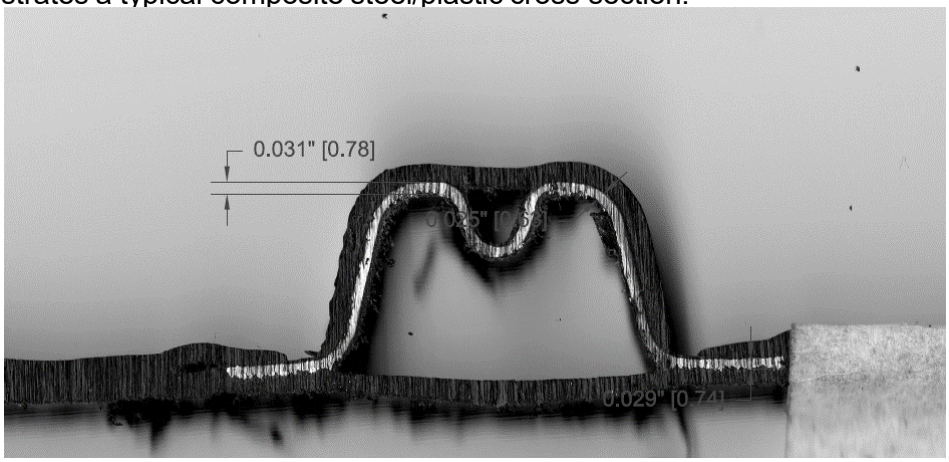


Figure 1. Photograph of Kanaflex composite steel-plastic cross section.

Figure 2 shows a CAD drawing of the Kanaflex composite cross section over one period of the composite wave form. It is noted, that a portion of the HDPE valley element is not supported with imbedded steel (shown as the outer extremities in period profile). Since the unsupported HDPE valley element is subject to direct soil pressure, a special design criterion for Kanaflex

pipe was developed to address the longitudinal strain developed when that section is loaded by earth loads.

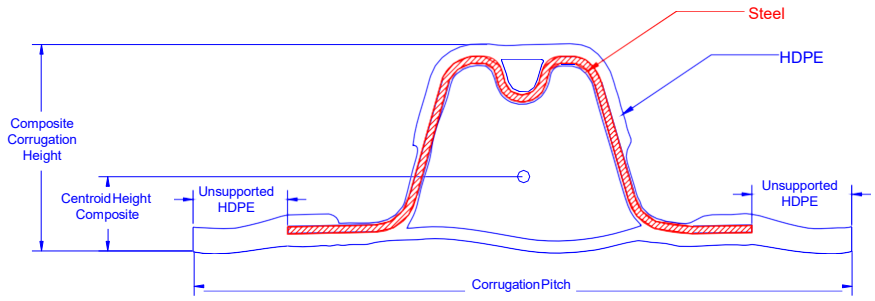


Figure 2. CAD drawing of Kanaflex composite cross-section over 1 period.

CANDE MODEL

CANDE does not have algorithms for the design of SRPE pipe. Therefore the design of SRPE pipe must be accomplished with the so called Level III CANDE analysis, which is essentially a custom developed input file to model Kanaflex SRPE pipe composite structure of steel and plastic pipe. The composite pipe strategy developed for this analysis is discussed below.

Composite Pipe Strategy.

The key assumption is that the steel and plastic components work in tandem to resist bending and hoop deformation. In CANDE this is achieved by defining two circular pipe groups, one representing HDPE plastic and one representing corrugated steel wherein both pipe groups are assigned the same set of nodes tracing the pipe's circumference through a common centroid. As a consequence, both pipe groups undergo the same kinematic deformations, thereby resisting deformation in proportion to material and sectional stiffness.

The table below shows the material properties assigned to steel and HDPE plastic components. It is noted that the steel stiffness dominates so that the steel component carries the vast majority of the soil load.

Table 1. Kanaflex material properties for steel and HDPE plastic.

Material	Young's Mod psi	Yield stress psi	Comments
Steel	29,000,000	52,000	Yield stress measured from actual tensile test specimens.
HDPE	22,000	900	Standard AASHTO values for HDPE in long-term loading such as deep burial.

To summarize, CANDE's steel pipe type is used to represent the steel component, the plastic pipe type is used to represent the plastic component, and together they form a reasonably accurate model of the Kanaflex composite pipe. The steel and plastic component models are discussed below in turn.

Corrugated Steel Cross Section.

A CAD drawing of the steel corrugated wave-form for a typical corrugation is shown in Figure 3. It is observed that the steel wave-form does not conform exactly to CANDE's Steel Pipe Type because, unlike standard corrugated steel pipes, the cross section is not symmetric about the mid-depth. However if the steel stress remains in the linear elastic range, there is no error in the CANDE algorithm due to the Kanaflex non-symmetric cross section. Non-symmetric cross sections introduce a slight error only if the cross section begins to yield in a plastic-like manner (plastic penetration). Another special design criterion (to be discussed) has been adopted for the Kanaflex steel waveform that limits plastic yielding of the outer fibers under service loading. Consequently CANDE's Steel Pipe type is used to model the Kanaflex steel corrugation without any appreciable error.

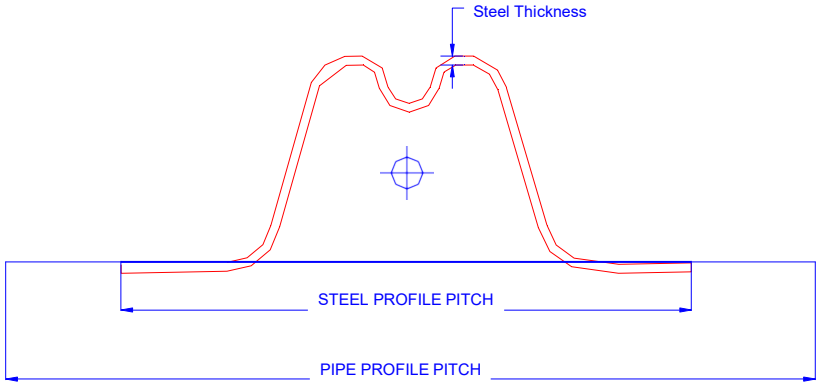


Figure 3. CAD drawing of Kanaflex steel corrugation over 1 period of pipe profile.

Table 2 shows the section properties used in CANDE to define the steel cross section for a typical cross section. The section area and moment of inertia match the CAD drawing. However, the section modulus used in CANDE is based on ½ section height which results in an error of less than 1%. Thus even if plastic yielding does occur, the net errors arising in CANDE's nonlinear solution would be less than 1%.

Table 2. Steel section properties input into CANDE Steel Pipe Type

Cross Section Property	Value per longitudinal inch	Comments
Section Area, A	0.0277 in^2/inch	Taken from Figure 3 for pipe profile pitch
Moment of Inertia, I	0.000717 in^4/inch	Taken from Figure 3 for pipe profile pitch
Section modulus, S (symmetric)	0.00287 in^3/inch	Computed as S = I/(h/2) where h = section height and h = 0.50 inches

Corrugated Steel Design Criteria.

The AASHTO LRFD load factor for flexible pipe under earth loading is 1.95, and the so-called redundancy factor is 1.05 so the net load factor is (1.05 X 1.95) = 2.05. As shown in in the top portion of Table 3 AASHTO's LRFD strength design criteria for standard corrugated steel culverts requires that the factored thrust-stress demand must be less than the steel yield stress (52,000 psi) and less than the global-buckling stress capacity (AASHTO Eq. 12.7.2.4-1). CANDE also offers the option to include another strength design criterion to prevent full plastic hinging from combined thrust and moment demands; however, AASHTO LRFD specifications does not impose any strength criterion for outer-fiber yielding nor any limitation on plastic hinging except for deep corrugations.

Table 3. Design Criteria for Steel Component of Kanaflex composite pipe

Design Criterion (Strength limits)	**Factored Demand (Load factor = 2.05)**	**Factored Capacity (Resistance factors = 1.0)**
(1) Thrust stress (psi) $\sigma_{max} < f_y$	σ_{max} = maximum thrust in steel circumference.	f_y = yield strength = 52,000,000 psi
(2) Global Buckling (psi) $\sigma_{max} < f_b$	σ_{max} = maximum thrust in steel circumference.	f_b = buckling capacity, via AASHTO Eq. 12.7.2.4-1&2
Performance Limits (at Service Load)	**Demand at service load (Load factor = 1.00)**	**Max allowable value**
(3) Max deflection (%) Δ_{max} < 5% Diameter	Δ_{max} = max vertical deflection as % of D_{avg}	Allowable = 5% Diameter
(4) Max outer-fiber strain $\varepsilon_{max} < \varepsilon_y$	ε_{max} = maximum outer-fiber strain (from diagnostics)	Allowable = $\varepsilon_y = f_y/E_e$ = 0.163% $E_e = E/(1-\nu^2)$ = 31,900,000 psi

The bottom half of Table 3 shows the performance limits, which are design criteria at the service load level (load factor = 1). Criterion #3 is the well-accepted AASHTO recommendation limiting vertical deflection to no more than 5% of the diameter. Criterion #4, which is introduced in this report especially for the Kanaflex pipe, states that the maximum outer-fiber strain should not exceed the steel's yield strain under service loads. Although this performance criterion is not an AASHTO requirement, it is considered prudent and also serves to limit the amount of plastic penetration under factored loading.

HDPE Profile Cross Section.

A CAD drawing of the HDPE wave-form is shown in Figure 4. From a structural viewpoint, the key geometric properties of the wave-form are the area of HDPE material per period and the moment of inertia per period along with wave height and centroid location.

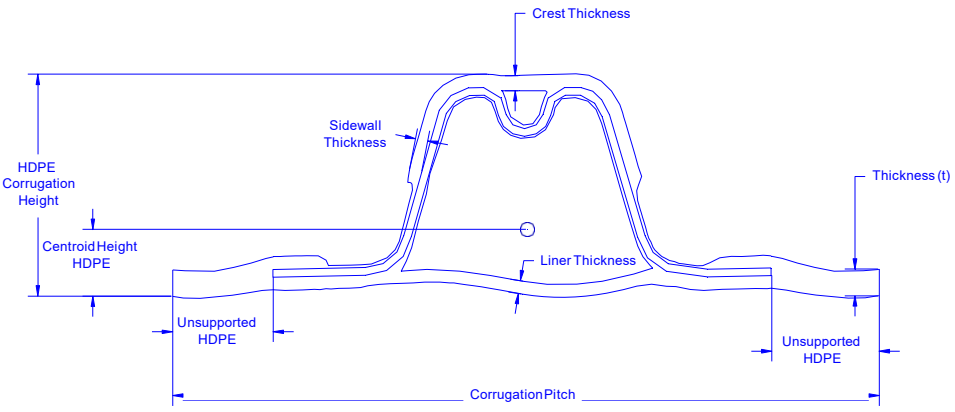


Figure 4. CAD drawing of Kanaflex HDPE wave-form over 1 period of pipe profile.

Because of the large stiffness of the imbedded steel component, local in-plane buckling of the HDPE elements is precluded. Therefore, CANDE's Plastic Pipe type with the "General wall" description is appropriate to model the HDPE component.

The length and average thickness of the HDPE valley element that is not supported with steel embedment. Specifically, the values of L and t are used to determine the longitudinal tensile strain in the HDPE valley element. For the example shown in Figure 4 above the length (L) is the sum of the unsupported HDPE on the left and right and the nominal-average thickness (t) of unsupported valley element is the average thickness of the unsupported HDPE. As discussed next, the unsupported portion of the valley element gives rise to a new design criterion for the Kanaflex pipe.

HDPE Design Criteria

The adopted design criteria for the HDPE component of the Kanaflex pipe are shown in the table below for LRFD strength limits under factored loads and performance limits under service loads.

Table 5. Kanaflex HDPE Design Criteria.

Design Criterion (Strength limits)	**Factored Demand (Load factor = 2.05)**	**Factored Capacity (Resistance factors = 1.0)**
(1) Thrust stress (psi) $\sigma_{max} < f_u$	σ_{max} = maximum thrust stress in HDPE pipe.	f_u = compressive strength = 900 psi (long-term value for deep burial)
(2) Global Buckling (psi) $\sigma_{max} < f_b$	σ_{max} = maximum thrust stress in HDPE pipe.	f_b = buckling capacity AASHTO Eq. 12.12.3.5.2-1
(3) Combined strain (in/in) $\varepsilon_{max} < \varepsilon_{ult}$	ε_{max} = maximum outer-fiber strain	ε_{ult} = failure strain = 0.0614 in/in = 1.5*f_u/(long-term modulus)
Performance Limits (at Service Load)	**Demand (Load factor = 1)**	**Max allowable value**
(4) Allowable in-plane tensile strain, $\varepsilon_{t\text{-}max} < \varepsilon_{t\text{-}allow}$	$\varepsilon_{t\text{-}max}$ = max tensile strain in in-plane cross section	$\varepsilon_{t\text{-}allow}$ = allowable tensile strain = 5%
(5) Allowable deflection $\Delta_{max} < \Delta_{allow}$	Δ_{max} = computed deflection as % of diameter	Δ_{allow} = 5% pipe diameter
(6) Allowable longitudinal tensile strain, $\varepsilon_{long\text{-}max} < \varepsilon_{t\text{-}allow}$	$\varepsilon_{long\text{-}max}$ = outer-fiber longitudinal bending strain in unsupported valley	$\varepsilon_{t\text{-}allow}$ = allowable tensile strain = 5%

Design criteria 1-3 in the above table are taken directly from AASHTO LRFD strength specifications for HDPE plastic pipe. The 4th and 5th criterions are the standard AASHTO performance criteria for in-plane tensile strain and allowable deflection.

The 6th criterion is a special design criterion developed especially for the Kanaflex composite pipe addressing the fact that the HDPE valley element has a periodic lack of steel support in the longitudinal direction as shown in Figure 5. The unsupported segment (beam) will experience local bending due to soil pressure thereby inducing tensile strains at the junctions of the steel support. This new performance design criterion requires that the outer-fiber longitudinal bending strain be no larger than AASHTO's allowable tensile strain of 5%.

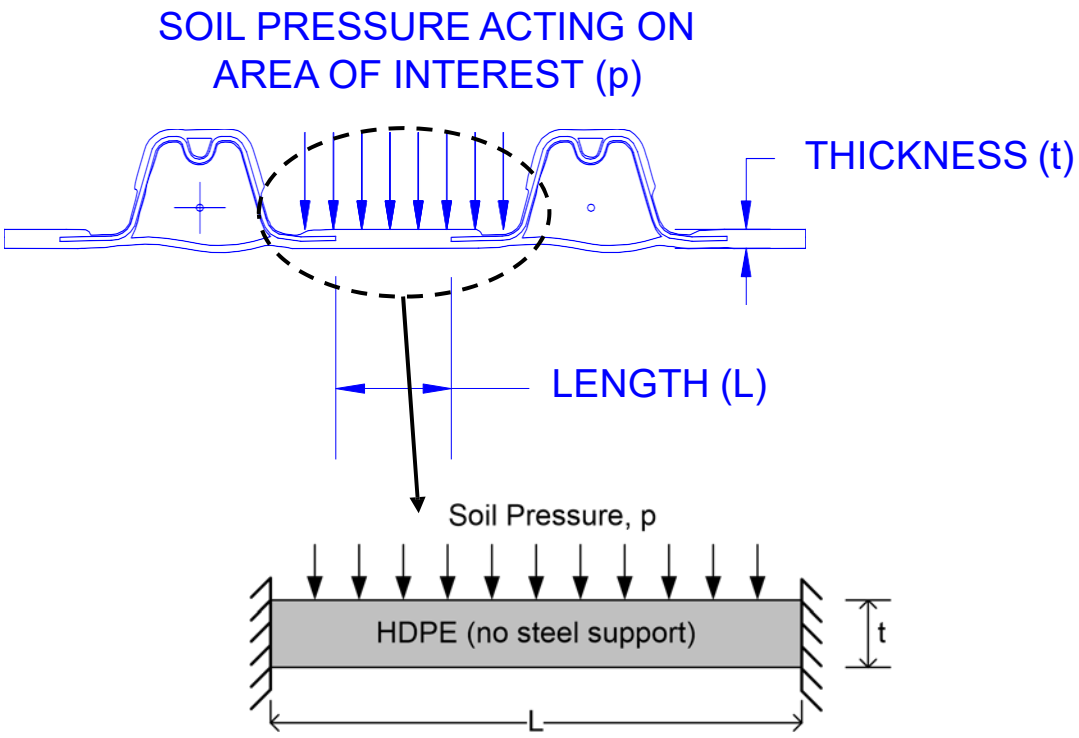


Figure 5. Illustration of longitudinal bending associated with design criterion #6.

Although CANDE does not directly predict this longitudinal bending strain, the CANDE solution does provide the pressure acting around the Kanaflex pipe. Hence based on simple fixed-end beam theory, the maximum outer-fiber bending strain in the longitudinal direction may be computed as shown below.

$$\varepsilon_{long} = 0.5\,\frac{p}{E}\left(\frac{L}{t}\right)^2 \le \varepsilon_{allow} = 0.05 \qquad \text{Equation 1}$$

Where: p = average soil pressure acting on Kanaflex pipe (determined from CANDE)
E = Young's modulus = 22,000 psi
L = unsupported valley length = 1.018 inch
t = unsupported valley thickness = 0.133inch

Soil Stiffness and Recommendation

CANDE utilizes material properties based on several theories, however the Duncan-Selig soil model recommended for the analysis. This soil model describes the composition of the soil in

accordance with the Unified Soils System described in ASTM D2487. Kanaflex pipe is required to be installed in accordance with ASTM D2321, which classifies the pipe embedment material as show in the Table 6 below:

Table 6 – AASHTO and ASTM D2321 Soil groups

Soil Group[A,B]	Soil Class	American Association of State Highway and Transportation Officials (AASHTO) Soil Groups[C]
Crushed rock, angular[D]: 100% passing 1-1/2in. sieve, </=15 % passing #4 sieve, </= 25 % passing 3/8in. sieve and </= 12 % passing #200 sieve	Class I	...
Clean, coarse grained soils: SW, SP, GW, GP or any soil beginning with one of these symbols with </=12 % passing #200 sieve[E,F]	Class II	A1,A3
Coarse grained soils with fines: GM, GC, SM, SC, or any soil beginning with one of these symbols, containing > 12 % passing #200 sieve; Sandy or gravelly fine-grained soils: CL, ML, or any soil beginning with one of these symbols, with >/= 30 % retained on #200 sieve	Class III	A-2-4, A-2-5, A-2-6, or A-4 or A-6 soils with more than 30% retained on #200 sieve
Fine-grained soils: CL, ML, or any soil beginning with one of these symbols, with <30 % retained on #200 sieve	Class IV	A-2-7, or A-4, or A-6 soils with 30% or less retained on #200 sieve
MH, CH, OL, OH, PT	Class V Not for use as embedment	A5, A7

However CANDE soil groups are describe by the Unified Soil Groups defined in ASTM D2487. The table above does correlate some of the soil groups however for the Class IV there is no good correlation. Regarding a Class I soil, some guidance is provided in AASHTO LRFD Section 12.12.3.5 which states *"If the structural backfill material is compacted crushed stone, then the secant constrained soil modulus, Ms, values for SN-100 may be used. If backfill is uncompacted (dumped) crushed stone, use the modulus values for SN-90."* While ASTM D2321 does not correlate the Class II soils to an SN soil type AASHTO Table 12.12.3.5-2 does (as seen below).

Table 7 – Equivalent ASTM and AASHTO Soil Classifications

Basic Soil Type (1)	ASTM D2487	AASHTO M 145
Sn (Gravelly sand, SW)	SW, SP (2) GW, GP sands and gravels with 12% or less fines	A1, A3 (2)
Si (Sandy silt, ML)	GM, SM, ML also GC and SC with less than 20% passing a No. 200 sieve	A-2-4, A-2-5, A4
Cl (Silty clay, CL)	CL, MH, GC, SC also GC and SC with more than 20% passing a No. 200 sieve	A-2-6, A-2-7, A5, A6

1. The soil classification listed in parentheses is the type that was tested to develop the constrained soil modulus values in Table 12.12.3.5-1. The correlations to other soil types are approximate.
2. Uniformly graded materials with an average particle size smaller than a No. 40 sieve shall not be used as backfill for thermoplastic culverts unless specifically allowed in the contract documents and special precautions are taken to control moisture content and monitor compaction levels.

