



THRUST RESTRAINT FOR PIPE LINES

BASED ON TEST PRESSURE OF 200 P.S.I.

HORIZONTAL RESTRAINT (ALL AREAS GIVEN ARE IN SQUARE FEET)				VERTICAL RESTRAINT (ALL VOLUMES GIVEN ARE IN CUBIC YARDS)**															
PIPE SIZE	DEGREE OF BEND	LBS. STATIC THRUST *	ALLOWABLE SOIL BEARING (PSF)																
			1000	2000	3000	4000	5000	6000	7000	8000									
4"	11/4"	516	1	1	1	1	1	1	1	1	1	1	1	4"	2	1/2"	0.25	0.50	0.75
	22 1/2"	1,226	1	1	1	1	1	1	1	1	1	1	6"		2	1/2"	0.50	1.0	1.75
	45"	2,403	2	2	2	2	2	2	2	2	2	2	8"		2	5/8"	0.75	1.50	3.0
	90"	4,424	4	4	4	4	4	4	4	4	4	4	10"		2	3/4"	1.25	2.25	4.50
6"	TEE/PLUG	3,684	3	3	3	3	3	3	3	3	3	3	12"	2	7/8"	1.75	3.25	6.50	
	11/4"	1,685	2	2	2	2	2	2	2	2	2	14"		4	5/8"	2.25	4.50	8.75	
	22 1/2"	4,785	4	4	4	4	4	4	4	4	4			16"	4	3/4"	3.0	6.0	11.50
	45"	8,403	8	8	8	8	8	8	8	8	8				**INCLUDES 1.50 SAFETY FACTOR				
90"	8,999	10	10	10	10	10	10	10	10	10									
TEE/PLUG	7,468	7	7	7	7	7	7	7	7	7									
8"	11/4"	2,454	2	2	2	2	2	2	2	2	2								
	22 1/2"	4,903	4	4	4	4	4	4	4	4	4								
	45"	8,999	8	8	8	8	8	8	8	8	8								
	90"	17,773	18	18	18	18	18	18	18	18	18								
10"	TEE/PLUG	16,558	14	14	14	14	14	14	14	14	14								
	11/4"	3,656	4	4	4	4	4	4	4	4	4								
	22 1/2"	7,651	8	8	8	8	8	8	8	8	8								
	45"	15,923	18	18	18	18	18	18	18	18	18								
12"	90"	27,768	28	28	28	28	28	28	28	28	28								
	TEE/PLUG	19,635	20	20	20	20	20	20	20	20	20								
	11/4"	4,424	4	4	4	4	4	4	4	4	4								
	22 1/2"	11,022	11	11	11	11	11	11	11	11	11								
14"	45"	21,441	22	22	22	22	22	22	22	22	22								
	90"	39,987	40	40	40	40	40	40	40	40	40								
	TEE/PLUG	28,274	28	28	28	28	28	28	28	28	28								
	11/4"	7,454	8	8	8	8	8	8	8	8	8								
16"	22 1/2"	15,015	15	15	15	15	15	15	15	15	15								
	45"	29,485	29	29	29	29	29	29	29	29	29								
	90"	54,326	54	54	54	54	54	54	54	54	54								
	TEE/PLUG	38,485	38	38	38	38	38	38	38	38	38								
16"	11/4"	9,852	10	10	10	10	10	10	10	10	10								
	22 1/2"	19,812	20	20	20	20	20	20	20	20	20								
	45"	38,411	38	38	38	38	38	38	38	38	38								
	90"	71,085	71	71	71	71	71	71	71	71	71								
TEE/PLUG	50,265	50	50	50	50	50	50	50	50	50									

* INCLUDES 1.25 SAFETY FACTOR

GENERAL NOTES:
 1. CONCRETE SHALL BE CLASS "B".
 2. CONCRETE SHALL NOT CONTACT BOLTS ENDS OF MECHANICAL JOINT FITTINGS.
 3. CONSULT WITH ENGINEER FOR CONCRETE REQUIREMENTS ON MAINS LARGER THAN 16 INCHES.
 (FOR VERTICAL & HORIZONTAL BENDS)
 4. ALLOWABLE SOIL BEARING SHALL BE DETERMINED BY THE ENGINEER.

