Optimization of Weight Run With Respect to Mechanical and Thermal Properties in Caesar II

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ABSTRACT

In boiler industries the operating pressure and temperature of boiler is very high, since boiler components like down comer, riser tubes, economizer and super heater connecting links are made of Carbon and Alloy steels. This paper deals with preparation of W.P.S for SS 316 using TIG welding and then with preparing a Weight run model for boiler components by using Caesar II. Due to availability and cost of material SS 316 has been selected since it contains Nickel, Chromium and trace of Molybdenum which prevents corrosion, withstand creep failure and can operate at elevated temperature. Generally piping and stress analysis deals with three types of run, they are Thermal run, Weight run, Final run. This paper deals with weight run. The main cause for weight run is strength and hardness and its application is mostly in power piping. Carbon, Cast iron and alloy steel are some of the power piping materials.

SS316 is experimentally investigated to find its mechanical properties and to check the strength before welding, spark test and micro test is carried out to check out the base colour of the material. TIG welding is carried out to joint pipes of same diameter with varying diameter of elbow connectors. After welding tensile, bend, hardness and impact test were carried out finally the output values are compared with raw material values and Caesar II values to optimize best and suitable material for power piping.

KEY WORDS: Caesar, Piping, Stress analysis, SS316.

1. INTRODUCTION

Pipe Stress Analysis is a complex engineering field which covers the design, analysis and identification of piping problems by using Thermal run, weight run, and Final run in which stresses are at acceptable levels specified in engineering design standards. It also includes the calculation of piping code stresses, loads and deflections under static and dynamic loading conditions. The stress analysis of pipe networks is normally done using the Finite Element analysis. The reasons for the analysis of pipe stresses on a piping system is essential to ensure that the piping is well supported and does not fall or deflect under its own weight; the deflections are well controlled, when thermal and other loads are applied; the loads and moments imposed on machinery and vessels by the thermal growth of the attached piping are not excessive; and that the stresses in the pipe work in cold and hot conditions are under the range allowed. Where the Thermal run concentrate about ductile materials, Weight run concentrates about and strengthened materials and final run concentrate about both ductile and strengthened materials. This paper is based on this software. The whole piping in any boiler can be solved by using Caesar software. Displacement, Local element forces, and stresses can be calculated easily

2. PROBLEM DESCRIPTION

Piping layout has more attachment and local element forces which reduce the life time of the material. Most of the materials fail under creep load, fatigue load pressure and low temperature of down comer and riser tubes. In addition to this, restraints and Vibrations occur due to increase in pressure of pipe lines which results in failure of supports. Stress is high in weight run due to weight of the pipe line. Poor welding in pipeline results in weld decay, blow holes, porosity.

Weight run: The piping which fails in creep is known as weight run. Weight run is a part of power piping. Weight run has lower displacement. In weight run process strength and hardness is more compare to the thermal run. We use in the code of ASME B31.1.Here stainless steel is a raw material which is used in BHEL and ONGC for routing of piping. It is used in down comer and riser tubes. The different types of run that has been used while welding different materials

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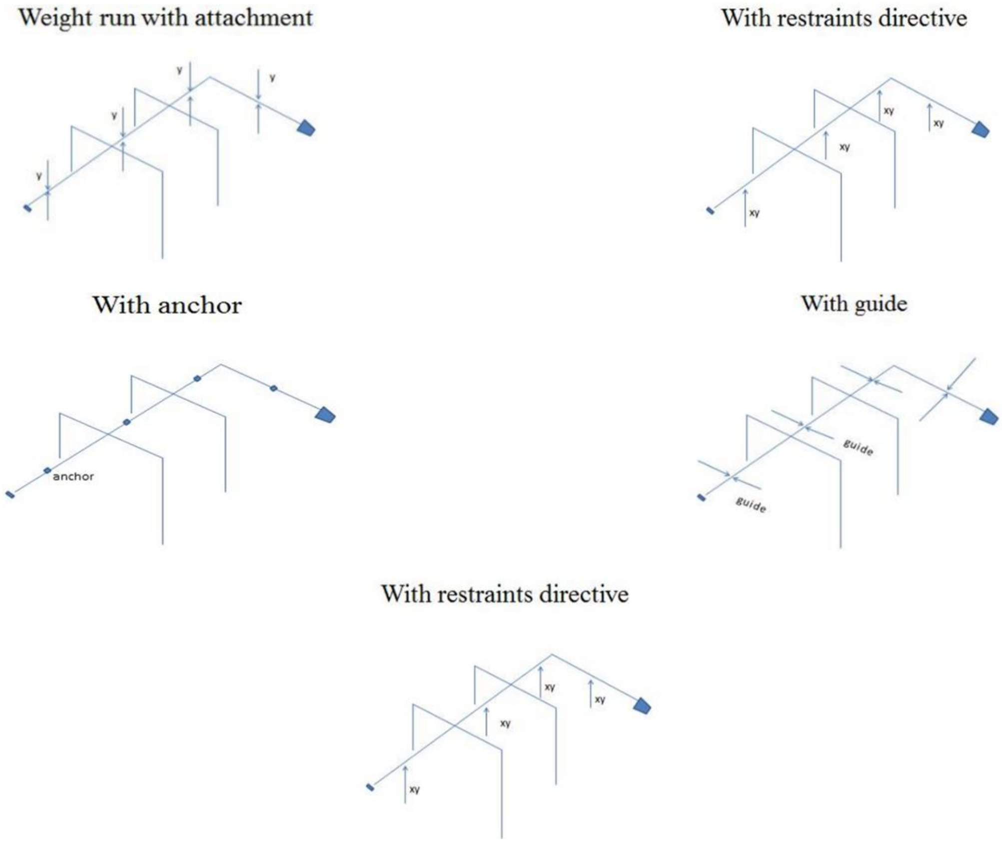