Based on the forgoing the correlation between the ASTM D2321 soils and Duncan-Selig soils used for the CANDE model are shown in the following Table 8:

Table 8 – Soil Correlation used for CANDE Analysis

ASTM D2321	Class I		Class II			Class III			Class IV(1)	
	compacted	uncompacted	95%	90%	85%	95%	90%	85%	95%	90%
CANDE Analysis	SW 100	SW 90	SW 95	SW 90	SW 85	ML 95	ML 90	ML 85	CL 90	CL 85

Notes: (1) Class IV is not recommended unless it is installed under the direction of a soils engineer to ensure proper placement and compaction. It is noted that the compaction densities used in the analysis are 5% lower than the corresponding ASTM D2321 values. This lower density is intended to compensate for contractor error associated with the difficulty of achieving proper compaction for these types of soils.

CANDE Soil-Structure Model.

Figure 7 is a generic view of a Kanaflex pipe installation in a trench configuration. For the deep-burial CANDE model the generic Kanaflex installation is represented by an embankment installation with no pavement, which are standard conservative assumptions so that the maximum predicted burial depths will be on the conservative side.

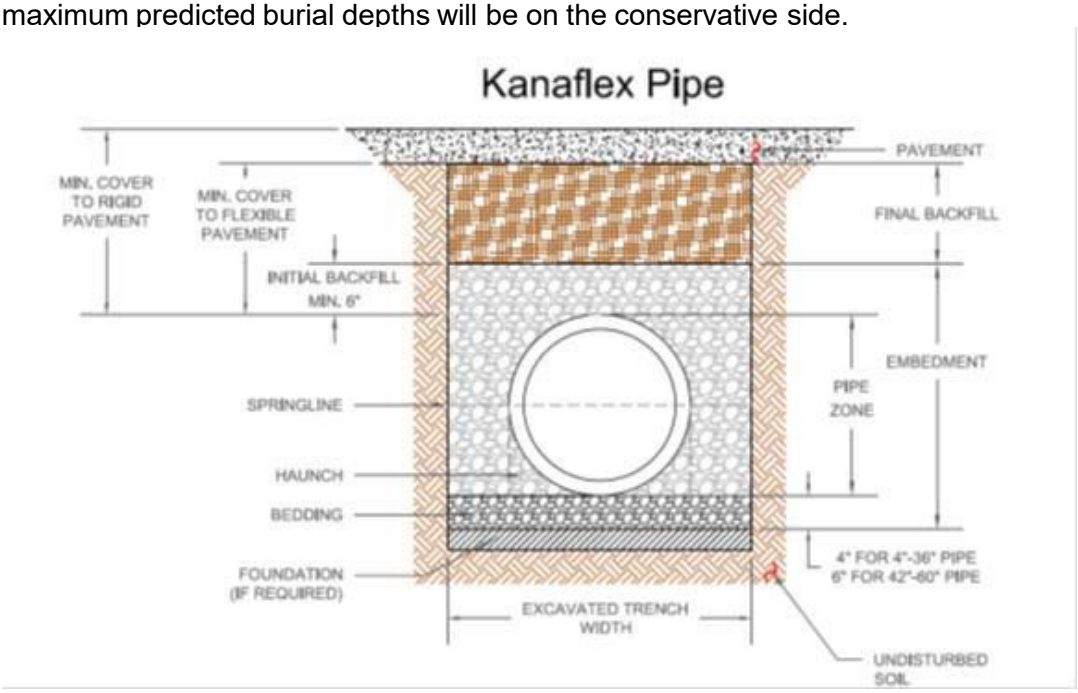


Figure 7. Generic view of Kanaflex pipe installation at variable burial depths.

Figure 8 shows the complete soil-structure CANDE model for an 18” inside diameter pipe in a deep burial condition. For the purposes of this report the 18” diameter Kanaflex pipe is used as an example. The 18” inside diameter Kanaflex pipe has an 18.43” diameter measured from the composite centroids. The finite element mesh is generated with CANDE by beginning with a Level 2 solution for the corrugated steel component, importing this mesh into Level 3, and then adding HDPE pipe component and finally making adjustments to the load-step sequence as shown in the figure.

Load steps are shown on the right side of Figure 8. Load step 1 includes insitu soil, bedding and Kanaflex pipe loaded by its own weight. Load steps 2 and 3 raise the soil surface from the invert to the springline and then to crown level. Load steps 4 and 5 raise the soil surface from crown level to 0.25 and then 1.5 pipe-diameters above the crown. Note that the pipe-diameter is the diameter from pipe-wall centroid to pipe-wall centroid or 18.43 inches (1.54 ft.). Therefore at load step 5 the soil cover height is 2.30 feet above the crown.

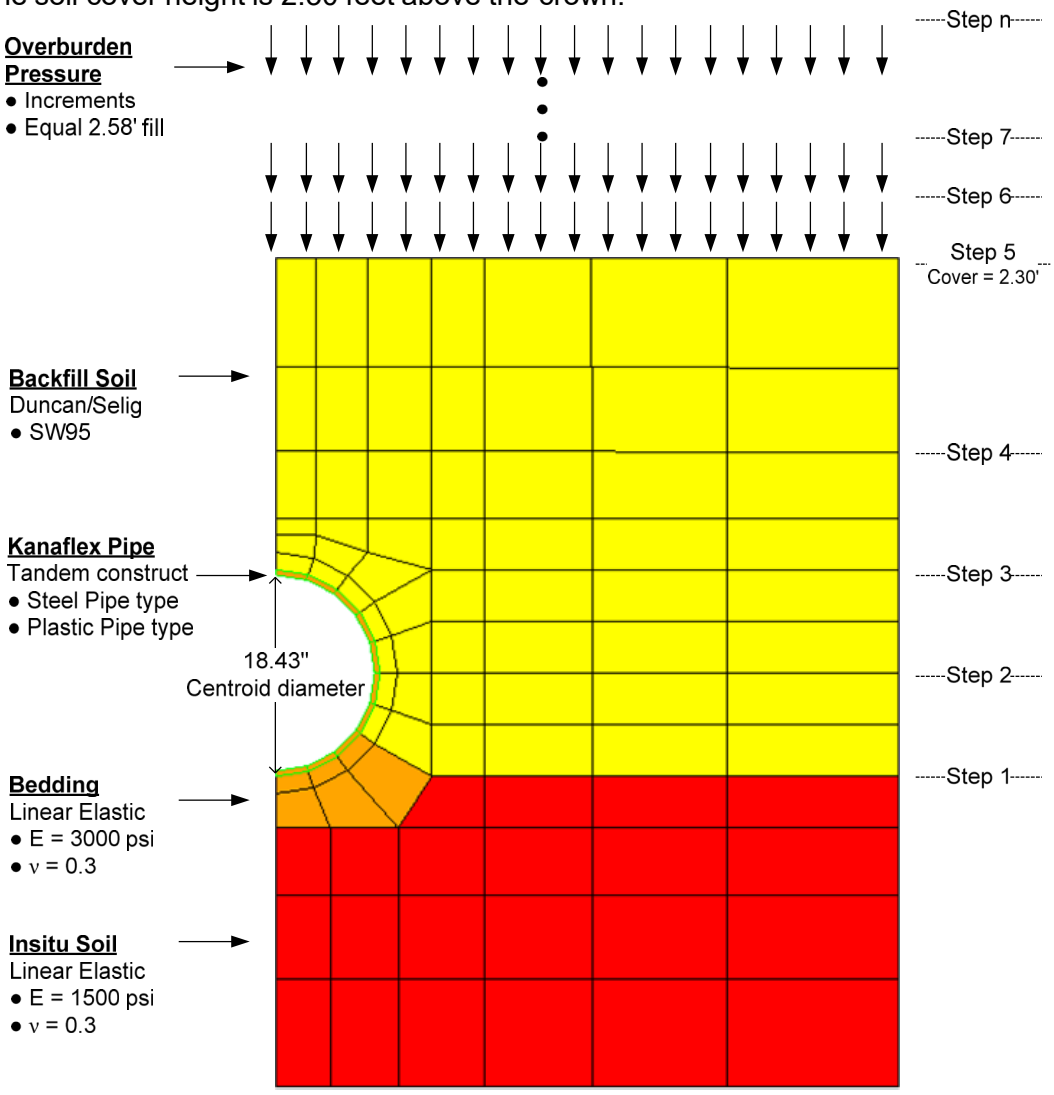


Figure 8. CANDE soil-structure model for deep burial of Kanaflex pipe.

For load steps 6 and all subsequent load steps the fill soil is applied as equivalent increments of overburden pressure based on a soil density of 120 pcf. Each pressure increment is 2.15 psi, which is equal to 2.58 feet fill; therefore the fill height associated with any load step "n" greater than 5 is given by the following equation.

$$\text{Soil cover height (ft)} = 2.53' + (n-5)\,2.58' \qquad \text{Equation 2}$$

Where:

- The cover height constant = 2.53 feet (for 18" ID pipe only); and

- n is defined as the load-step number.

CANDE SOLUTIONS AND RESULTS

The following sections describe the two dominate design criteria of the 10 design checks. Also addressed is a description of extraction of design data from a CANDE analysis output file.

Dominate Design Criterion.

Based on the analysis and loading conditions examined to date, the performance limits are mostly dictated by, either by longitudinal bending strain in the unsupported HDPE valley element or by outer-fiber yielding of the steel. For illustrative purposes the HDPE and steel demand to capacity ratio for the design criteria were plotted as a function of cover height in Figures 9 and 10 below. These figure are not intended to show the general relationship and not intended for quantities values.

Regarding the longitudinal bending strain of the unsupported HDPE valley element, a study of plastic design criteria vs fill heights was performed to understand the relationship between the individual failure modes. As shown in Figure 9, longitudinal tension strain approaches the demand to capacity ratio of one more quickly than other design criterial.

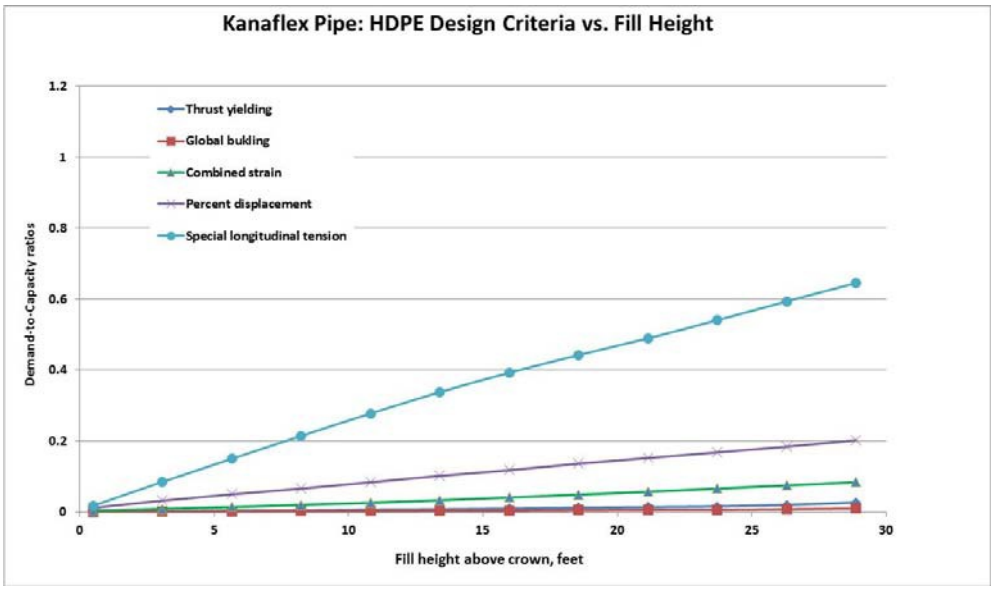


Figure 9 Demand-to-capacity ratios for HDPE component of Kanaflex pipe.

The key observation is that the HDPE component is not in structural distress because all demand-to-capacity ratios remain well less than 1.0 for fill heights up to 30 feet for the case illustrated. Indeed, the standard design criteria for thrust yielding, global buckling, combined strain, and deflection remain less than 0.2 because the steel stiffness inhibits the bending and hoop strains in the softer HDPE material. Likewise, the standard design criterion for allowable tensile strain (not shown) remains essentially zero.

Figure 10 shows the demand-to-capacity ratios for the steel component of Kanaflex pipe. In this case the design criteria are the standard AASHTO design criteria for steel pipes. However as shown in Figure 10, the plastic penetration failure mode dominates the design criterial. It is important to know that the plastic penetration design criterion is not an official AASHTO design

criterion. Rather it is an official recommendation that has not, as yet, been accepted by AASHTO. However in an effort to be conservative, the design method recommended for Kanaflex pipe recommends the inclusion of plastic penetration as a design criteria. As illustrated in Figure 10 the steel component governs the allowable burial depth and is controlled by the plastic penetration design criterion. Specifically, the value of the demand-to-capacity curve becomes 1.0 at about 18 feet of fill, meaning the allowable burial depth of the Kanaflex pipe is 18 feet.

However, it is noted that Figure 10 illustrates the plastic penetration with a load factor equal to 2.05. However, as discussed previously in this report the plastic penetration is evaluated at service load condition (i.e. load factor = 1.0). This criterion is considered reasonable especially considering plastic penetration is not an official AASHTO design criterion. Officially, AASHTO has no restraints on plastic penetration except for structures with deep corrugations and metal box structures.

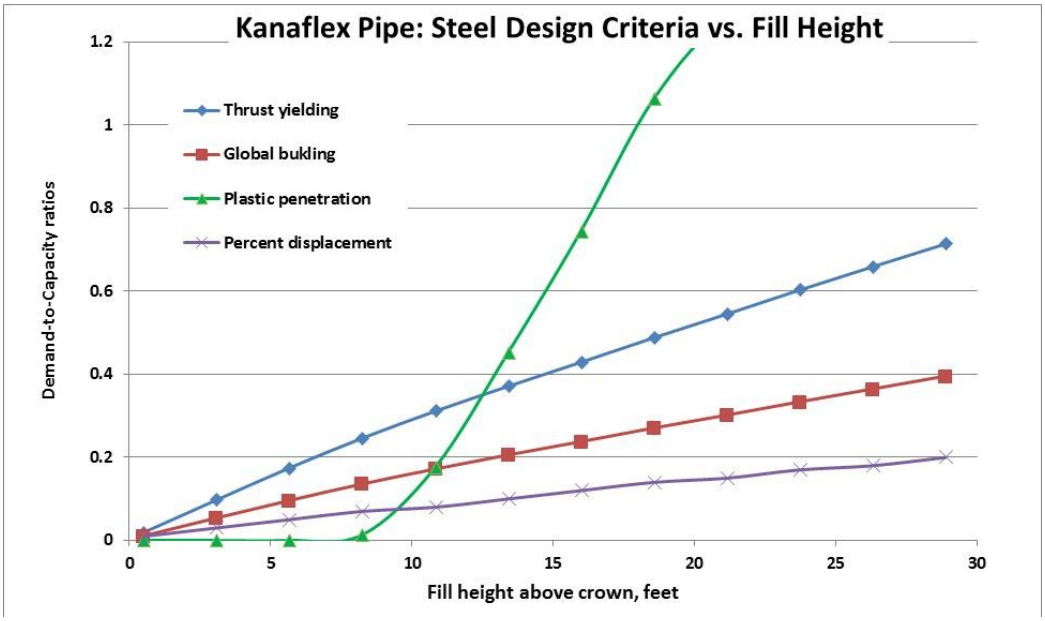


Figure 8. Demand-to-capacity ratios for steel component of Kanaflex pipe.

Based on the analysis and loading conditions examined to date, the performance limits are dictated by, either by longitudinal bending strain in the unsupported HDPE valley element or by outer-fiber yielding of the steel. It should be noted, in rare cases global buckling is the limiting design factor.

Obtaining and Interpreting CANDE Solutions.

It is necessary to execute two CANDE solutions in order to determine the allowable burial depth for any given Kanaflex-soil system. The first solution is with load factors set to 1.0 to evaluate the service load performance limits for the steel and plastic components. The second solution is with load factors set to 2.05 to evaluate the strength design criterion for steel and plastic components. Lastly, it is beneficial to generate an excel sheet to organize the data and perform some of the repetitive calculations. Listed below is a recommended step-by-step procedure for locating data from the CANDE output report.

1. **Steel Performance Limits**.

   Open CANDE's output report (listed under the "View" tab) for load factor = 1 (performance limits) and search through the steel pipe evaluation summaries to find the load step wherein steel's plastic-penetration response becomes non zero. This is the load step causing the first occurrence of outer fiber yielding, which we will identify as load step number as X_{Steel}. Note: The predicted values of outer-fiber steel strain are printed in the strain diagnostics section.

2. **HDPE Performance Limits**

   For longitudinal tensile strain due to bending of the unsupported HDPE valley element, it is convenient to rearrange Equation 1 to solve for the limiting normal pressure p_{Limit} required to create longitudinal bending strain = 5% (shown as Equation #3 in Table 9 below). Table 9 below illustrates and example for 18" diameter pipe where P_{Limit} is 37.33 psi.

   CANDE's prediction for normal pressure acting on the composite Kanaflex pipe is the sum of the pressures from both the steel and plastic components, which are tabulated in the list of structural responses. Search through the structural response of each load step to find the first load step wherein the average combined pressure just meets or exceeds p_{Limit}. Identify this as load step number $X_{HDPE.}$ Next look at the HDPE plastic pipe evaluation summary at load step X_{HDPE} and verify the performance limits for allowable deflection and in-plane tensile strain are safe. If not, then re-determine the controlling load step X_{HDPE}.

Table 9 – Example Calculations from Excel File.

Solution Method:				
Based simple beam theory critical strain is found by the following equation				
$p_{Limit} = 2E\left(\frac{t}{L}\right)^2 \varepsilon_{allow} =$			**37.3**	**psi**
Where				
ε_{allow} =	Allowable longidudinal strain= 0.05 (defined by AASHTO)			
P_{Limit} =	Maximum allowable soil pressure based on average of crown and spirngline (determined from CANDE)			
E =	Young's modulus = 22,000 psi (defined by AASHTO)			
L =	beam length			
t =	beam thickness = 0.01 inch			
Given Design Information:				**Notes:**
Diameter	D =	18	in	Inside diameter
Beam Length (L)	L =	1.018	in	Unsupported length between Steel Corrugations
Wall Thickness (t)	t =	0.1326	in	
Design Life	tp=	50	years	
Allowable Strain Capacity	ϵ_{allow} =	0.050	in/in	HDPE allowable strain in/in
Modulus of HDPE	E =	22,000	psi	for specfic design life
Analysis:				
	P_{Limit} =	37.33	psi	

3. **Controlling performance load step**.

   Let the load step number $X_{Perform}$ be the controlling load step number for all performance limits of the composite Kanaflex pipe; as illustrated in the equation below:

$$X_{Perform} = \text{minimum}\,(X_{Steel}, X_{HDPE})$$

4. **Steel and HDPE Strength Limits.**

   Next open CANDE's output report for load factor equal to 2.05 (strength limits) and go to load step $X_{Perform}$. Verify that factored demand-to-capacity ratios are all safe (less than 1.0) for both the HDPE plastic and steel components. If not, find the new controlling load step that occurred before load step $X_{Perform}$ and identify the new controlling load step number as $X_{Strength}$.

5. **Controlling Load Step**.

   Define the controlling step number as $X_{Control}$ as the minimum load step based on all performance and strength design criteria, as shown in the equation below.

$$X_{Control} = \text{minimum}\,(X_{Perform}, X_{Strength})$$

   The actual controlling load step is a rational number X* between the integers XControl -1 and XControl. The value of X* is determined by linear interpolation.

6. **Calculating Fill Height**

   Finally, the maximum fill height is determined from Equation 2 where we let n = X*, as shown in the equation below:

$$\text{Soil cover height (ft)} = 1.93' + (X^*\text{-}5)\ 2.58'$$

   It is noted that this equation is using values for the 18" diameter pipe for illustrative purposes.

