Simple Pipe Bend Stress Calculation

based on ASME ND (Class III)

$d_a = 76{,}1mm$ outer diameter of pipe

$t_n = 4{,}5mm$ nominal wall thickness

$R = 95mm$ nominal bend radius

$r = \frac{d_a - t_n}{2} = 35{,}8mm$ mean radius of pipe

$d_i = d_a - 2 * tn = 67{,}1mm$ inner diameter pipe

$Z = \frac{\pi}{32} \frac{(d_a^{\,4} - d_i^{\,4})}{d_a} = 17115mm^3$ section modulus

$h = \frac{tn \cdot R}{r^2} = 0{,}33$ flexibility charakteristic

$B_1 = 0{,}4 \cdot h - 0{,}1 = 0{,}03$ primary stress index

$B_2 = \frac{1{,}30}{h^{2/3}} = 2{,}72$ primary stress index

Load combination : S2(W+F1) + D1

$Mx = 233Nm$, $Mx = 308Nm$, $Mx = 411Nm$ from Caesars dynamic data output

$M_{sum} = M_{il} + M_{ill} = \sqrt{M_x^{\,2} + M_y^{\,2} + M_z^{\,2}} = 563980Nmm$

$s_{II} = B_2 \cdot \frac{M_{sum}}{Z} = 2{,}72 \cdot \frac{563980Nmm}{17115mm^3} = 89{,}63 \frac{N}{mm^2}$ code stress, no inside pressure

compared to Data output $s_{II} = 101 \frac{N}{mm^2}$ see next page

$\Delta = \frac{101}{89{,}6} = 112\%$

Where does the discrepancy come from ?

Kraefte und Spannungen
(OCC)COMBINATION # 3

Knoten	---Kraefte(N.)----- FX	FY	FZ	--Momente(N.m.)--- MX	MY	MZ	SEFI	SEFO	(N./sq.mm Span.	zul
2520	381	416	695	118	423	128	1.00	1.00	27	
2520	383	416	695	118	423	128	1.00	1.00	18	
2530	383	416	706	112	423	151	2.36	2.36	22	
2530	376	223	543	233	343	428	2.36	2.36	26	
4500	376	223	532	233	308	411	1.00	1.00	24	
4500	374	223	532	233	308	411	1.87	1.87	101	
4489	374	223	525	220	323	388	1.87	1.87	97	

Spannungen durch Lastkombinationen
(OCC)COMBINATION # 3

Knoten	------Spannungen(N./sq.mm.)---------- Axial	Biegung	Torsion	Gesamt Spannung	SEFI	SEFO	--(N./sq.mm.)-- Spanng.	zul.Sp.
2530	0	49	4	52	2.36	2.36	26	235
4500	0	19	4	24	1.00	1.00	24	235
4500	0	56	6	63	1.87	1.87	101	235
4489	0	51	11	57	1.87	1.87	97	235
4489	0	51	11	57	1.87	1.87	97	235
4490	0	49	9	54	1.87	1.87	90	235