SHEET 2 OF 2

THRUST RESTRAINT FOR WATER MAINS

PROJECT REFERENCE NO. <i>B-5331</i>	SHEET NO. <i>UC-3B</i>
DESIGNED BY: SAG	
DRAWN BY: SAG	
CHECKED BY: KCZ	
APPROVED BY: KCZ	
REVISED:	
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION UTILITIES ENGINEERING SEC. PHONE: (919) 707-6690 FAX: (919) 250-4151	
UTILITY CONSTRUCTION PLANS ONLY	

UTILITY CONSTRUCTION

DUCTILE IRON PIPE RESTRAINED JOINT DESIGN TABLE

FITTING	REQUIRED RESTRAINED LENGTH (FT) OF BARE D.I. PIPE BY DEPTH OF COVER							
	3 FT	4 FT	5 FT	6 FT	7 FT	8 FT	9 FT	10 FT
HORIZONTAL BENDS								
8 INCH DIA - 11.25 DEG	3	3	2	2	2	2	2	2
8 INCH DIA - 22.5 DEG	7	6	5	5	4	4	3	3
8 INCH DIA - 45 DEG	14	12	10	9	8	8	7	7
8 INCH DIA - 90 DEG	33	29	25	23	20	19	17	16

FITTING	REQUIRED RESTRAINED LENGTH (FT) OF BARE D.I. PIPE BY DEPTH OF COVER							
	3 FT	4 FT	5 FT	6 FT	7 FT	8 FT	9 FT	10 FT
VERTICAL DOWN BENDS								
8 INCH DIA - 11.25 DEG	10	8	7	6	6	5	5	5
8 INCH DIA - 22.5 DEG	19	17	15	13	12	11	10	9
8 INCH DIA - 45 DEG	40	35	30	27	25	22	21	19

FITTING	REQUIRED RESTRAINED LENGTH (FT) OF BARE D.I. PIPE BY DEPTH OF COVER							
	3 FT	4 FT	5 FT	6 FT	7 FT	8 FT	9 FT	10 FT
VERTICAL UP BENDS								
8 INCH DIA - 11.25 DEG	3	3	2	2	2	2	2	2
8 INCH DIA - 22.5 DEG	7	6	5	5	4	4	3	3
8 INCH DIA - 45 DEG	14	12	10	9	8	8	7	7

FITTING	REQUIRED RESTRAINED LENGTH (FT) OF BARE D.I. PIPE BY DEPTH OF COVER							
	3 FT	4 FT	5 FT	6 FT	7 FT	8 FT	9 FT	10 FT
DEAD ENDS / VALVES								
8 INCH DIA	65	59	54	50	46	43	40	38

ASSUMPTIONS

LAYING CONDITION = TYPE 4
 SOIL DESIGNATION = GC = COHESIVE-GRANULAR

DESIGN PRESSURE = 200 PSI (TEST PRESSURE)
 SAFETY FACTOR = 1.5

NOTES

- RESTRAINED LENGTH IS MEASURED FROM THE CENTER OF THE BEND AS FOLLOWS:
 - HORIZONTAL AND VERTICAL BENDS: ALONG EACH SIDE OF BEND.
 - HORIZONTAL AND VERTICAL BENDS - OFFSET OR COMBINED: ALONG THE OUTER SIDE OF EACH BEND.
 ALL PIPE BETWEEN THE TWO BENDS SHALL BE RESTRAINED JOINT WHEN THE DISTANCE BETWEEN THEM IS EQUAL TO OR LESS THAN THE REQUIRED RESTRAINED LENGTH. WHEN THE DISTANCE BETWEEN BENDS IS LESS THAN REQUIRED, THE BALANCE OF THE REQUIRED RESTRAINED LENGTH SHALL BE ADDED ON TO THE LENGTH ALONG THE OUTSIDE OF EACH BEND RESPECTIVELY TO MAKE UP FOR THE DEFICIENCY IN THAT DIRECTION.

HORIZONTAL BEND EXAMPLE...

 INSTALL A 8 INCH 45 DEG BEND AND A 22.5 DEG BEND WITH 10 FEET BETWEEN BENDS AND 4 FEET OF COVER. THE CONTRACTOR SHALL PROVIDE AN ADDITIONAL 1 FOOT OF RESTRAINED LENGTH BEYOND THE 45 DEGREE BEND (FOR A TOTAL OF 13 FEET) AND AN ADDITIONAL 7 FEET OF RESTRAINED LENGTH BEYOND THE 22.5 DEGREE BEND (FOR A TOTAL OF 13 FEET).
- WHEN IT IS NOT POSSIBLE TO INSTALL THE RESTRAINED LENGTHS AS NOTED BY THIS TABLE, THE CONTRACTOR SHALL INSTALL THE APPROPRIATE CONCRETE THRUST RESTRAINTS AS PER THE DETAILS HEREIN.