Once these values are determined data is assembled in an excel file and the maximum burial depth is determined. An example of the data extracted from the CANDE analysis and assembled into an excel table is shown in Table 9 below.

Table 9 Summary of Data from a Typical CANDE analysis

Analysis Results AASHTO Design:

Item	Material	Load Step/ Burial Depth (ft.)	Loading Case	Design Criterion	Demand At Higher Load Step	Capacity / Allowable	units	Ratio
1	HDPE	23	Strength Limit	Maximum Thrust	22.03	900	psi	0.02
2	HDPE	23	Strength Limit	Global Buckling	22.03	1,953	psi	0.01
3	HDPE	23	Strength Limit	Combined Strain	0.00621	0.0614	in/in	0.10
4	**HDPE**	**23**	**Service Limit**	**Allowable In Plane Tensile Strain**	**0.00116**	**0.05**	**in/in**	**0.02**
5	**HDPE**	**23**	**Service Limit**	**Vertical Deflection**	**1.4**	**5**	**%**	**0.28**
6	**HDPE**	**45.00**	**Service Limit**	**Longitudinal Strain**	**5**	**5**	**%**	**1.00**
7	Steel	23	Strength Limit	Thrust Stress	26,644	52,000	psi	0.51
8	Steel	23	Strength Limit	Global Buckling	26,644	44,076	psi	0.60
9	**Steel**	**23**	**Service Limit**	**Vertical Deflection**	**1.4**	**5**	**%**	**0.28**
10	**Steel**	**48.00**	**Service Limit**	**Outer Fiber Strain**	**0.163**	**0.163**	**%**	**1.00**

Note: Max burial depth is the lowest burial depth when comparing the load step depth and direct enter in the "Load Step/Burial Depth" column
load step values in the "load step/burial depth" column are shown as values without decimal point

Load Step 23 = 48.00 Ft

Maximum Allowable Burial Depth AASHTO Design = 45.00 Feet

As shown in Table 9 above the longitudinal strain and steel outer fiber strain has a capacity to allowable ratio of one, which indicates the greatest burial depth for a safe design. It is also noted that the service limit for the steel outer fiber strain also has a capacity to demand ratio of 1. However, the burial depth for the outer fiber strain was 48 feet. Since the longitudinal strain occurred at only 45 feet burial depth that is the limiting design factor. A summary table for each of the recommended maximum burial depths (similar to Table 9 above) is shown in Attachment 1 to this report.

Burial Depth Table

Based on the design method described in this report, the allowable burial depth for Kanaflex SRPE pipe is shown in Table 10 below. The analysis used the LRFD Section 12 requirements to the extent applicable. It is noted that these burial depths are based on embankment. Trench conditions or special designs of the embedment may allow deeper burial depths.

Table 10 - Recommended Maximum Burial depth for Kanaflex SRPE pipe

AASHTO Design - Allowable Burial Depth (feet)										
Diameter (in)	**Class I**		**Class II**			**Class III**			**Class IV**	
	Compacted	**Dumped**	**95%**	**90%**	**85%**	**95%**	**90%**	**85%**	**95%**	**90%**
12	67	37	54	37	35	38	30	27	27	25
15	59	30	47	30	26	30	22	18	18	16
18	50	28	45	28	23	29	19	15	14	12
24	64	27	45	27	22	29	20	16	16	14
30	42	25	38	25	23	26	17	13	13	11
36	27	22	25	22	19	23	15	11	10	8
42	41	22	36	22	22	23	15	11	11	9
48	31	18	27	18	16	18	12	9	9	8
60	28	19	22	19	12	16	11	8	8	7

Note: Class I, II, III and IV soils are defined in ASTM D2321. Percent compactions are based on standard proctor density.

The maximum allowable burial depth for Kanaflex SRPE pipe varies based on the burial depth and the soil embedment. Attachment 1 to this report includes Summary Tables for each Diameter and Soil Condition Associated with the CANDE Analysis used in the development of the burial depth table above. This summary of the data extracted from the CANDE analysis includes data for a load factors of 1.0 (service limits) and 2.05 (strength limits).

Attachment 1

Summary Tables for each Diameter and Soil Condition Associated with the CANDE Analysis

Kanaflex®

Suction & Discharge
Cold Weather/ Flexible
Heavy-Duty
Abrasion Resistance
Petroleum
Food Grade
Duct
Specialty
Accessories

General Catalog Industrial Hose

Kanaflex manufactures PVC, rubber, polyurethane and polypropylene hose and ducting of the highest quality utilizing advanced technology, equipment, and proprietary blends of raw materials. Each product series has been designed and tested to ensure outstanding service life and dependability in applications that conform to the required specifications.

Since 1952, Kanaflex's revolutionary production methods have taken the best properties of plastics and rubber, producing products capable of outperforming conventional plastic and rubber hose. Today, Kanaflex technology leads the industry and we continue to search for new raw materials and manufacturing processes to meet the most demanding current and future applications.

Kanaflex Corporation operates manufacturing facilities in Vernon Hills, Illinois, and Compton, California, and a distribution center in Houston, Texas. The company is a wholly owned subsidiary of Kanaflex Corporation Japan. Kanaflex hose is sold through a network of distributors throughout the United States and Canada.

Kanaflex hose is flexible, easy-to-handle, lightweight, and inherently durable. Our hoses continue to replace more expensive and harder-to-handle hoses for many of the industry's toughest jobs.

Flexible
Kanaflex hose lends itself to working in tight spaces.

Lightweight
Kanaflex is up to 50% lighter than conventional rubber hose, making it easier to handle and less expensive to transport.

Economical
Initial cost is low, and Kanaflex hoses are virtually maintenance-free which saves money in the long run.

Smooth bore
A smooth bore and flexible bending characteristics make for the fastest and most efficient transfer of fluids.

Premium rubber materials
Our hose properties are ideally suited for the following applications and conditions:

- Oil
- Chemicals
- Gasoline
- Abrasives
- Extreme temperature variations
- Extreme weather conditions

Because we continually improve our products, we reserve the right to alter specifications without notice.

SELECTION GUIDE

CATEGORY	PRODUCT	PAGE	GENERAL DESCRIPTION	
Suction & Discharge 	Kanalite Flex CL (100CL)	8	General water suction and discharge hose	
	Kanaflo U 113UVCLBK	9	All weather suction and discharge hose	
	Kanaflo 110CL/110 (110CL/110GR)	10	Heavy-duty water suction and discharge hose	
	Kanaflo 112CL/112AG (112CL/112AG)	11	Economical heavy-duty water suction and discharge hose	
	Kanaflo 114CL/114GR	12	Light weight water suction and discharge hose	
Cold Weather/Flexible 	Kanaline Blue	13	Heavy-duty water suction and discharge hose for applications requiring combined vacuum, higher working pressures, and increased flexibility	
	Kanaflo Blue (116 Blue)	14	Heavy-duty water suction and discharge hose	
	Kanalite Blue (100 Blue)	15	Low temp general water suction and discharge hose	
	Kanalite CW (100CWFLX)	16	Low temp general water suction and discharge hose	
	Kanaflo 116CL (116CL)	17	Heavy-duty water suction and discharge hose	
	Kanaline CW	18	Heavy-duty water suction and discharge hose for applications requiring combined vacuum, higher working pressures, and increased flexibility	
Heavy Duty **HD**	Kanaline SR	19	Water suction and discharge hose for heavy-duty applications requiring combined vacuum and higher working pressures	
	KanaChem RS (220RS)	20	All weather suction and discharge hose	
	KanaChem 300 (300GR/EPDM)	21	All weather suction and discharge hose	
	KanaChem 390 (390SDBK)	22	All weather suction and discharge hose	
	KanaVac Max (Kanapower AT)	23	Heavy-duty abrasion resistant suction and discharge hose	
Abrasion Resistance 	KanaVac AR (180AR)	24	Heavy-duty abrasion resistant suction and discharge hose	
	KanaVac STAR (180STAR)	25	Heavy-duty abrasion resistant suction and discharge hose	
	KanaVac MV (180MV)	26	Abrasion resistant medium-duty suction and discharge hose	
	KanaVac Lite (180BL)	27	Lightweight abrasion resistant blower and suction hose	
	KanaVac HR (180HR)	28	High temperature abrasion resistant suction hose	
	KanaBoom (STKB)	29	Heavy-duty abrasion resistance hose with copper grounding wire for handling wet or dry materials	
	Kanaline UFG (STKLUFG)	30	Heavy-duty food-grade static dissipative PVC and polyurethane construction with copper grounding wire for handling wet or dry materials	
	Kanalite U (100UCLRD)	31	Medium-duty polyurethane dry material handling hose	
Petroleum 	KanaPower (ST120LT)	32	Tank truck drop hose with static grounding wire; 50% lighter than conventional rubber hose	
	KanaVapor (ST120VP)	33	Gasoline vapor recovery hose	
	KanaVapor Bio (ST120UACVR)	34	The ultimate all purpose tank truck and terminal vapor recovery hose with clear static dissipating tube and static grounding wire	

	CONSTRUCTION	TEMP RANGE (F°) −60 −40 −20 0 20 40 60 80 100 120 140	WORKING PRESSURE (72°F, P.S.I.)	SIZE
	Flexible PVC, rigid PVC helix, smooth bore, corrugated O.D.	-13 140	30 to 50	1" to 10"
	Flexible PVC blended with polyurethane, rigid PVC helix, smooth bore, smooth O.D.	-13 140	55 to 86	1" to 3"
	Flexible PVC, rigid PVC helix, smooth bore, smooth O.D.	-13 140	28 to 86	3/4" to 8"
	Flexible PVC, rigid PVC helix, smooth bore, smooth O.D.	-13 140	50 to 80	1-1/4" to 4"
	Flexible PVC, rigid PVC helix, smooth bore, smooth O.D.	-13 140	45 to 65	1-1/4" to 4"
	Flexible cold weather PVC, rigid PVC helix, synthetic braiding, smooth bore, corrugated O.D.	-40 140	30 to 75	1-1/2" to 10"
	Flexible PVC, rigid PVC helix, smooth bore, smooth O.D.	-40 140	21 to 70	1" to 8"
	Cold weather PVC, rigid PVC helix, smooth bore, corrugated O.D.	-40 140	20 to 40	1" to 8"
	Cold weather PVC, rigid PVC helix, smooth bore, corrugated O.D.	-22 140	20 to 25	3" to 6"
	Flexible PVC, rigid PVC helix, smooth bore, smooth O.D.	-22 140	21 to 70	1" to 8"
	Flexible cold weather PVC, rigid PVC helix, synthetic braiding, smooth bore, corrugated O.D.	-22 140	50 to 70	2" to 6"
	Flexible PVC, rigid PVC helix, synthetic braiding, smooth bore, corrugated O.D.	-13 140	28 to 110	1-1/2" to 12"
	SBR rubber with carbon black, rigid PVC helix, smooth bore, smooth O.D.	-40 140	23 to 50	1-1/2" to 6"
	EPDM rubber, polyethylene helix, smooth bore, corrugated O.D.	-40 140	23 to 50	1" to 6"
	EPDM rubber, polyethylene helix, synthetic braiding, smooth bore, corrugated O.D.	-40 140	90 to 100	1-1/4" to 3"
	SBR rubber blended with static dissipating carbon black	-30 140	140	4" to 6"
	SBR rubber blended with static carbon black, rigid PVC helix, smooth bore, corrugated O.D.	-40 140	25 to 45	1-1/4" to 12"
	SBR rubber blended with static carbon black, rigid PVC helix, smooth bore, with copper wire, corrugated O.D.	-40 140	10 to 20	2" to 4"
	SBR rubber with carbon black, rigid PVC helix, smooth bore, corrugated O.D.	-40 140	8	5" to 6"
	SBR rubber blended with static carbon black, rigid PVC helix, smooth bore, corrugated O.D.	-40 140	8 to 18	2-1/2" to 8"
	EPDM rubber, polyethylene helix, metal helical wire, smooth bore, corrugated O.D.	-40 220	30	4" to 8"
	Flexible high abrasion polyurethane liner, rigid PVC helix, synthetic braiding, no direction required, smooth bore, extra UV inhabitant PVC corrugated O.D. with static dissipating materials and copper grounding wire.	-33 140	60 to 75	4" to 8"
	Flexible static dissipative polyurethane liner and PVC, rigid PVC helix, synthetic braiding, no direction required, smooth bore, PVC corrugated O.D. with copper grounding wire.	-33 140	70 to 75	4" to 6"
	Flexible polyurethane lined PVC tube, rigid PVC helix, smooth bore, PVC corrugated O.D.	-13 140	30 to 40	2" to 6"
	Nitrile rubber static dissipating tube, rigid PVC helix, synthetic braiding, smooth bore, static grounding wire, corrugated O.D.	-30 140	65	2" to 4"
	Nitrile rubber, rigid PVC helix, smooth bore, corrugated O.D., static grounding wire	-40 140	10 to 20	2" to 4"
	Lightweight clear static dissipating non-permeable polyurethane with smooth bore, corrugated O.D., rigid PVC helix, static grounding wire	-52 140	7 to 9	2" to 4"

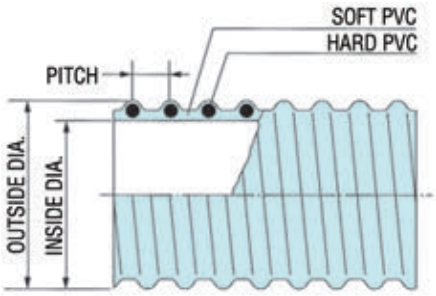
SELECTION GUIDE

CATEGORY	PRODUCT	PAGE	GENERAL DESCRIPTION	
Petroleum (continued) 	KanaPower Bio (ST120UAPDH)	35	The ultimate all purpose tank truck drop hose with clear static dissipating tube and static grounding wire	
	KanaPower Max (ST120HP)	36	Tank truck drop hose with static grounding wire; 50% lighter than conventional rubber hose	
	Kanaline OR	37	Oil resistant PVC heavy-duty suction and discharge hose *** Oil Use Only, NOT for use with gasoline or similar fuels ***	
Food Grade 	Kanalite FG (200SFG)	38	Food grade suction and discharge hose	
	Kanalite STFG (ST200SFG)	39	Medium-duty, lightweight, hose for pneumatic conveying	
	Kanaflo FG (210HFG)	40	Heavy-duty food grade suction and discharge hose	
	Kanaflo MK (212MK)	41	Heavy-duty food grade suction and discharge hose	
	Kanaline FW	42	Heavy-duty food grade suction and discharge hose	
Duct 	KanaDuct 150 (150CL)	43	Lightweight PVC blower and ducting hose	
	KanaDuct 620 (620WD)	44	General ducting and blower hose with metal wire helix	
	KanaDuct 625 (620WD WS)	45	General ducting and blower hose with metal wire helix and external wear strip	
	KanaDuct 630 (630ED)	46	Medium-duty blower and ducting hose	
	KanaDuct 660 (660YD)	47	Heavy-duty duct hose with “safety yellow” helix for high visibility	
	KanaDuct 150U (150UDH)	48	Polyurethane medium-duty blower and ducting hose	
	Kanalite 155 (155GY)	49	Heavy-duty PVC blower and ducting hose	
Specialty 	Kanalite PS UVOR (101PSUVOR)	50	Methane gas recovery at landfills, water suction/discharge. Solid wall construction and extra UV inhibitors provide extended life.	
	Kanalite PS (101PS)	51	Methane gas recovery at landfills, water suction/discharge	
	Kanaflo Spa (Spa Cream)	52	Flexible PVC spa hose	
	KanaDuct Poly (Kanaduct)	53	Duct hose, with interlock construction, allows the inside diameter to be changed by twisting the hose, while still holding its shape	
Accessories	Banding Sleeve	54	Plastic banding sleeve for use with ST 120 LT hose	
	Banding Coil (black or white)	54	Designed to fit and fill the area between the helix	
	Duct Clamp	55		
	PowerLock Clamp	55		
	PowerLock Clamp PS	55		

	CONSTRUCTION	TEMP RANGE (F°) −60 −40 −20 0 20 40 60 80 100 120 140	WORKING PRESSURE (72°F, P.S.I.)	SIZE
	Non-permeable polyurethane inner and outer tube with synthetic braiding, smooth bore, corrugated O.D., PVC helix for easy drag, clear static dissipating tube and multi-strand copper static wire	-52 140	65	2" to 4"
	Nitrile rubber static dissipating tube, rigid PVC helix, synthetic braiding, smooth bore, static grounding wire, corrugated O.D.	-30 140	150	3" to 4"
	Flexible oil-resistant PVC, rigid PVC helix, synthetic braiding, smooth bore, corrugated O.D.	-13 140	60 to 80	2" to 4"
	Produced entirely of compounds in compliance with FDA and 3-A non toxic specifications, flexible PVC, rigid PVC helix, smooth bore, corrugated O.D.	-13 140	30 to 50	1" to 4"
	Produced entirely of compounds in compliance with FDA and 3-A nontoxic specifications, flexible PVC, rigid PVC helix, multi-strand copper static grounding wire, smooth bore, corrugated O.D.	-13 140	30 to 45	1-1/2" to 4"
	Produced entirely of compounds in compliance with FDA and 3-A nontoxic specifications, flexible PVC, rigid PVC helix, smooth bore, corrugated O.D.	-13 140	55 to 86	3/4" to 4"
	Produced entirely of compounds in compliance with FDA and 3-A nontoxic specifications, flexible PVC, rigid PVC helix, smooth bore, corrugated O.D.	-13 140	62 to 66	1-1/2" to 3"
	Produced entirely of compounds in compliance with FDA and 3-A nontoxic specifications, flexible PVC, rigid PVC helix, synthetic braiding, smooth bore, corrugated O.D.	-13 140	70 to 110	1-1/2" to 6"
	Flexible PVC, rigid PVC helix, smooth bore, corrugated O.D.	-13 140	2 to 6	2-1/2" to 8"
	EPDM rubber, metal wire helix, smooth bore, slightly corrugated O.D.	-40 220	3 to 12	2" to 12"
	EPDM rubber, metal wire helix, wearstrip, smooth bore, corrugated O.D.	-40 220	3 to 12	2-1/2" to 12"
	EPDM rubber, polypropylene helix, smooth bore, corrugated O.D.	-40 158	—	2" to 8"
	EPDM rubber, polypropylene helix, smooth bore, corrugated O.D.	-40 158	3 to 9	4" to 12"
	Flexible clear polyurethane, rigid PVC helix, smooth bore, corrugated O.D.	-20 140	3 to 9	2-1/2" to 8"
	Flexible PVC, rigid PVC helix, smooth bore, corrugated O.D.	-13 140	10 to 20	1-1/2" to 8"
	Flexible PVC, rigid PVC helix, smooth bore, corrugated O.D.	-13 140	30 to 35	2-3/4" to 4-1/2"
	Rigid PVC and helix	-13 140	30 to 35	2-3/4" to 4-1/2"
	Flexible PVC, rigid PVC helix, smooth bore, smooth O.D.	-13 158	60 to 100	1/2" to 2"
	Interlocked polypropylene	-13 180	—	2-1/2" to 12"
	PVC construction, corrugated inside, smooth O.D.	-40 140	—	—
	PVC	—	—	—
	Steel	—	—	—
	Steel	—	—	—
	Steel	—	—	—

Kanalite Flex CL (100CL)

General water suction and discharge hose



Made in USA

SPECIFICATIONS

Temp. Range: -13°F to 140°F
Applications: General water suction hose
Construction: Flexible PVC, rigid PVC helix, smooth bore, corrugated O.D.
Note: Not a food-grade hose

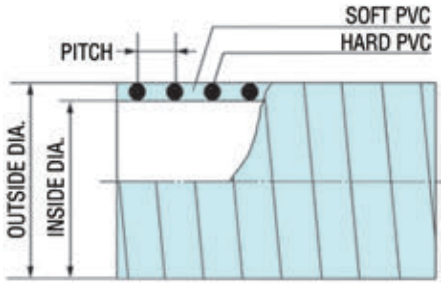
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
1	1.25	0.30	1.5	50	29.8	0.18	100
1-1/4	1.52	0.33	2.0	45	29.8	0.22	100
1-1/2	1.81	0.35	2.5	45	29.8	0.35	100
2	2.36	0.39	3.0	40	29.8	0.50	100
2-1/2	2.87	0.56	4.5	35	29.8	0.68	100
3	3.50	0.59	6.0	35	29.8	1.00	100
4	4.63	0.65	8.0	30	29.8	1.52	100
6	6.85	0.87	11.0	30	28.0	3.10	50,100
8	9.04	0.91	16.0	30	28.0	5.38	25
10	11.26	1.02	30.0	30	28.0	8.88	20

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

Kanaflo U 113UVCLBK

All weather suction and discharge hose



Made in USA

Temp. Range: -13°F to 140°F

Applications: Economical heavy-duty water suction hose, air seeder hose and abrasion resistant.

Construction: Flexible PVC blended with polyurethane, rigid PVC helix, smooth bore, smooth O.D.

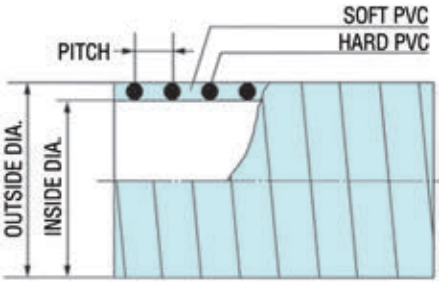
Note: Not a food-grade hose

AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
1	1.25	0.22	1.9	86	29.8	0.25	100
1-1/4	1.47	0.26	3.0	80	29.8	0.25	100
1-1/2	1.77	0.30	4.0	70	29.8	0.39	100
1-3/4	2.00	0.30	4.5	65	29.8	0.48	100
2	2.30	0.33	5.0	65	29.8	0.63	100
2-1/2	2.84	0.37	6.0	65	29.8	0.87	100
3	3.35	0.37	8.0	55	29.8	1.05	100

Kanaflo 110 CL/110 GR (110 CL/110 GR)

Heavy-duty water suction and discharge hose



Made in USA

SPECIFICATIONS

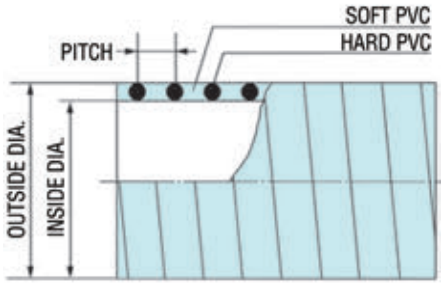
Temp. Range: -13°F to 140°F
Applications: Heavy-duty water suction hose
Construction: Flexible PVC, rigid PVC helix, smooth bore, smooth O.D.
Note: Not a food-grade hose

AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
3/4	0.95	0.22	1.9	86	29.8	0.16	100
1	1.25	0.22	1.9	86	29.8	0.26	100
1-1/4	1.52	0.26	2.7	79	29.8	0.37	100
1-1/2	1.81	0.30	2.8	72	29.8	0.44	100
2	2.38	0.33	3.9	72	29.8	0.74	100
2-1/2	2.92	0.37	5.0	72	29.8	1.01	100
3	3.41	0.37	7.0	62	29.8	1.21	100
4	4.50	0.43	9.1	55	29.8	2.01	100
5	5.55	0.45	14.0	33	28.0	2.45	50,100
6	6.67	0.53	15.0	33	28.0	3.37	50,100
8	8.83	0.70	20.0	28	28.0	5.80	25

Kanaflo 112 CL /112 AG (112 CL /112 AG)

Economical heavy-duty water suction and discharge hose



Made in USA

SPECIFICATIONS

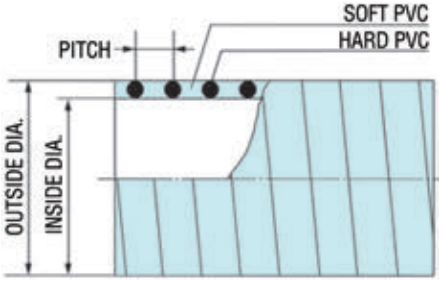
Temp. Range: -13°F to 140°F
Applications: Economical heavy-duty water suction hose, air seeder hose.
Construction: Flexible PVC, rigid PVC helix, smooth bore, smooth O.D.
Note: Not a food-grade hose

AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
1-1/4	1.47	0.26	3.0	80	29.8	0.29	100
1-1/2	1.77	0.30	4.0	70	29.8	0.39	100
2	2.30	0.33	5.0	65	29.8	0.63	100
2-1/2	2.84	0.37	6.0	65	29.8	0.87	100
3	3.35	0.37	8.0	55	29.8	1.05	100
4	4.45	0.43	10.0	50	29.8	1.80	100

Kanaflo 114CL/114GR

Light weight water suction and discharge hose



Made in USA

SPECIFICATIONS

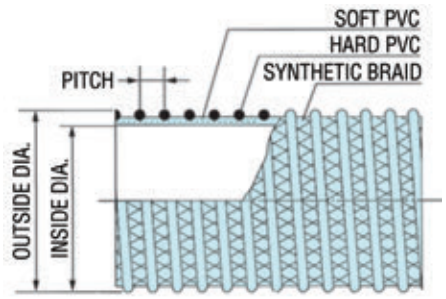
Temp. Range: -13°F to 140°F
Applications: Light weight water suction
Construction: Flexible PVC, rigid PVC helix, smooth bore, smooth O.D.
Note: Not a food-grade hose

AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
1-1/4	1.44	0.26	3.0	65.0	29.8	0.23	100
1-1/2	1.69	0.30	4.0	65.0	29.8	0.28	100
2	2.24	0.33	5.0	60.0	29.8	0.46	100
2-1/2	2.80	0.37	6.0	60.0	29.8	0.66	100
3	3.31	0.37	8.0	50.0	29.8	0.81	100
4	4.39	0.43	10.0	45.0	29.8	1.43	100

Kanaline Blue

Heavy-duty water suction and discharge hose for applications requiring combined vacuum, higher working pressures, and increased flexibility



Made in USA

SPECIFICATIONS

Temp. Range: -40°F to 140°F

Applications: Heavy-duty suction and discharge with increased flexibility for use in colder environment applications, where more flexibility is desired, and liquid fertilizer

Construction: Flexible cold weather PVC, rigid PVC helix, synthetic braiding, smooth bore, corrugated O.D.

Features: Lightweight and flexible. External helix provides for easy drag. Rated for both suction and discharge. Clear sidewall permits visual check of material flow.

Note: Banding coil must be used for all sizes. Not a food-grade hose.

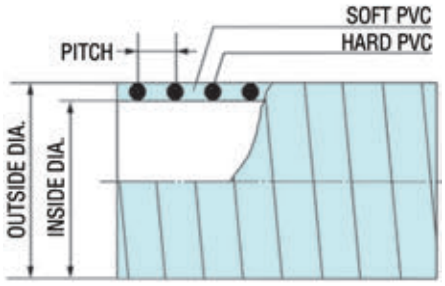
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
1-1/2	2.10	0.37	2.0	75	28.0	0.47	60,100
2	2.60	0.43	3.0	70	28.0	0.70	60,100
3	3.70	0.59	5.0	70	28.0	1.13	60,100
4	4.80	0.63	7.0	60	28.0	1.74	60,100
6	7.30	0.98	9.0	50	28.0	3.88	60,100
8	9.50	1.07	15.0	40	28.0	5.54	15,20,25,40
10	11.63	1.22	24.5	30	28.0	8.68	Not stock item

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

Kanaflo Blue (116 Blue)

Heavy-duty water suction and discharge hose



Made in USA

SPECIFICATIONS

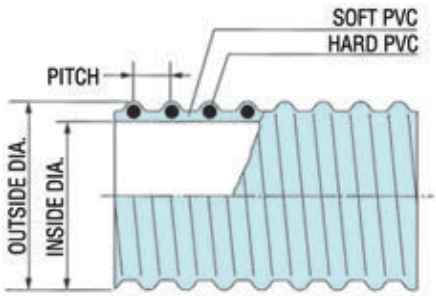
Temp. Range: -40°F to 140°F
Applications: Heavy-duty water suction and discharge hose with increased flexibility
Construction: Flexible PVC, rigid PVC helix, smooth bore, smooth O.D.
Note: Not a food-grade hose

AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
1	1.25	0.22	1.5	70	29.8	0.25	100
1-1/2	1.78	0.30	2.5	56	29.8	0.38	100
2	2.33	0.33	3.0	50	29.8	0.64	100
3	3.38	0.37	6.0	50	29.8	1.10	100
4	4.46	0.43	10.0	42	29.8	1.85	100
6	6.67	0.53	13.0	28	28.0	3.37	50,100
8	8.83	0.70	20.0	21	28.0	5.80	25

Kanalite Blue (100 Blue)

Low temp general water suction and discharge hose



Made in USA

SPECIFICATIONS

Temp. Range: -40°F to 140°F

Applications: General-duty low temperature water suction and discharge hose with increased flexibility

Construction: Cold weather PVC, rigid PVC helix, smooth bore, corrugated O.D.

Features: Lightweight with increased flexibility even at sub-zero temperatures. Clear sidewall permits visual check of material flow. External helix provides for easy drag.

Accessories: Banding coil, Powerlock clamp

Note: Not a food-grade hose

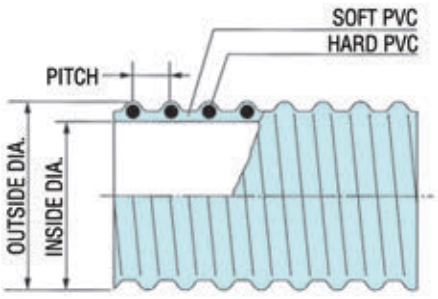
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
1	1.25	0.30	1.5	40	29.0	0.18	100
1-1/2	1.81	0.35	2.0	35	29.0	0.35	100
2	2.36	0.39	2.5	27	29.0	0.50	100
3	3.50	0.59	5.0	25	29.0	1.00	100
4	4.55	0.65	6.5	20	28.0	1.52	100
6	6.73	0.85	10.6	20	28.0	3.10	50,100
8	9.04	0.91	16.0	20	28.0	5.38	25

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

Kanalite CW (100 CWFLX)

Low temp general water suction and discharge hose



Made in USA

SPECIFICATIONS

Temp. Range: -40°F to 140°F

Applications: General-duty low temperature water suction and discharge hose with increased flexibility

Construction: Cold weather PVC, rigid PVC helix, smooth bore, corrugated O.D.

Features: Lightweight with increased flexibility even at sub-zero temperatures. Clear sidewall permits visual check of material flow. External helix provides for easy drag.

Accessories: Banding coil, Powerlock clamp.

Note: Not a food-grade hose

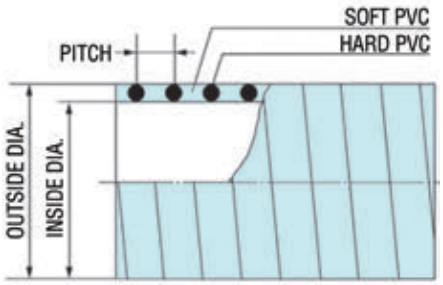
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
3	3.50	0.59	5.0	25	29.0	1.00	100
4	4.55	0.65	6.5	20	28.0	1.52	100
5	5.73	0.85	9.5	20	28.0	2.50	50,100
6	6.73	0.85	10.6	20	28.0	3.10	50,100

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

Kanaflo 116 CL (116 CL)

Heavy-duty water suction and discharge hose



Made in USA

SPECIFICATIONS

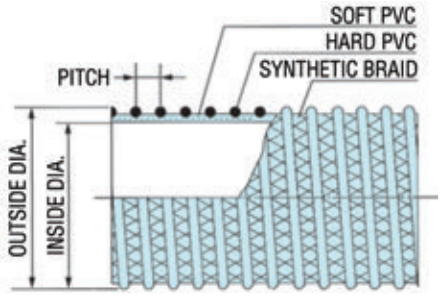
Temp. Range: -40°F to 140°F
Applications: Heavy-duty water suction and discharge hose with increased flexibility
Construction: Flexible PVC, rigid PVC helix, smooth bore, smooth O.D.
Note: Not a food-grade hose

AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
1	1.25	0.22	1.5	70	29.8	0.25	100
1-1/4	1.50	0.26	2.0	70	29.8	0.30	100
1-1/2	1.78	0.30	2.5	56	29.8	0.38	100
2	2.33	0.33	3.0	50	29.8	0.64	100
2-1/2	2.90	0.37	4.5	50	29.8	0.90	100
3	3.38	0.37	6.0	50	29.8	1.10	100
4	4.46	0.43	10.0	42	29.8	1.85	100
5	5.55	0.45	12.5	28	28.0	2.47	50,100
6	6.67	0.53	13.0	28	28.0	3.37	50,100
8	8.83	0.70	20.0	21	28.0	5.80	25

Kanaline CW

Heavy-duty water suction and discharge hose for applications requiring combined vacuum, higher working pressures, and increased flexibility



Made in USA

SPECIFICATIONS

Temp. Range: -40°F to 140°F

Applications: Heavy-duty suction and discharge with increased flexibility for use in colder environment applications, where more flexibility is desired, and liquid fertilizer

Construction: Flexible cold weather PVC, rigid PVC helix, synthetic braiding, smooth bore, corrugated O.D.

Features: Lightweight and flexible. External helix provides for easy drag. Rated for both suction and discharge. Clear sidewall permits visual check of material flow.

Note: Not a food-grade hose. Banding coil must be used for all sizes.

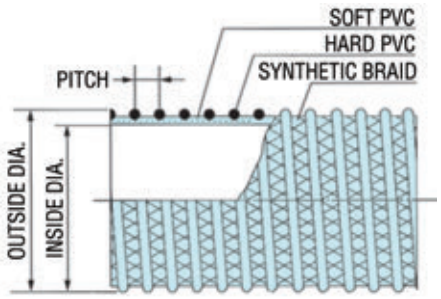
AVAILABLE SIZES

Inside Dia. Inches	**Outside Dia.** Inches	**Pitch** Inches	**Minimum Bend Radius** 72°F, Inches	**Working Pressure** 72°F, P.S.I.	**Vacuum Rating** 72°F, In Hg	**Weight** Lbs/Ft	**Standard Length** Ft
2	2.60	0.43	3.0	70	28.0	0.70	60,100
3	3.70	0.59	5.0	70	28.0	1.13	60,100
4	4.78	0.63	7.0	60	28.0	1.74	60,100
6	7.2	0.98	9.0	50	28.0	3.88	60,100

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

Kanaline SR

Water suction and discharge hose for heavy-duty applications requiring combined vacuum and higher working pressures



Made in USA

SPECIFICATIONS

Temp. Range: -13°F to 140°F

Applications: Heavy duty suction and discharge hose for use in fish suction and rental/construction pumping

Construction: Flexible PVC, rigid PVC helix, synthetic braiding, smooth bore, corrugated O.D.

Features: Lightweight and flexible. External helix provides for easy drag. Rated for both suction and discharge. Clear sidewall permits visual check of material flow.

Note: Not a food-grade hose. Banding coil must be used for 1-1/2", 2", 3", 4", 5" and 6" sizes.

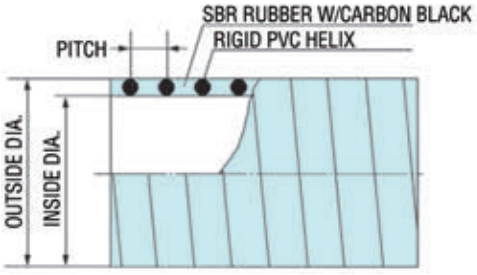
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
1-1/2	2.1	0.37	2.5	110	28.0	0.47	60,100
2	2.6	0.43	4.0	100	28.0	0.70	60,100
3	3.7	0.59	6.3	100	28.0	1.13	60,100
4	4.8	0.65	7.1	75	28.0	1.74	60,100
5	6.1	0.87	9.2	70	28.0	2.90	60,100
6	7.2	0.93	10.2	70	28.0	3.88	60,100
8	9.5	1.07	15.7	60	28.0	5.54	15,20,25,40
10	11.63	1.22	24.8	40	28.0	8.68	15,20,25,40
12	13.8	1.34	45.0	28	25.0	10.30	20,40

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

KanaChem RS (220RS)

All weather suction and discharge hose



Made in USA

SPECIFICATIONS

Temp. Range: -40°F to 140°F

Applications: Heavy-duty liquid suction hose for use in construction dewatering, liquid waste, cesspool cleaning, septic handling, agricultural applications and marine use

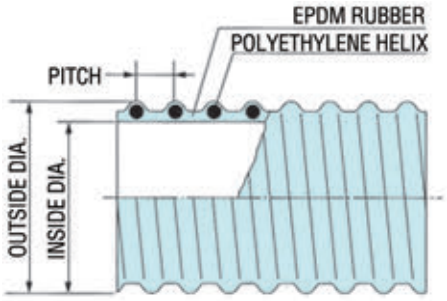
Construction: SBR rubber with static carbon black, rigid PVC helix, smooth bore, smooth O.D.

AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
1-1/2	1.85	0.35	3.0	50	29.8	0.50	100
2	2.40	0.39	4.0	50	29.8	0.74	100
2-1/2	2.99	0.56	5.0	50	29.8	1.01	100
3	3.50	0.59	6.0	43	29.8	1.30	100
4	4.57	0.65	9.0	38	29.8	2.01	100
6	6.69	0.87	15.0	23	28.0	3.37	60,100

KanaChem 300 (300GR/EPDM)

All weather suction and discharge hose



Made in USA

SPECIFICATIONS

Temp. Range: -40°F to 140°F

Applications: Heavy-duty liquid suction hose for use in construction dewatering, liquid waste, cesspool cleaning, septic handling, agricultural applications and marine use.

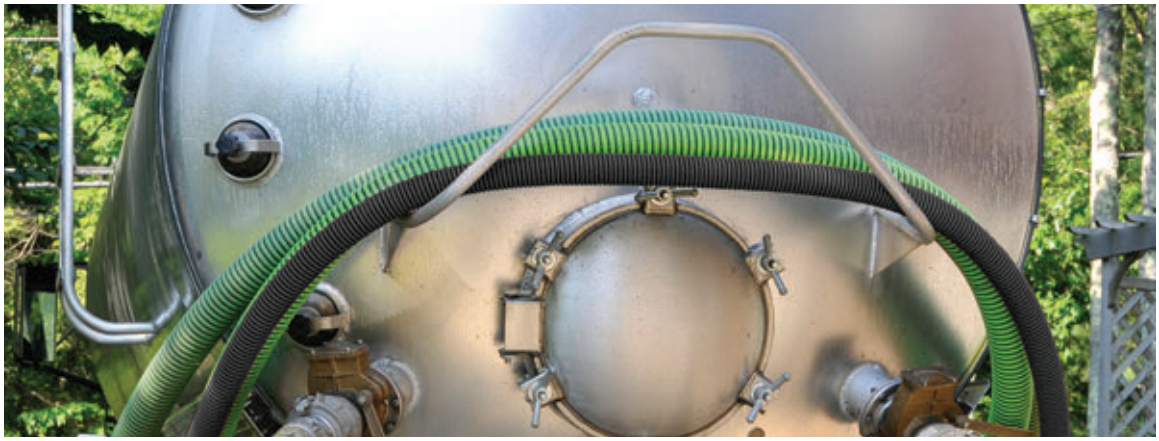
Construction: EPDM rubber, polyethylene helix, smooth bore, corrugated O.D.

Features: Lightweight and flexible. External helix provides for easy drag. Resistant to agricultural chemicals.

Note: Hose available with red, blue, yellow, and black helix with 500 ft. minimum order.

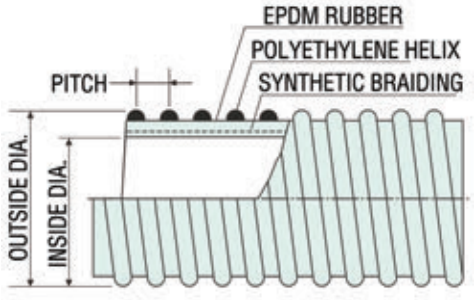
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
1	1.34	0.30	1.9	50	29.8	0.23	100
1-1/4	1.7	0.33	3.2	50	29.8	0.34	100
1-1/2	2.0	0.35	3.2	50	29.8	0.40	100
2	2.5	0.39	5.2	50	29.8	0.67	100
2-1/2	3.1	0.56	5.6	50	29.8	0.92	100
3	3.6	0.59	7.1	43	29.8	1.10	100
4	4.7	0.65	11.0	38	29.8	1.84	100
6	6.9	0.87	20.0	23	28.0	3.07	60,100



KanaChem 390 (390 SD)

All weather suction and discharge hose



Made in USA

SPECIFICATIONS

Temp. Range: -40°F to 140°F

Applications: Suction and discharge of liquids in the construction, rental and agricultural industries such as agricultural chemicals, liquid fertilizers and dewatering

Construction: EPDM rubber, polyethylene helix, synthetic braiding, smooth bore, corrugated O.D.

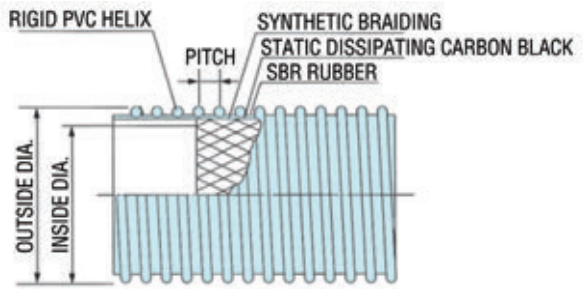
Features: Lightweight and flexible. Rated for both suction and discharge. External helix provides for easy drag. Resistant to agricultural chemicals. Durable in construction applications.

AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
1-1/4	1.8	0.39	3.0	100	29.8	0.45	60,100
1-1/2	2.1	0.43	3.0	100	29.8	0.50	60,100
2	2.6	0.47	5.0	100	29.8	0.73	60,100
3	3.7	0.59	7.0	90	29.8	1.25	60,100

KanaVac Max (Kanapower AT)

Extremely durable and heavy-duty high pressure suction and discharge hose



Made in USA

SPECIFICATIONS

Temp. Range: -30°F to 140°F

Applications: Abrasion resistant suction and discharge hose designed for demanding applications such as slurry in micro-tunneling applications and directional boring

Construction: SBR rubber blended with static dissipating carbon black

Note: 6" size is not a stock item. Consult factory for availability.

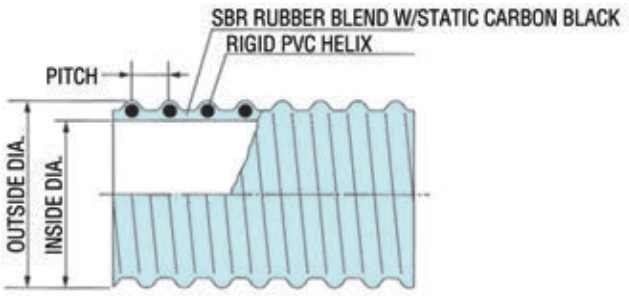
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
4	5.28	0.65	10.0	140	28.0	2.85	60,100
6	7.36	0.87	16.0	140	28.0	4.50	Not stock item

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

KanaVac AR (180 AR)

Heavy-duty abrasion resistant suction and discharge hose



Made in USA

SPECIFICATIONS

Temp. Range: -40°F to 140°F

Applications: Heavy-duty abrasion resistant suction hose for vacuum trucks or handling abrasives such as crushed rock, sand, pea gravel, cement powder, dry fertilizer, iron ore and grains

Construction: SBR rubber blended with static carbon black, rigid PVC helix, smooth bore, corrugated O.D.

Features: Lightweight and flexible. Extremely abrasion resistant. Static dissipating with no grounding wire. Consult factory for specific applications.

Note: This hose was not designed for bulk handling such as unloading of rail cars.

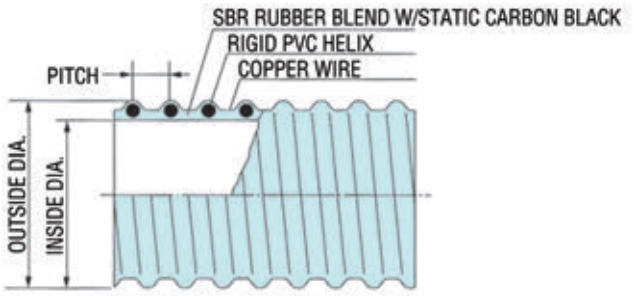
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
1-1/4	1.6	0.33	2.0	45	29.8	0.31	100
1-1/2	1.9	0.35	2.0	45	29.8	0.37	100
2	2.4	0.39	2.5	40	29.8	0.50	100
2-1/2	3.0	0.56	2.5	35	29.8	0.88	100
3	3.5	0.59	3.0	35	29.8	1.10	100
3-1/2	4.11	0.64	4.0	30	29.8	1.35	100
4	4.63	0.65	4.5	30	29.8	1.77	50,100
5	5.76	0.87	5.0	30	28.0	2.47	50,100
6	6.8	0.87	9.2	30	28.0	3.08	50,100
7	7.83	0.87	14.0	30	27.0	4.10	50
8	9.04	0.91	15.0	30	27.0	5.65	50
10	11.18	1.00	30.0	28	25.0	8.88	20
12	13.31	1.18	40.0	25	25.0	10.43	20

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

KanaVac STAR (180 STAR)

Heavy-duty abrasion resistant suction and discharge hose



Made in USA

SPECIFICATIONS

Temp. Range: -40°F to 140°F

Applications: Heavy-duty abrasion resistant suction hose for vacuum trucks or handling abrasives such as crushed rock, sand, pea gravel, cement powder, dry fertilizer, iron ore and grains

Construction: SBR rubber blended with static carbon black, rigid PVC helix, smooth bore, with copper wire, corrugated O.D.

Features: Lightweight and flexible. Extremely abrasion resistant. Static dissipating with grounding wire. Consult factory for specific applications.

Note: This hose was not designed for bulk handling such as unloading of rail cars.

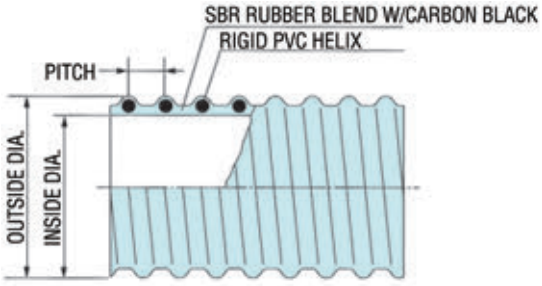
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
1-1/2	1.90	0.35	2.5	45	29.8	0.50	100
2	2.44	0.39	2.5	40	29.8	0.60	100
3	3.50	0.59	3.0	35	29.8	1.19	100
4	4.63	0.65	4.5	30	29.8	1.84	50,100
6	6.80	0.87	9.2	30	28.0	3.26	50,100

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

KanaVac MV (180 MV)

Abrasion resistant medium-duty suction and discharge hose



Made in USA

SPECIFICATIONS

Temp. Range: -40°F to 140°F
Applications: Designed for numerous applications such as grain and roof vacuums
Construction: SBR rubber with carbon black, rigid PVC helix, smooth bore, corrugated O.D.

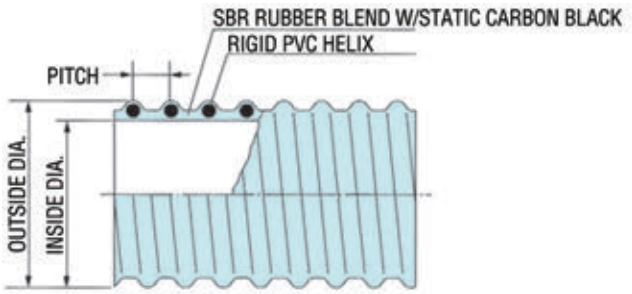
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
5	5.75	0.87	5.0	8	18.0	2.00	50,100
6	6.73	0.87	9.0	8	18.0	2.70	50,100

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

KanaVac Lite (180 BL)

Lightweight abrasion resistant blower and suction hose



Made in USA

SPECIFICATIONS

Temp. Range: -40°F to 140°F

Applications: Designed for suction and light blowing of lightweight abrasives such as rockwool, fiberglass, sawdust, grain, insulation and cement dust

Construction: SBR rubber blended with static carbon black, rigid PVC helix, smooth bore, corrugated O.D.

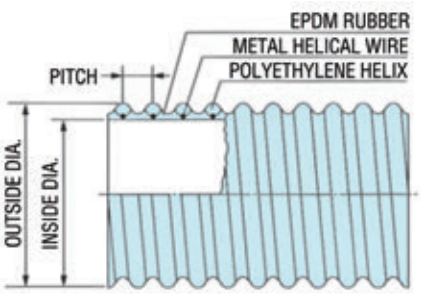
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
2-1/2	2.91	0.56	2.5	18	25.0	0.71	100
3	3.44	0.59	3.0	13	23.0	0.92	100
4	4.53	0.65	4.0	10	20.0	1.50	50,100
5	5.63	0.87	5.0	8	15.0	1.68	50,100
6	6.67	0.87	9.0	8	15.0	2.40	50,100
7	8.71	0.87	10.0	8	15.0	3.00	50
8	8.98	0.91	12.0	8	15.0	4.40	50

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

KanaVac HR (180 HR)

High temperature abrasion resistant suction hose



Made in USA

SPECIFICATIONS

Temp. Range: -40°F to 220°F

Applications: Heavy-duty suction applications where high temperature and abrasion are factors such as vacuum trucks or the handling of fly ash, crushed rock, sand, pea gravel or cement powder

Construction: EPDM rubber, polyethylene helix, metal helical wire, smooth bore, corrugated O.D.

Features: Lightweight and flexible. Integral wire helix can be grounded. External helix provides easy drag. Rated up to 220°F.

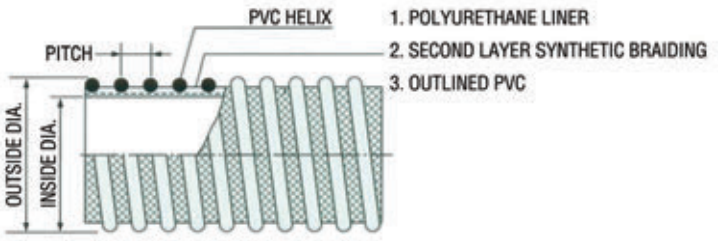
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
4	4.69	0.65	5.5	30	29.8	1.75	50,100
6	6.9	0.87	9.8	30	28.0	3.46	50,100
8	9.13	0.87	15.0	30	27.0	6.00	50

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

KanaBoom (STKB)

Heavy-duty abrasive resistance hose with copper grounding wire for handling wet or dry materials



SPECIFICATIONS

Temp. Range: -33°F to 140°F

Applications: Hydro-vac truck, vacuum truck, general construction use, wet and dry full vacuum rated.

Construction: Flexible high abrasion polyurethane liner, rigid PVC helix, synthetic braiding, no direction required, smooth bore, extra UV inhabitant PVC corrugated O.D. with static dissipating materials and grounding wire.

Features: Lightweight and flexible in sub-zero temperatures. Abrasive resistant polyurethane tube provides increased lifetime, prevents material build-up and provides quiet operation. Static copper wire in construction dissipates static charge when connected to a grounded system. External helix provides for easy drag.

Accessories: Banding coil or Powerlock Clamp must be used for all sizes. Static wire must be properly imbedded during fitting installation and tested to assure proper static grounding of hose to a grounded system.

Note: Not a food-grade hose

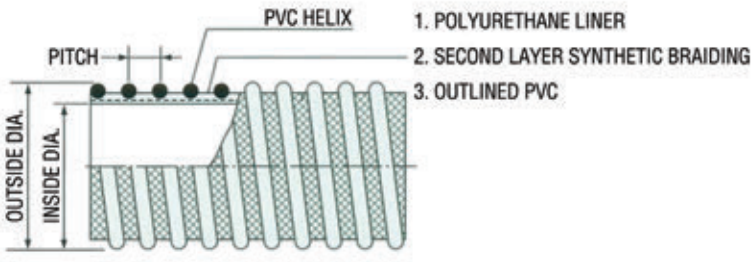
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
4	4.86	0.69	9.0	75	29.8	2.1	60,100
6	7.37	1.04	22.0	70	28.0	4.7	60,100
8	9.54	1.16	34.0	60	28.0	6.5	26, 31, 35, 40

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

Kanaline UFG (STKLUFG)

Heavy-duty food-grade static dissipative PVC and polyurethane construction with copper grounding wire for handling wet or dry materials



Made in USA

White helix is available with 500 ft. minimum order

SPECIFICATIONS

Temp. Range: -33°F to 140°F

Applications: Transfer of abrasive/food grade materials - bulk unloading of railcars and trucks. Fish suction.

Construction: Flexible static dissipative polyurethane liner and PVC, rigid PVC helix, synthetic braiding, no direction required, smooth bore, PVC corrugated O.D. with copper grounding wire. Produced entirely of compounds in compliance with FDA and 3-A non-toxic specifications.

Features: Lightweight and flexible in sub-zero temperatures. Clear food-grade polyurethane tube provides increased abrasion resistance, permits visual check of material flow, prevents material build up and provides quiet operation. Static copper wire and dissipative material in construction dissipates static charge when connected to a grounded system. External helix provides for easy drag.

Accessories: Banding coil or Powerlock Clamp must be used for all sizes. Static wire must be properly imbedded during fitting installation and tested to assure proper static grounding of hose to a grounded system.

Note: Made with NSF51 approved materials

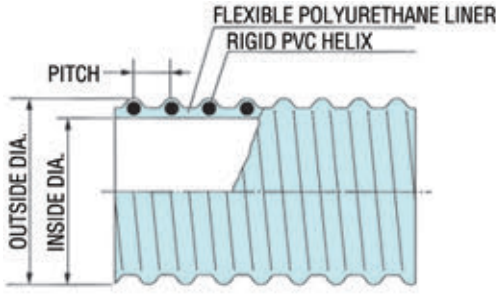
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
4	4.8	0.69	7.5	75	28.0	1.94	60,100
5	6.1	1.00	9.5	70	28.0	3.20	60,100
6	7.2	1.00	11.0	70	28.0	4.34	60,100

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

Kanalite U (100 UCLRD)

Medium-duty polyurethane dry material handling hose



Made in USA

SPECIFICATIONS

Temp. Range: -13°F to 140°F

Applications: Dry material pneumatic conveying systems and plastic pellet and powder transfer when static is not a concern. Agricultural applications, such as air seeders, abrasive material vacuum systems, and industrial vac equipment.

Construction: Flexible polyurethane lined PVC tube, rigid PVC helix, smooth bore, PVC corrugated O.D.

Features: Lightweight and flexible in sub-zero temperatures. Clear polyurethane lined PVC tube provides abrasion resistance, permits visual check of material flow, prevents material build up, and provides quiet operation. Corrugated PVC O.D. with raised PVC helix for increased flexibility and easy drag.

Accessories: Banding coil, Powerlock clamp

Note: Not a food-grade hose

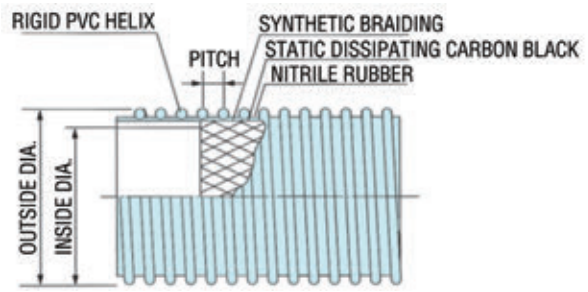
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
2	2.36	0.39	3.0	40	29.8	0.50	100
2-1/2	2.93	0.53	5.0	35	29.8	0.71	100
3	3.50	0.59	6.0	35	29.8	1.00	100
4	4.63	0.65	8.0	30	29.8	1.52	100
5	5.73	0.87	11.0	30	28.0	2.50	50,100
6	6.85	0.87	12.0	30	28.0	3.10	50,100

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

KanaPower (ST120 LT)

Tank truck drop hose with static grounding wire; 50% lighter than conventional rubber hose



Made in USA

SPECIFICATIONS

Temp. Range: -30°F to 140°F

Applications: Gasoline tank truck gravity drop hose for fluids such as naphtha, kerosene, light and heavy oil, diesel and some ethanol

Construction: Nitrile rubber static dissipating tube, rigid PVC helix, synthetic braiding, smooth bore, static grounding wire, corrugated O.D.

Features: Lightweight and flexible. External helix provides for easy drag. Rated for up to 40% aromatic content.

Note: Banding sleeves or banding coils must be used for all sizes.

Static wire must be properly imbedded during fitting installation and tested to assure proper static grounding of hose to a grounded system.

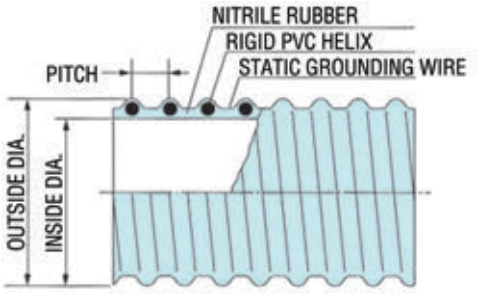
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
2	2.68	0.39	5.0	65	29.8	1.13	60,100
3	3.8	0.59	6.0	65	29.8	1.37	60,100
4	4.9	0.65	8.0	65	29.8	2.16	60,100

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

KanaVapor (ST120 VP)

Gasoline vapor recovery hose



Made in USA

SPECIFICATIONS

Temp. Range: -40°F to 140°F

Applications: Gasoline vapor recovery only

Construction: Nitrile rubber, rigid PVC helix, smooth bore, corrugated O.D., static grounding wire

Note: Static wire must be properly imbedded during fitting installation and tested to assure proper static grounding of hose to a grounded system.

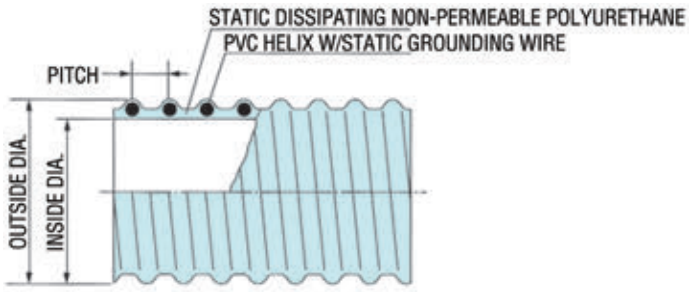
AVAILABLE SIZES

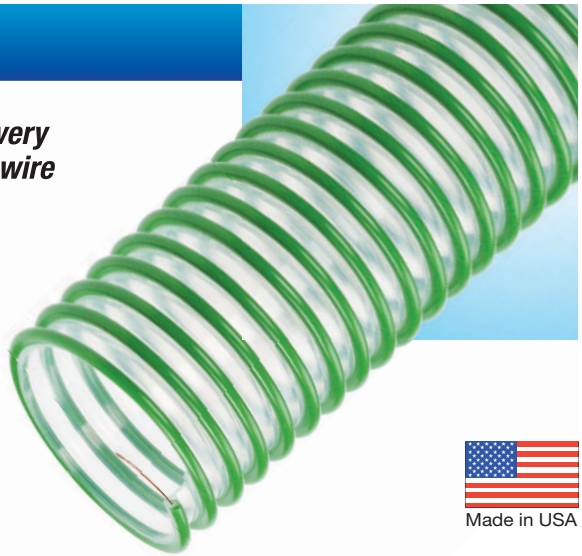
Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
2	2.36	0.39	3.0	20	29.8	0.61	60,100
3	3.46	0.59	3.5	10	29.8	1.00	60,100
4	4.57	0.65	5.0	10	29.8	1.70	60,100

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

KanaVapor Bio (ST120 UACVR)

The ultimate all purpose tank truck and terminal vapor recovery hose with clear static dissipating tube and static grounding wire





Made in USA

SPECIFICATIONS

Temp. Range: -52°F to 140°F

Applications: Tank truck and terminal recovery of gasoline, ethanol, and biodiesel vapors.

Construction: Lightweight clear static dissipating non-permeable polyurethane with smooth bore, corrugated O.D., rigid PVC helix, and static grounding wire.

Features: Lightweight and flexible even in sub-zero temperatures. Polyurethane construction allows use with all gasoline blends, biodiesel (up to B100), ethanol (up to E85; currently testing E100), kerosene, diesel, and ASTM fuel oils. Static dissipating tube combined with multi-strand copper static wire provides the ultimate protection against static discharge. Clear tube allows visual confirmation of fuel backup into the hose.

Note: Banding sleeve or banding coil must be used. Static wire must be properly imbedded during fitting installation and tested to assure proper static grounding of hose to a grounded system.

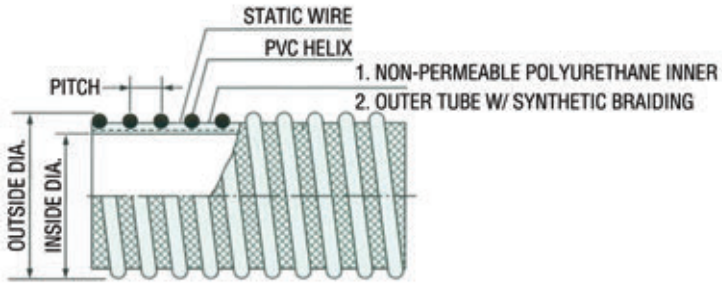
AVAILABLE SIZES

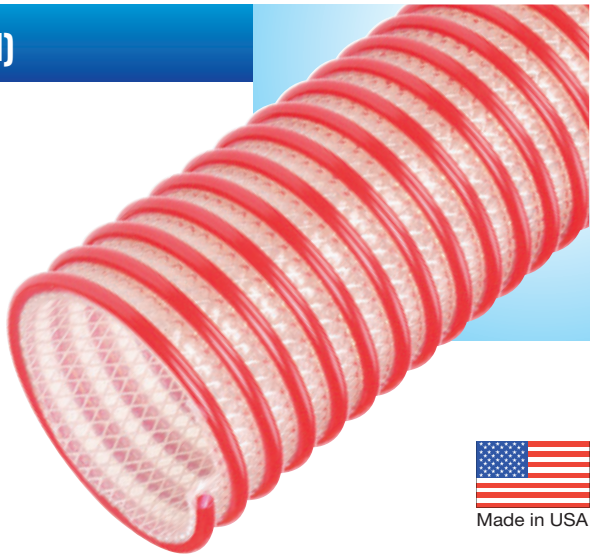
Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
2	2.38	0.39	2.0	9	16.0	0.44	60,100
3	3.56	0.57	3.0	8	15.0	0.71	60,100
4	4.57	0.65	4.0	7	13.0	0.98	60,100

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

KanaPower Bio (ST120 UAPDH)

The ultimate all purpose tank truck drop hose with clear static dissipating tube and static grounding wire





Made in USA

SPECIFICATIONS

Temp. Range: -52°F to 140°F

Applications: All purpose tank truck gravity drop hose for items such as gasoline, ethanol, biodiesel, kerosene and diesel.

Construction: Non-permeable polyurethane inner and outer tube with synthetic braiding, smooth bore, corrugated O.D., PVC helix for easy drag, clear static dissipating tube and multi-strand copper static wire providing maximum protection against static discharge.

Features: Lightweight and flexible even in sub-zero temperatures. Static dissipating polyurethane inner and outer tube provides maximum resistance to gasoline, biodiesel (up to B100 compliant with ASTM D6751), ethanol (E85 to E100), kerosene, diesel and ASTM fuel oils. Clear tube allows visual confirmation of flow.

Note: Banding coil or banding sleeve must be used for all sizes. Static wire must be properly imbedded during fitting installation and tested to assure proper static grounding of hose to a grounded system.

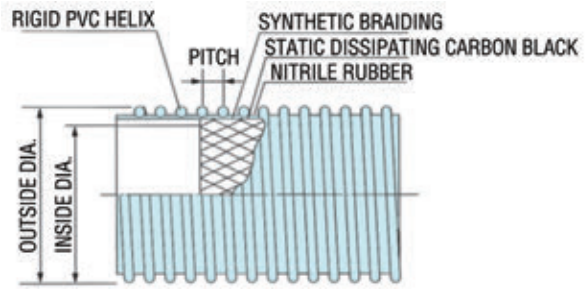
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
2	2.68	0.43	5.0	65	29.8	0.95	60,100
3	3.72	0.62	6.3	65	29.8	1.40	60,100
4	4.81	0.68	7.0	65	29.8	1.87	60,100

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

KanaPower Max (ST120 HP)

Tank truck drop hose with static grounding wire; 50% lighter than conventional rubber hose



Made in USA

SPECIFICATIONS

Temp. Range: -30°F to 140°F

Applications: Gasoline tank truck gravity drop hose for fluids such as naphtha, kerosene, light and heavy oil, diesel and some ethanol

Construction: Nitrile rubber static dissipating tube, rigid PVC helix, synthetic braiding, smooth bore, static grounding wire, corrugated O.D.

Features: Lightweight and flexible. External helix provides for easy drag. Rated for up to 40% aromatic content.

Note: Banding sleeves or banding coils must be used for all sizes.

Static wire must be properly imbedded during fitting installation and tested to assure proper static grounding of hose to a grounded system.

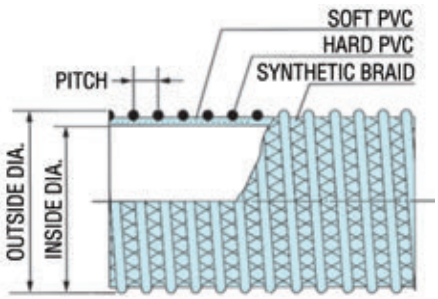
AVAILABLE SIZES

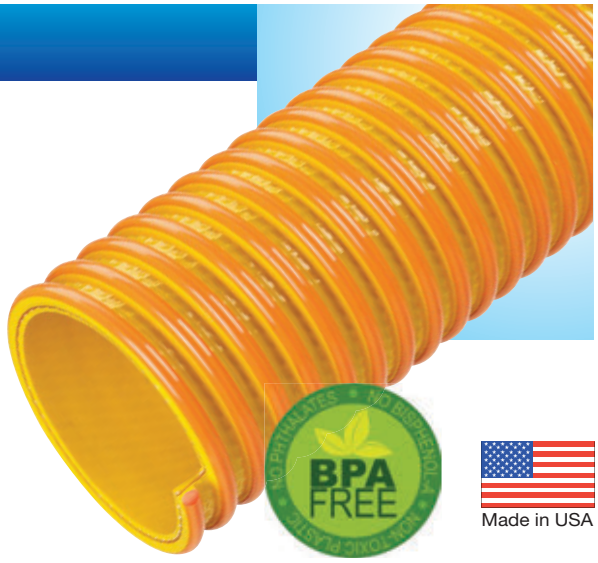
Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
3	3.88	0.62	6.0	150	29.8	1.55	60,100
4	4.98	0.65	8.0	150	29.8	2.60	60,100

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

Kanaline OR

Oil resistant PVC heavy-duty suction and discharge hose for light oils and animal fats





Made in USA

SPECIFICATIONS

Temp. Range: -13°F to 140°F

Applications: Heavy-duty suction and discharge of light oils and animal fats
Oil Use Only. NOT for use with gasoline or similar fuels.

Construction: Flexible oil-resistant PVC, rigid PVC helix, synthetic braiding, smooth bore, corrugated O.D.

Features: Lightweight and flexible. External helix provides for easy drag. Rated for both suction and discharge.

Note: Not a food-grade hose. Banding coil must be used for all sizes.

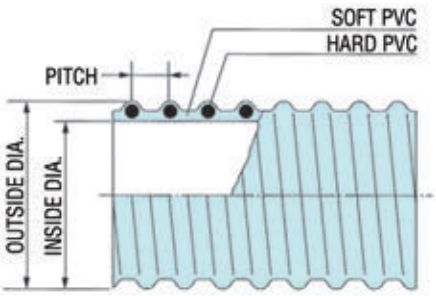
AVAILABLE SIZES

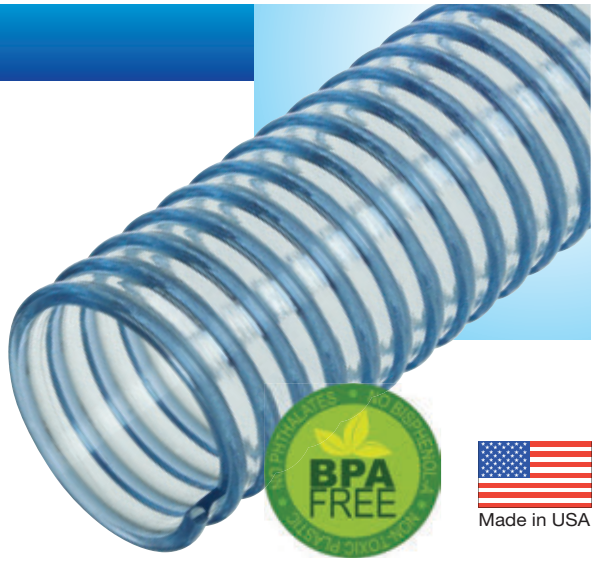
Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
2	2.60	0.43	4.0	80	28.0	0.77	60,100
3	3.74	0.59	6.3	80	28.0	1.48	60,100
4	4.84	0.65	7.1	60	28.0	2.14	60,100

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

Kanalite FG (200 SFG)

Food grade suction and discharge hose





Made in USA

SPECIFICATIONS

Temp. Range: -13°F to 140°F

Applications: Food grade suction hose for use in canning, dairy and bottling

Construction: Produced entirely of compounds in compliance with FDA and 3-A non toxic specifications, flexible PVC, rigid PVC helix, smooth bore, corrugated O.D.

Note: Made with NSF51 approved materials

AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
1	1.25	0.30	1.5	50	29.8	0.18	100
1-1/4	1.52	0.33	2.0	45	29.8	0.22	100
1-1/2	1.81	0.35	2.5	45	29.8	0.35	100
2	2.36	0.39	4.0	40	29.8	0.50	100
2-1/2	2.87	0.56	4.5	35	29.8	0.68	100
3	3.50	0.59	6.0	35	29.8	1.00	100
4	4.63	0.65	8.0	30	29.8	1.52	100

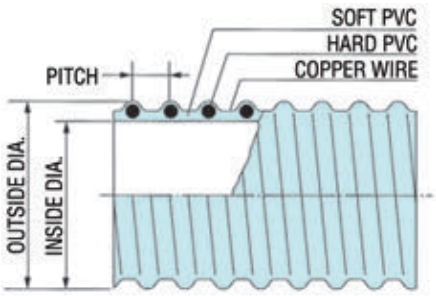
Metric

45 mm	2.13	0.39	4.0	37	29.8	0.45	100
57 mm	2.60	0.43	4.5	35	29.8	0.60	100

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

Kanalite STFG (ST 200 SFG)

Medium-duty, lightweight, hose for pneumatic conveying



Made in USA

SPECIFICATIONS

Temp. Range: -13°F to 140°F

Applications: Pneumatic conveying of lightweight solids such as powders and plastic pellets. Copper static wire is located within the hose tube. Not to be used for conveying edible food products.

Construction: Produced entirely of compounds in compliance with FDA and 3-A nontoxic specifications, flexible PVC, rigid PVC helix, multi-strand copper static grounding wire, smooth bore, corrugated O.D.

Note: Made with NSF51 approved materials. **If used for abrasive materials, monitor the hose for excessive wear. Excessive wear may expose the material to the copper static wire.**

AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
1-1/2	1.81	0.35	2.5	45	29.8	0.44	50,100
2	2.36	0.39	4.0	40	29.8	0.58	50,100
2-1/2	2.87	0.56	4.5	35	29.8	0.75	50,100
3	3.50	0.59	6.0	35	29.8	1.07	50,100
4	4.63	0.65	8.0	30	29.8	1.52	50,100

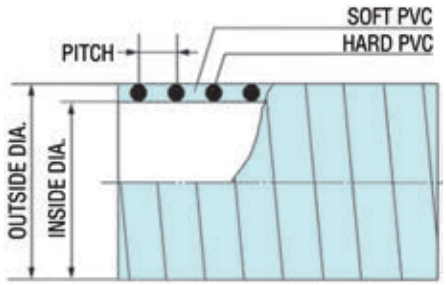
Metric

45 mm	2.17	0.39	4.0	37	29.8	0.53	50,100
57 mm	2.64	0.43	4.5	35	29.8	0.67	50,100

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

Kanaflo FG (210 HFG)

Heavy-duty food grade suction and discharge hose



Made in USA

SPECIFICATIONS

Temp. Range: -13°F to 140°F

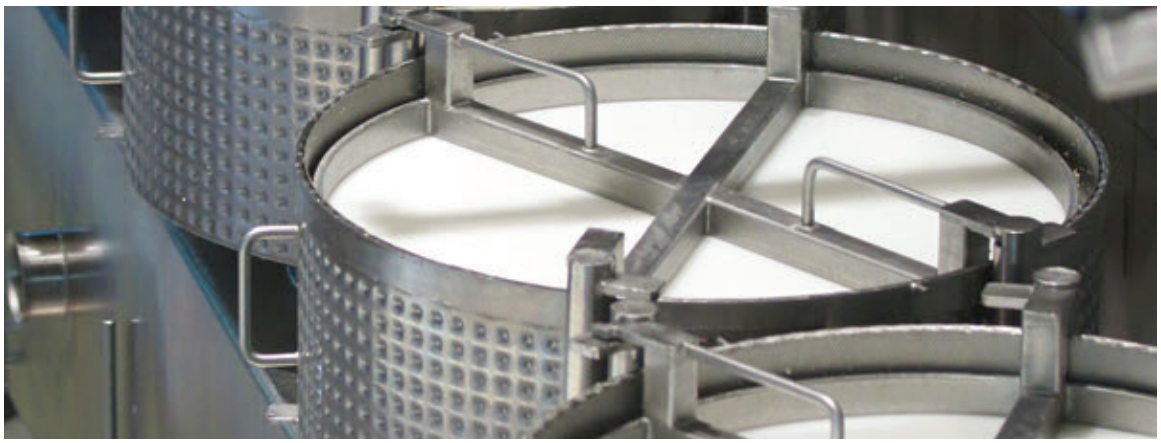
Applications: Heavy-duty food grade suction hose for bottling and dairy industries

Construction: Produced entirely of compounds in compliance with FDA and 3-A nontoxic specifications, flexible PVC, rigid PVC helix, smooth bore, smooth O.D.

Note: Made with NSF51 approved materials

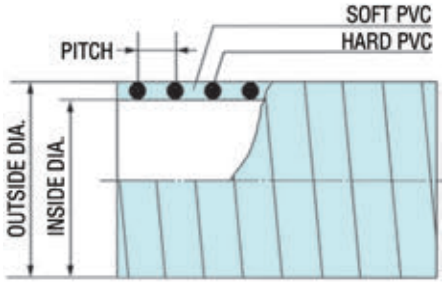
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
3/4	.96	0.22	1.9	86	29.8	0.16	100
1	1.25	0.22	1.9	86	29.8	0.26	100
1-1/4	1.54	0.26	2.7	79	29.8	0.37	100
1-1/2	1.82	0.30	2.8	72	29.8	0.44	100
2	2.39	0.33	3.9	72	29.8	0.74	100
2-1/2	2.93	0.37	5.0	72	29.8	1.01	100
3	3.43	0.37	7.0	62	29.8	1.21	100
4	4.53	0.43	9.1	55	29.8	2.01	100



Kanaflo MK (212 MK)

Heavy-duty food grade suction and discharge hose



Made in USA

SPECIFICATIONS

Temp. Range: -13°F to 140°F

Applications: More flexible; designed for milk hauling (tank truck) and pick-up

Construction: Produced entirely of compounds in compliance with FDA and 3-A nontoxic specifications, flexible PVC, rigid PVC helix, smooth bore, smooth O.D.

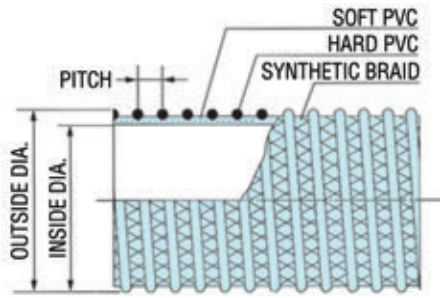
Note: Made with NSF51 approved materials

AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
1-1/2	1.82	0.30	2.0	66	29.8	0.44	100
2	2.39	0.33	2.5	66	29.8	0.74	100
2-1/2	2.93	0.37	4.7	66	29.8	1.01	100
3	3.43	0.37	6.1	62	29.8	1.21	100

Kanaline FW

Heavy-duty food grade suction and discharge hose



SPECIFICATIONS

Temp. Range: -13°F to 140°F

Applications: Heavy-duty food grade suction and discharge hose for bottling, wine making, canning, dairy, brewing and liquid foods

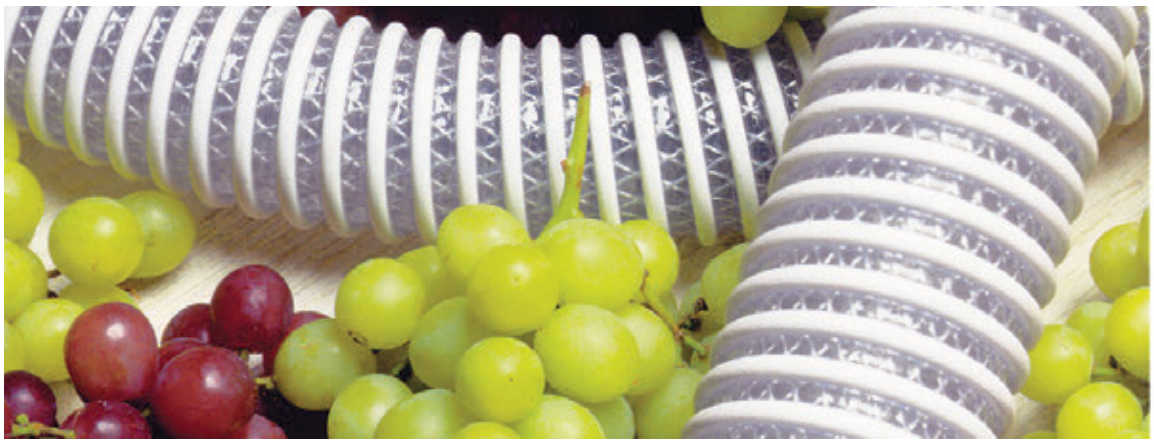
Construction: Produced entirely of compounds in compliance with FDA and 3-A nontoxic specifications, flexible PVC, rigid PVC helix, synthetic braiding, smooth bore, corrugated O.D.

Features: Lightweight and flexible. External helix provides for easy drag. Rated for both suction and discharge. Clear sidewall permits visual check of material flow.

Note: Made with NSF51 approved materials. Banding coil must be used for all sizes. 5" and 6" sizes are not a stock item. Consult factory for availability.

AVAILABLE SIZES

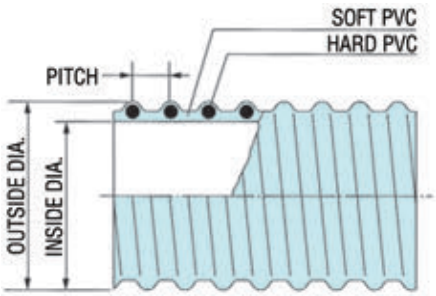
Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
1-1/2	2.1	0.39	2.5	110	28.0	0.56	60,100
2	2.6	0.41	4.0	100	28.0	0.75	60,100
3	3.7	0.59	6.3	100	28.0	1.20	60,100
4	4.8	0.65	7.1	75	28.0	1.74	60,100
5	6.1	0.87	9.2	70	28.0	2.90	Not stock item
6	7.3	0.93	10.2	70	28.0	3.88	Not stock item



* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

KanaDuct 150 (150 CL)

Lightweight PVC blower and ducting hose



Made in USA

SPECIFICATIONS

Temp. Range: -13°F to 140°F
Applications: Lightweight general ducting for ventilation and grass clippings, leaves, dust and fumes
Construction: Flexible PVC, rigid PVC helix, smooth bore, corrugated O.D.
Note: Not a food-grade hose

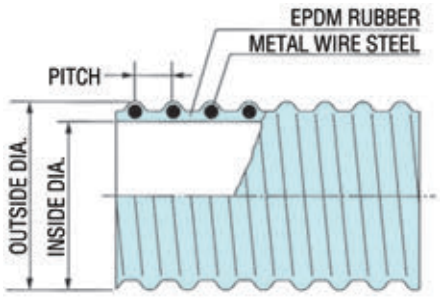
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
2-1/2	2.81	0.55	2.5	6	—	0.37	50,100
3	3.37	0.59	3.0	6	—	0.54	50,100
4	4.41	0.61	4.0	5	—	0.71	50,100
5	5.55	0.80	5.0	3	—	1.00	50,100
6	6.51	0.80	6.0	3	—	1.29	50,100
7	7.54	0.85	7.0	2	—	1.38	50,100
8	8.55	0.85	8.0	2	—	1.71	50

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

KanaDuct 620 (620 WD)

General ducting and blower hose with metal wire helix



Made in USA

SPECIFICATIONS

Temp. Range: -40°F to 220°F

Applications: General ducting and blower applications. For use with lightweight abrasives such as sawdust, grass clippings, street refuse and cotton pickers.

Construction: EPDM rubber, metal wire helix, smooth bore, slightly corrugated O.D.

Features: Rated to 220°F. Abrasion resistant yet very flexible. 100% rubber sidewall (no fabric).

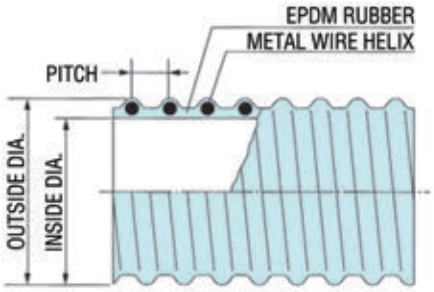
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
2	2.36	0.43	2.0	12	12.0	0.40	50
2-1/2	3.00	0.58	3.0	12	9.0	0.44	50
3	3.37	0.60	3.0	12	8.0	0.55	50
4	4.39	0.65	4.0	9	6.0	0.73	50
5	5.43	0.88	5.0	7	5.0	0.84	50
6	6.36	0.87	6.0	6	4.0	1.04	50
7	7.32	0.89	7.0	5	4.0	1.17	50
8	8.35	0.92	8.0	4	4.0	1.38	50
10	10.45	1.02	10.0	3	4.0	2.40	50
12	12.40	1.20	12.0	3	4.0	2.50	25

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

KanaDuct 625 (620 WD WS)

General ducting and blower hose with metal wire helix and external wear strip



Made in USA

SPECIFICATIONS

Temp. Range: -40°F to 220°F

Applications: Same as 620 WD, but external wearstrip makes it ideal for “light dragging” applications

Construction: EPDM rubber, metal wire helix, wearstrip, smooth bore, corrugated O.D.

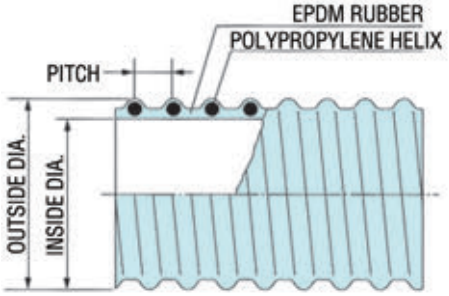
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
2-1/2	3.11	0.58	3.0	12	9.0	0.48	50
3	3.48	0.60	3.0	12	8.0	0.61	50
4	4.57	0.65	4.0	9	6.0	0.85	50
5	5.61	0.88	5.0	7	5.0	0.90	50
6	6.54	0.87	6.0	6	4.0	1.17	50
7	7.48	0.89	7.0	5	4.0	1.27	50
8	8.54	0.92	8.0	4	4.0	1.50	50
10	10.69	1.02	10.0	3	4.0	2.67	50
12	12.60	1.20	12.0	3	4.0	2.80	25

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

KanaDuct 630 (630 ED)

Medium-duty blower and ducting hose



Made in USA

SPECIFICATIONS

Temp. Range: -40°F to 158°F

Applications: Medium-duty blower and ducting applications such as hay bailing, street refuse, grain dust, cotton pickers, wood chips, straw blowing, leaf and grass collection

Construction: EPDM rubber, polypropylene helix, smooth bore, corrugated O.D.

Features: Thicker sidewall for more abrasion resistance. External helix acts as a scuff guard. 100% rubber sidewall (no fabric).

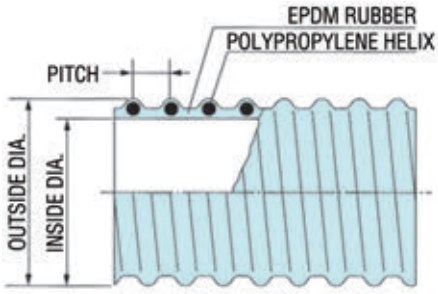
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
2	2.36	0.39	3.5	—	—	0.31	50
2-1/2	2.89	0.56	3.5	—	—	0.38	50
3	3.43	0.59	4.0	—	—	0.49	50
4	4.53	0.67	4.0	—	—	0.70	50
6	6.56	0.83	6.0	—	—	1.05	50
8	8.66	0.87	8.0	—	—	1.46	50

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

KanaDuct 660 (660 YD)

Heavy-duty duct hose with "safety yellow" helix for high visibility



Made in USA

SPECIFICATIONS

Temp. Range: -40°F to 158°F

Applications: Heavy-duty ducting applications such as duct cleaning, commercial grass and leaf collection, cement dust recovery for floor finishing, blast cabinet dust collection systems, and grain auger downspouts

Construction: EPDM rubber, polypropylene helix, smooth bore, corrugated O.D.

Features: Smooth bore for higher laminar flow. Extra heavy-duty "safety yellow" helix for high visibility and superior external abrasion resistance for "dragging" applications. 100% rubber sidewall (no fabric).

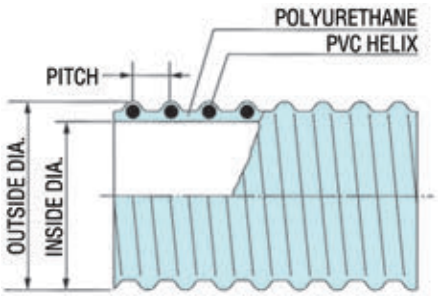
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
4	4.57	0.67	4.0	9	6.0	0.79	50
5	5.53	0.87	5.0	7	5.0	0.83	50
6	6.57	0.82	6.0	6	4.0	1.26	50
8	8.72	0.83	8.0	4	4.0	1.92	50
10	10.83	1.06	10.0	4	4.0	2.38	25
12	12.73	1.18	12.0	3	3.0	2.65	25

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

KanaDuct 150U (150 UDH)

Polyurethane medium-duty blower and ducting hose



Made in USA

SPECIFICATIONS

Temp. Range: -40°F to 140°F

Applications: Medium-duty ducting and blower applications. For use with light to medium weight abrasives, leaf and grass collection, cotton pickers, mulch blowing, dust and sawdust collection.

Construction: Flexible clear polyurethane, rigid PVC helix, smooth bore, corrugated O.D.

Features: Lightweight and flexible. External helix provides for easy drag. Abrasion-resistant polyurethane and smooth bore eliminate material build-up.

Note: Not a food-grade hose

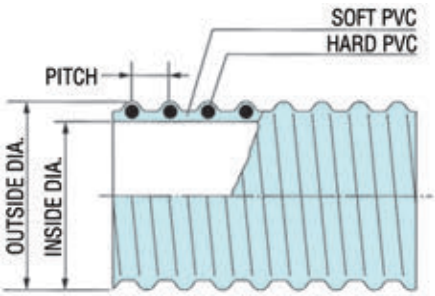
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
2-1/2	2.89	0.53	2.5	9	16.0	0.34	50
3	3.46	0.57	3.0	8	15.0	0.48	50
4	4.46	0.59	4.0	7	12.0	0.70	50
5	5.57	0.83	5.0	6	9.0	1.10	50
6	6.56	0.83	6.0	5	7.0	1.30	50
7	7.59	0.85	7.0	4	6.0	1.56	50
8	8.59	0.85	8.0	3	5.0	1.65	50

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

Kanalite 155 (155 GY)

Heavy-duty PVC blower and ducting hose



Made in USA

SPECIFICATIONS

Temp. Range: -13°F to 140°F
Applications: Heavy-duty PVC blower and ducting hose for collection of grass, leaves, dust, and fumes
Construction: Flexible PVC, rigid PVC helix, smooth bore, corrugated O.D.
Note: Not a food-grade hose

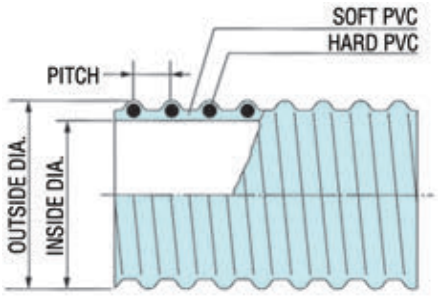
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
1-1/2	1.79	0.35	1.5	20	20.0	0.26	100
2	2.31	0.39	2.5	15	18.0	0.39	100
2-1/2	2.85	0.54	3.0	15	15.0	0.44	100
3	3.39	0.56	3.5	15	15.0	0.70	100
4	4.60	0.65	4.5	15	15.0	1.43	100
5	5.52	0.87	8.8	12	12.0	1.87	100
6	6.52	0.87	9.0	11	10.0	2.32	100
8	8.85	0.91	14.0	10	9.0	4.03	50

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

Kanalite PS UVOR (101 PS UVOR)

Methane gas recovery at landfills, water suction/discharge. Solid wall construction and extra UV inhibitors provide extended life.



Made in USA

SPECIFICATIONS

Temp. Range: -13°F to 140°F

Applications: Methane gas recovery at landfills; connection between rigid pipes of the same size; repair of broken rigid lines.

Construction: Flexible PVC, rigid PVC helix, smooth bore, corrugated O.D.

Note: Not a food-grade hose

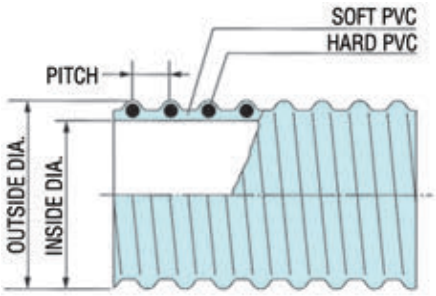
AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
2.375	2.76	0.41	3.5	35	29.8	0.64	100
3-1/2	4.02	0.63	7.0	30	29.8	1.10	100
4-1/2	5.08	0.67	9.0	30	28.0	1.70	100

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

Kanalite PS (101 PS)

Methane gas recovery at landfills, water suction/discharge.
Solid wall construction.



Made in USA

SPECIFICATIONS

Temp. Range: -13°F to 140°F

Applications: Methane gas recovery at landfills; connection between rigid pipes of the same size; repair of broken rigid lines.

Construction: Flexible PVC, rigid PVC helix, smooth bore, corrugated O.D.

Note: Not a food-grade hose

AVAILABLE SIZES

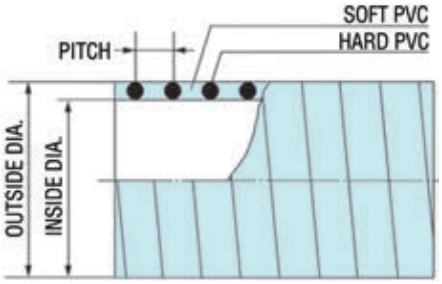
Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
2.375	2.76	0.41	3.5	35	29.8	0.64	100
3-1/2	4.02	0.63	7.0	30	29.8	1.10	100
4-1/2	5.08	0.67	9.0	30	28.0	1.70	100

The Powerlock Clamp PS is available for use with our 101 PS Series in 2", 3" and 4" sizes.

* Over flexing or repeated flexing of hose within 18" of fitting is a common cause of hose failure. Installing a 12"-14" section of our Banding Coil at the end of the hose should be considered. ***Kanaflex will not be responsible for damage to hose due to over flexing.***

Kanaflo Spa (Spa Cream)

Flexible PVC spa hose



Made in USA

SPECIFICATIONS

Temp. Range: -13°F to 158°F

Applications: Water lines, air lines, pump lines

Construction: Flexible PVC, rigid PVC helix, smooth bore, smooth O.D.

Note: Not a food-grade hose. For use with PVC solvent weld fittings only. Inside diameter is nominal. Tolerance on outside diameter is + .020, - .005

See usage/storage suggestions and warranty information before use.

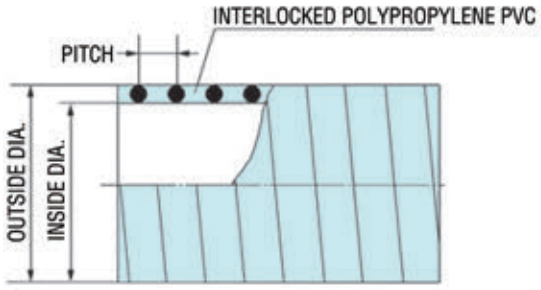
AVAILABLE SIZES

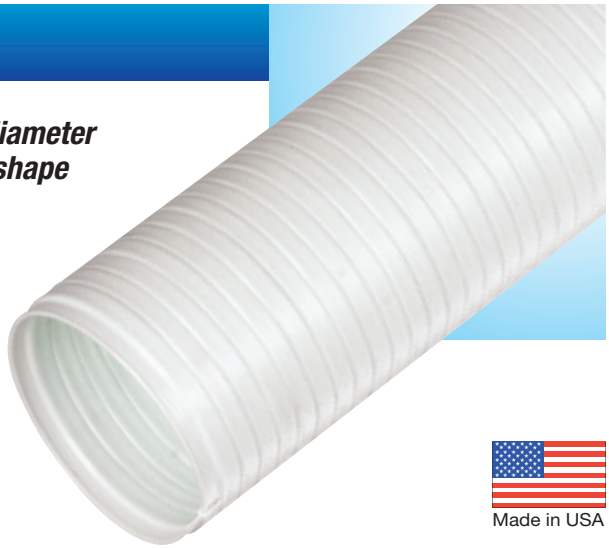
Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
1/2	0.840	0.22	3.0	100	29.8	0.16	50,100
3/4	1.050	0.22	3.0	100	29.8	0.23	50,100
1	1.315	0.28	3.0	100	29.8	0.32	50,100
1-1/4	1.660	0.30	4.0	80	29.8	0.37	50,100
1-1/2	1.900	0.30	4.0	65	29.8	0.50	50,100
2	2.375	0.34	5.0	60	29.8	0.65	50,100

Note: Burying the Spa Cream hose voids our hose warranty. Kanaflex will not be liable in any way for special, incidental, or consequential damages, or loss of revenue, which may result if the hose has been buried.

KanaDuct Poly (Kanaduct)

Duct hose, with interlock construction, allows the inside diameter to be changed by twisting the hose, while still holding its shape





Made in USA

SPECIFICATIONS

Temp. Range: -13°F to 180°F

Applications: General ducting and blower hose used for spot coolers, clean room venting, fume/dust removal, elbows for rigid pipe

Construction: Interlocked polypropylene

AVAILABLE SIZES

Inside Dia. Inches	Outside Dia. Inches	Pitch Inches	Minimum Bend Radius 72°F, Inches	Working Pressure 72°F, P.S.I.	Vacuum Rating 72°F, In Hg	Weight Lbs/Ft	Standard Length Ft
2-1/2	2.80	—	6.0	—	—	0.35	20
3	3.23	—	7.0	—	—	0.36	20
4	4.20	—	11.0	—	—	0.52	20
5	5.20	—	14.0	—	—	0.76	20
6	6.16	—	15.0	—	—	0.79	20
8	8.06	—	20.0	—	—	1.07	20
10	10.21	—	27.0	—	—	1.52	10
12	12.07	—	32.0	—	—	1.68	10

Banding Sleeve

Plastic banding sleeve for use with ST 120 LT hose

Temp. Range: -40°F to 140°F

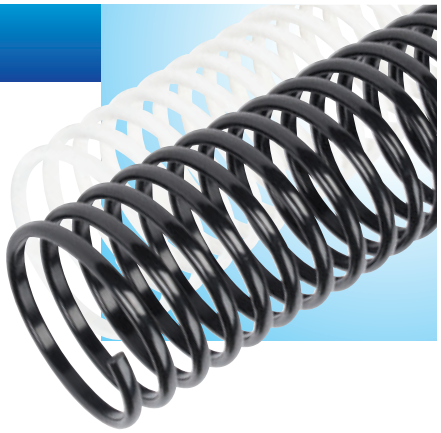
Applications: 9" sections are recommended at each end of the ST 120 LT tank truck drop hose.

Construction: PVC construction, corrugated inside, smooth O.D.

Available Sizes: 3" and 4". Standard length: 3 ft.

Made in USA

Banding Coil (black or white)



Black or white PVC banding coil available in 1-1/2", 2", 3", 4", 5", 6", 8", 10", and 12" sizes

Applications: PVC Banding Coil designed to fit and fill the area between the helix providing a smooth service for installation of tension bands. Use 4" of banding coil to cover 9" length of the hose. Also, when used behind the coupling, the coil adds rigidity to the hose, preventing over flexing at the coupling. Coil can be installed on individual hoses as noted. Standard length: 1 ft.

Duct Clamp

Steel, worm gear type clamp designed specifically for use with our duct hose. Easily installed with only a screw driver. Available in 2-1/2", 3", 4", 5", 6", 7", 8", 10" and 12" sizes.

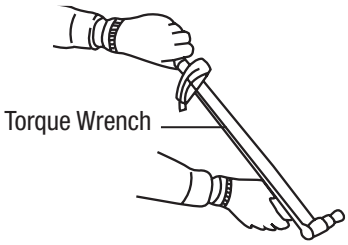
Powerlock Clamp/Powerlock Clamp PS

The Powerlock clamp is a steel, double bolt clamp designed specifically for use with our corrugated hose such as Series 100, 180, 200 and KANALINE. Available in 2", 2-1/2", 3", 4", 5", 6", 8", 10" and 12" sizes.

The Powerlock clamp PS is available for use with our 101 PS Series in 2", 3" and 4" sizes.

Tightening Kanaflex Powerlock Clamps

Please use the table below to determine the correct torque recommended when tightening down our Powerlock clamps.



Size (in)	2	2-1/2	3	4	5	6	8	10	12
Torque (lbs-ft)	7.2	7.2	9.4	14.5	14.5	16.6	16.6	18.1	18.1

Chemical Resistance

A — Satisfactory B — Suggest Testing C — Unsatisfactory

Chemical Name	Concentration	All PVC Hoses 150 UDH*, Kanaline UFG*	Kanaline OR	ST 120 HP ST 120 LT ST 120 VP	KP-AT, 180 STAR, 180 AR, 180 BL, 220 RS	180 HR,390 SD, 620 WD, 630 ED, 660 YD	300 EPDM GR	ST120 UAPDH
Acetaldehyde		C	C	C	C	B	C	–
Acetamide		C	C	A	C	B	B	–
Acetic acid	10%	A	A	C	C	A	A	B
Acetic acid	50%	B	B	C	C	B	B	–
Acetic acid	100%	C	C	C	C	C	C	–
Acetic anhydride		C	C	C	C	C	C	–
Acetone		C	C	C	C	B	C	–
Alums___ NH3, Cr, K		A	A	A	A	A	A	–
Ammonium hydroxide (ammonia water)		B	B	C	C	A	A	–
Animal oil (Lard oil)		C	A	A	C	C	C	–
ASTM reference fuel A		C	A	A	C	C	C	–
ASTM reference fuel B		C	B	A	C	C	C	–
ASTM reference fuel C		C	C	A	C	C	C	–
ASTM #1 oil		C	A	A	C	C	C	–
ASTM #2 oil		C	A	A	C	C	C	–
ASTM #3 oil		C	A	A	C	C	C	–
Beer		A	A	A	A	A	A	–
Benzene (Benzol)		C	C	C	C	C	C	–
Benzine		C	C	B	C	C	C	B
Benzyl alcohol		C	C	C	C	B	B	–
Biodiesel, B20		–	–	–	–	–	–	A
Biodiesel, B100		–	–	–	–	–	–	A
Brake Fuel (H.D.)		–	–	–	–	–	–	A
Bromine		C	C	C	C	C	C	–
Bunker oil		C	–	A	C	C	C	–
Butane		–	–	A	–	–	–	A
Calcium chloride		A	A	A	A	A	A	–
Calcium hydroxide		A	A	A	A	A	A	–
Carbon disulfide		C	C	C	C	C	C	–
Carbon tetrachloride		C	C	C	C	C	C	–
Carbonic acid		A	A	A	A	A	A	–
Chlorine gas (dry)		C	C	C	C	C	C	–
Chlorine gas (wet)		C	C	C	C	C	C	–
Chromic acid	2%	A	C	C	C	C	C	–
Chromic acid	5%	B	C	C	C	C	C	–
Chromic acid	10%	C	C	C	C	C	C	–
Chromic acid	25%	C	C	C	C	C	C	–
Creosote oil		C	C	B	C	C	C	–
Cresol		C	C	C	C	C	C	–
Cyclohexane		C	C	B	C	C	C	–
Cyclohexanone		C	C	C	C	C	C	C
Developing solutions (Hypos)		A	A	A	B	A	A	–
Diesel Fuel		–	–	A	–	–	–	A
Diethyl ether		C	C	C	C	B	C	–
Diethylene glycol		A	A	A	A	A	A	–
Dimethyl formamide		C	C	C	C	C	C	C
Dioctyl phthalate (DOP)		C	C	C	C	B	B	A
Ethanol E85		–	–	A	–	–	–	A
Ethanol E98		–	–	T	–	–	–	A
Ethanol E100		–	–	T	–	–	–	A
Ethyl acetate		C	C	C	C	B	C	–
Ethyl acetoacetate		C	C	C	C	B	C	–
Ethyl alcohol		B	A	A	A	A	B	–
Ethylene dichloride		C	C	C	C	C	C	C
Ethylene glycol		A	A	A	A	A	A	A
Ethylene glycol H20	50%	–	–	A	–	–	–	A
Fluoroboric acid		–	–	A	B	A	A	–
Formaldehyde	40%	B	B	B	C	B	B	–
Formic Acid	50%	B	C	C	C	B	B	–
Freon 11		C	C	A	C	C	C	C
Freon 113		C	C	B	B	C	C	C
Freon 114		C	C	A	A	C	C	–
Freon 12		C	C	B	C	B	–	A
Freon 21		C	C	C	C	C	C	–
Freon 22		C	C	C	C	C	C	–

* Exceeds PVC ratings

The "Chemical Resistance classification" for each Kanaflex Hose is determined by the phenomenon (change of the quality of the material) which results when the material is exposed to the specified chemical. Testing is conducted on straight sections of hose which are set in a static position. Unless otherwise noted, the concentration of water solution is saturated and temperature is 72°F.

A — Satisfactory B — Suggest Testing C — Unsatisfactory

Chemical Name	Concentration	All PVC Hoses 150 UDH*, Kanaline UFG*	Kanaline OR	ST 120 HP ST 120 LT ST 120 VP	KP-AT, 180 STAR, 180 AR, 180 BL, 220 RS	180 HR,390 SD, 620 WD, 630 ED, 660 YD	300 EPDM GR	ST120 UAPDH
Furan Furufuran		C	C	C	C	C	C	–
Gasoline (Aromatic content: less than 40%)		C	C	A	C	C	C	A
Glycerin		A	A	A	A	A	A	–
Hexane		C	A	A	C	C	C	–
Hydrobromic acid	20%	–	–	C	C	B	B	–
Hydrochloric acid	10%	A	A	C	B	A	A	–
Hydrochloric acid	38%	B	B	C	C	B	B	–
Hydrofluoric acid	10%	A	A	C	C	A	A	–
Hydrofluoric acid	20%	B	B	C	C	A	A	–
Hydrofluoric acid	40%	C	C	C	C	B	B	–
Hydrofluoric acid anhydrous		C	C	C	C	C	C	–
Hydrogen peroxide	5%	A	A	C	C	B	B	–
Hydrogen peroxide	30%	A	A	C	C	B	B	–
Hydrogen sulfide		–	–	C	C	A	A	–
Hypochlorous acid		–	–	C	C	C	C	–
Isooctane		C	A	A	C	C	C	–
Isopropyl alcohol		B	A	B	B	B	B	–
Jet Fuel, JP-8		–	–	A	–	–	–	A
Kerosene		C	A	A	C	C	C	A
Lacquer		C	C	C	C	C	C	–
Magnesium hydroxide		A	A	B	B	A	A	–
Mercury		A	A	A	A	A	A	–
Methyl alcohol		B	A	A	A	A	A	B
Methyl ethyl ketone (MEK)		C	C	C	C	B	B	–
Nitric acid	10%	A	A	C	C	B	B	–
Nitric acid	30%	B	B	C	C	B	B	–
Nitric acid	61.3%	C	C	C	C	C	C	
Nitric acid	(fuming)	C	C	C	C	C	C	–
Nitrobenzene		C	C	C	C	C	C	–
Oil, Transmission Type A		–	–	A	–	–	–	A
Oleic acid		A	A	B	C	B	B	–
Oxalic acid		A	A	C	C	B	B	–
Oxygen		A	A	B	B	A	A	–
Ozone		B	B	C	C	A	A	–
Perchloric acid		A	B	B	B	B	B	–
Phosphoric acid	50%	A	A	B	C	A	A	–
Potassium dichromate	10%	A	A	A	B	A	A	–
Potassium hydroxide	30%	B	B	B	B	A	A	–
Potassium permanganate	5%	A	A	B	B	A	A	–
Potassium permanganate	30%	A	B	B	A	B	B	–
Propyl alcohol		A	A	A	A	A	A	–
Sea water		A	A	A	A	A	A	–
Silicone grease		A	A	A	A	A	A	–
Silicone oils		A	A	A	A	A	A	–
Soap solutions		B	A	A	B	A	A	–
Sodium hydroxide	10%	A	A	B	A	B	B	B
Sodium hypochlorite	5%	A	A	C	C	A	A	–
Sodium peroxide		C	C	B	B	A	A	–
Sodium phosphate		A	A	A	A	A	A	–
Soybean oil		C	A	A	B	C	C	–
Sulfur dioxide		A	A	C	C	A	A	–
Sulfuric acid	10%	A	A	B	A	B	B	A
Sulfuric acid	30%	B	B	C	B	C	C	B
Sulfuric acid	98%	C	C	C	C	C	C	–
Sulfuric acid	(fuming)	C	C	C	C	C	C	–
Sulfurous acid	10%	A	A	C	C	C	C	–
Tetrachloroethane		C	C	C	C	C	C	–
Tetrahydrofuran		C	C	C	C	B	C	–
Toluene		C	C	C	C	C	C	B
Trichloroethylene (Trichlene)		C	C	C	C	C	C	C
Turpentine		–	–	B	–	–	–	A
Vegetable oil		C	A	A	C	C	C	–
Vinegar		A	A	B	B	A	A	–
Whiskey		B	A	A	A	A	A	–
Xylene		C	C	C	C	C	C	–

* Exceeds PVC ratings

Note: Differing phenomena may result during hose use as a result of application variables such as hose bends, stress, vacuum, pressure, temperature, etc.

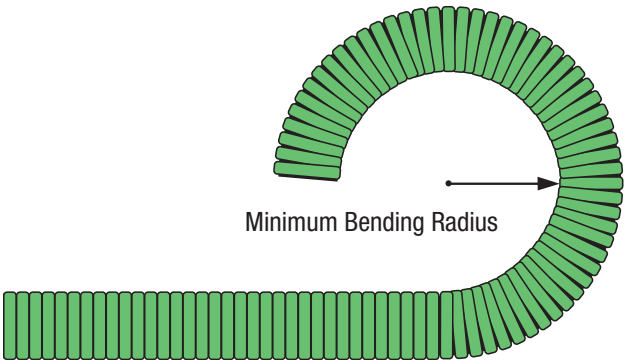
Application Guide

	100 CL/100 CWFLX/101 PS 101 PSUVOR, 100 Blue	100 UCLRD	110 CL/110 GR	112 AG/112 CL, 113UVCLBK, 114CL/GR	116 CL/116 Blue/Kanaflo Blue	150 CL	150 UDH	155 GY	180 AR/180 STAR STKB	180 BL	180 HR	180 MV	200 SFG	210 HFG/212 MK	220 RS	300 EPDM	390 SD BK	620 WD	620 WD WS	630 ED	660 YD	ST 120 LT/ST 120 UAPDH/ ST120HP, ST 120 VP	ST 200 SFG	Banding Coil	Banding Sleeve	Duct Clamp	Kanaduct	Kanaline CW Kanaline Blue	Kanaline FW	Kanaline OR	Kanaline SR	Kanaline UFG (STKLUFG)	Kanapower AT	Powerlock Clamp/PS	Spa Cream
Agriculture, Grain																																		
Agriculture, Chemical																●	●																	
Air Seeder		●	●	●																														
Auger Down Spout																		●	●	●						●								
Cotton							●			●								●	●	●	●					●							●	
Fertilizer Sprayer			●	●	●											●	●																	
Foam Markers			●	●													●																	
Grain Vac									●			●																					●	
Irrigation			●	●	●											●							●											
Manure Spreader			●	●												●	●																	
General Use	●		●	●	●											●							●								●			
Boating, Marine																																		
Bilge, Sanitary			●	●												●							●								●			
Ventilation																		●								●								
General Use	●		●	●												●							●								●			
Construction																																		
Cement Plant, Dust							●		●	●											●					●							●	
Concrete Surfacing, Dust							●													●	●					●							●	
Directional Drilling																							●								●			
Micro Tunneling																																●		
Vacuum Excavators									●	●																							●	
Water Pumping	●		●	●	●											●							●								●			
Fishing																																		
Fish Suction	●																						●					●			●	●		●	
Ice Slinging	●		●	●																			●					●			●	●		●	
Food, Milk Handling																																		
Food Processing													●	●									●						●			●		
Milk Truck													●	●									●						●					
Wine Processing													●	●									●						●			●		
General Plant Services																																		
Car Wash																		●								●								
Duct Cleaning						●	●	●		●	●	●									●					●								
Ducting (exhaust)						●	●	●										●	●	●	●					●								
Ducting (fumes, vent)						●												●	●	●	●					●								
Fly Ash											●																						●	
Power Plant, Coal Dust		●							●		●	●																					●	
Sand Blast Recovery									●	●	●							●	●	●	●					●							●	
Sand Dust/Wood Chips																		●	●	●	●					●								
Shipyard Ducting																		●		●						●								
Spot Coolers																											●							
General Use	●		●	●	●											●														●				

	100 CL/100 CWFLX/101 PS 101 PSUVOR, 100 Blue	100 UCLRD	110 CL/110 GR	112 AG/112 CL, 113UVCLBK, 114CL/GR	116 CL/116 Blue/Kanaflo Blue	150 CL	150 UDH	155 GY	180 AR/180 STAR STKB	180 BL	180 HR	180 MV	200 SFG	210 HFG/212 MK	220 RS	300 EPDM	390 SD BK	620 WD	620 WD WS	630 ED	660 YD	ST 120 LT/ST 120 UAPDH/ ST120HP, ST 120 VP	ST 200 SFG	Banding Coil	Banding Sleeve	Duct Clamp	Kanaduct	Kanaline CW Kanaline Blue	Kanaline FW	Kanaline OR	Kanaline SR	Kanaline UFG (STKLUFG)	Kanapower AT	Powerlock Clamp/PS	Spa Cream
Insulation																																		
Blower						●	●	●		●								●	●	●	●					●							●	
Lawn Mower, Gardening																																		
Grass Collection						●		●										●	●	●	●					●								
Mulch Blowing						●	●	●										●	●	●														
Material Handling																																		
Bulk Unloading									●																			●				●		
Pneumatic Conveying	●	●											●	●									●										●	
Mining																																		
Cable Guard						●																												
Coal Rock Dust			●	●					●																								●	
Oil Drill Site Clean Up																●															●			
Rock Drill Dust									●																								●	
General Use			●	●	●											●															●	●		
Petroleum																																		
General Tank Truck																						●												
Gasoline Terminal																						●												
Refinery, Catalyst Removal											●																						●	
Plant, Tank Scale										●																							●	
Rental																																		
Lawn & Garden						●		●										●		●	●					●								
Water Pumping			●	●	●											●															●	●		
Roofing																																		
Gravel Removal									●		●	●																					●	
Spa																																		
Water Lines																																		●
Transportation																																		
Aircraft, Avionics Cooling							●														●					●								
Airport, Lavatory Drop																				●	●					●								
RV, Ducting																		●																
Railroad Lavatory Drop																		●																
Waste Management																																		
Honey Truck															●	●																		
Landfill (methane gas)	●																																●	
Sanitation Plant																●															●			
Street Sweeper										●										●	●					●							●	
Vacuum Truck									●		●				●																		●	
General Use	●		●	●					●		●					●	●													●			●	

Minimum Bending Radius

Minimum bending radius is the smallest diameter to which a hose can be bent without causing internal damage to the hose or flattening in the cross-section of the hose (kinking). Minimum bending radius is measured to the inside curvature of the hose as illustrated.



For Kanaflex hose, minimum bend radius is established at 72°F. Temperature changes, either lower or higher, will effect minimum bend radius. Caution should be taken to assure proper hose selection for the actual application temperature of both the material handled and the ambient temperature surrounding the application.

During storage of hose, ambient temperature should also be considered to prevent hose damage. When possible, minimum bending radius of the hose should be as large as possible to avoid damage to the hose and early hose failure.

Note: Over flexing or repeated flexing of hose within 18" of the fitting is a common cause of hose failure. To help support the hose, installing a 12" - 14" section of our Banding Coil at the end of the hose, just before the fitting, should be considered. And, to help prevent this common problem, Kanaflex recommends caution when using the hose.

Kanaflex will not be responsible for damage to the hose due to over flexing.

Temperature Effects

Kanaflex conducts tests at 72°F to determine the recommended minimum bending radius, working pressures, and vacuum ratings. Straight lengths of hose are used during testing. If the ambient temperatures, or application induced temperatures, vary from the 72°F baseline, stated specifications and ratings for the hose will change. If the hose application and placement includes bends, the stated specifications and ratings for the hose will also change.

Please take these variance guidelines into account when determining the suitability of a hose for a specific application.

Usage and Storage Suggestions

CARE AND MAINTENANCE

When Using Your Hose
The life of the hose is greatly influenced by the surrounding temperature, fluid temperature and time of exposure. Please select the proper hose according to the fluid used.

Especially in the case of a PVC hose, if the fluid temperature reaches or exceeds 120°F, do not exceed one half the rated working pressure of the hose.

In pressure applications, please open and close the valve slowly to avoid impact pressure. Suddenly closing the valve could cause the hose to burst.

Please do not use high-grade chemicals with high toxicity and hazardous materials such as high concentrations of Acidum or Alkalies and flammable or explosive gas.

Please set pump pressure below working pressure when you use it in the upright part of an underwater pump, otherwise there is a possibility of a failure caused by a water hammer when the pump is turned off.

Please do not use for compressed air; there is a possibility of a burst.

Please do not use for food grade unless indicated. Also, do not use for pharmaceutical products.

Exposure to the weather will increase the deterioration rate of the hose.

Remember hoses are replaceable items. The rate of their replacement will depend on the conditions under which they are used and deterioration.

Installation
Prior to the installation, please consider the impact on human health and surrounding facilities in case of a hose failure.

Since the hose will expand and contract because of internal pressure, please provide sufficient slack at the time of installation for expansion and contraction.

If twisted, the performance of a hose will fall. Please use a joint when a twist arises by rocking or rotation.

The hose could be damaged if there is a sharp bend at the fitting. Use appropriate elbows and fittings to support the hose so that when it is operational it will not bend sharply at the fitting. Please use an elbow or allow extra length to avoid this problem.

Please protect the hose against external impact (i.e. falling rock or running over the hose with a vehicle). If the installation of the hose requires 150 or more feet of continuous length, the resulting head or loss of pressure may disrupt the quantity of flow.

The hose will deteriorate with age. If you find any defects in your periodic inspections please replace the hose.

Storage — As Stock
Temperature, humidity, ozone, sunlight, oils, solvents, corrosive liquids, fumes, insects, rodents, and radioactive materials can adversely affect hose products in storage.

Exposure to direct or reflected sunlight should be avoided.

The hose needs to be stored under these conditions:
1. Out of direct sun, preferably a dark location
2. In a cool location
3. Low humidity
4. Free of dust and dirt
5. First-in, first-out basis
6. Ideal temperature range is 50 to 70 degrees F

The hose should not be piled or stacked to such an extent that the weight of the stack creates distortions on the lengths stored at the bottom.

Storage — After Use
Follow above recommendations.

After using, remove residual substance by washing the hose in cold water, etc.

Please store the hose with good ventilation so that air passes through the inside of a hose freely. In the case of rubber hose, please cap the ends.

Transport
When moving hose, please do not drag on the ground.

Handle carefully to protect the hose from impact during loading and unloading.

If you are lifting the hose by a crane, etc., do not lift it up by only one point but use several.

Exterior Inspection
If the following abnormalities are discovered, please stop use immediately and replace the hose.
- Hose shows any swelling or leakage near fittings
- Exterior cracking that allows any loss of fluid or creates a safety hazard
- Collapsing or kinking
- An inside swelling and exfoliation
- Others: hardening, swelling, cracking, etc.

Precautionary Statement

Kanaflex Corporation manufactures and distributes hose, ducting, and other products that conform to established specifications. These specifications are to be used as guidelines for the selection of hose to meet the specified criteria of each application. However, these established specifications are not intended to predict the performance of a Kanaflex product in any particular application.

Since application criteria vary, Kanaflex makes no recommendation of our products for use in a particular application. The distributor and final customer of the product should determine the acceptability of use of the product. Therefore, the distributor and customer will assume all responsibility regarding the proper selection and resultant success of Kanaflex products used for any application.

Claims

All claims on Kanaflex products must be reported to Kanaflex immediately. Kanaflex will forward a claim form and all information requested on the form is to be inserted and returned to Kanaflex. Kanaflex will request either the entire amount of product in question or sections of the product. The returned product must be labeled clearly and sent to the attention of the Kanaflex staff member responsible for receipt of the claim information. All additional product in question must be retained until a final determination is made regarding the claim.

Upon receipt of the requested material, Kanaflex will determine if the product meets all requirements as stated within our WARRANTY and then send notification as to the determination of the claim.

Often, the exact cause of failures cannot be determined. Kanaflex may suggest possible causes in an effort to prevent future failures.

Returned Goods Policy

The following guidelines must be met for acceptance of returned product:

1. Contact Kanaflex Customer Service department for return authorization.
2. Product must have been purchased within the last 90 days.
3. Only standard products, in standard lengths may be returned.
4. Merchandise must be sent back freight prepaid.
5. Merchandise must reach Kanaflex in good condition so that it may be resold. Damaged goods will be refused.
6. Restocking fee will apply.

Warranty

Every KANAFLEX hose is thoroughly inspected and tested before leaving the factory and is warranted to be free from defects in material and workmanship at the time of shipment by Kanaflex. Should any trouble develop within ninety (90) days of the date of shipment, please notify the manufacturer and obtain a written authorization for return. If an inspection by the manufacturer shows the trouble to be caused by defects in material or workmanship, Kanaflex will replace such merchandise at no charge, freight prepaid.

This warranty shall not apply (1) in the event the hose has been abused or involved in an accident; (2) in the event of misuse (such as subjecting the hose to pressure beyond rated capacity, exceeding minimum bending radius specifications or transfer of materials not recommended by the manufacturer); (3) in the event of damage caused by insects and/or rodents.

THIS WARRANTY IS THE SOLE AND EXCLUSIVE WARRANTY OF KANAFLEX AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED, IMPLIED, STATUTORY OR OTHERWISE CREATED UNDER APPLICABLE LAW INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL KANAFLEX BE LIABLE FOR SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, OR FOR LOSS OF PROFITS.

Notes:

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