Figure.1. Piping attachment

Welding (WPS): Welding Procedure Specification, it contains all of the essential information such as type of base and filler metals, welding process used, preheat, inter pass or post weld heat treatment shielding gases and so on. Welding could be done without preparation of WPS, but which may results in improper weld or with defects like weld decay, knife line attack and stress corrosion cracking. To avoid such cases WPS is followed in all industries. Sometimes improper welding will increase the strength due to this the life time of materials may be changed.

WPS refers to converting thermal property of a material (melting point, thermal conductivity, and thermal expansion) in to electrical property (polarity, speed, voltage, current). Welding metallurgy of stainless steel includes problems of corrosion resistance of weldment such as weld decay, knife line attack and stress corrosion resistance. Welding is done with respect to properties of materials so that weld defects may be reduced. Preheating is done under the Environmental condition by adjusting the current and voltage before welding, generally material with less thickness are not to be considered for pre heating and post heating will be carried out in case of any defects in the weld.

3. RESULTS

Chemical and Micro Result:

SS316:

Grain : FSS and ASS grains

ASME Grain Size : No: 7

SS347:

Grain : Ferrite & Austenite grains

ASME Grain Size : No: 8

Table.1. Comparison of Result

Grade	Chemical & micro analysis	Testing	Asme
347 TIG	429MPa	618MPa	643MPa
316 TIG	424MPa	486MPa	515MPa

Bend Test Result:

S.S 316 & 347

Face Bend: No Defects and Satisfactory

Root Bend: No Defects and Satisfactory

Table.2. Hardness Result

Specimen	Hardness	Result
347	90HRB	85HRB
316	95HRB	85HRB

Strength Calculation:

Tensile Strength=15.4

[19.1 + 1.8 X % Mn+ 5.4 X % Si +0.25 x % Pearlite + $0.5d^{1/2}$]

Local Element Forces of Weight Run for Without Attachments

Table.3. Local element forces of weight run for without attachments

NODE	fx N	fy N	fz N	mx N.m	my N.m	mz N.m
10	-109	458	-11808	11618	75348	2573
12	109	-458	9281	-11618	5001	914
12	4213	273	41	475	-5178	-267
20	311	4408	-161	-1283	1336	8261
20	-311	161	4408	1283	-8261	1336
30	311	-161	-8568	-1283	-73150	680
198	-1737	-273	-41	-475	4873	2306
198	1737	-41	273	475	2306	-4873
200	-273	41	1658	4867	-2090	468
200	273	-41	-1658	-4867	2090	-468
210	-273	41	-2502	4867	-7383	-45
210	2502	273	-41	45	-4867	7383
220	-10922	-273	41	-45	5906	-447
299	-1084	10	383	1832	-750	1898
299	1084	-10	-383	-1832	750	-1898
300	-495	10	998	2637	-662	46
300	495	-10	-998	-2637	662	-46
310	-495	10	-3162	2637	-14237	-85
310	3162	495	-10	85	-2637	14237
320	-11582	-495	10	-85	2901	-1652

Table.4. Local Element Forces for Weight Run by Adding Attachments

NODE	fx N	fy N	fz N	mx N.m	my N.m	mz N.m
12	61	-208	-1982	471	-3835	-356
12	-61	208	-3046	-471	3835	356
14	61	-208	1783	471	5364	437
14	4540	166	5	95	21	-528
25	122	-65	-1621	545	-3025	-137
25	-122	65	-1504	-545	3025	137
198	-2065	-166	-5	-95	-59	1770
198	2065	-5	166	95	1770	59
210	-166	5	-2175	-60	-2677	30
210	2175	166	-5	-30	60	2677
220	-10595	-166	5	30	71	1547
298	-2063	-164	2	37	61	1755
298	2063	2	164	-37	1755	-61
299	-1547	-2	1315	70	-1682	18
299	1547	2	-1315	-70	1682	-18
300	-164	-2	1984	62	-1473	-36
300	164	2	-1984	-62	1473	36
310	-164	-2	-2176	62	-2677	-13
310	2176	164	2	13	-62	2677
320	-10597	-164	-2	-13	14	1491

Table.5. Local Element Forces for Weight Run Adding Attachment (Anchor)

NODE	fx N	fy N	fz N	mx N.m	my N.m	mz N.m
12	0	82	-3544	-389	5949	157
14	0	-82	2281	389	5147	157
14	4562	165	0	0	0	-778
20	0	-249	0	805	0	660
20	0	0	-249	-805	-660	0
25	0	0	-1806	805	-4164	0
25	0	0	-1053	0	1114	0
198	-2086	-165	0	0	0	2009
198	2086	0	165	0	2009	0
200	-165	0	2007	0	-1724	0
200	165	0	-2007	0	1724	0
210	-165	0	-2153	0	-2639	0
210	2153	165	0	0	0	2639
220	-10574	-165	0	0	0	1548
298	-2078	-168	0	-4	42	1953
298	2078	0	168	4	1953	-42
299	1560	0	-1322	-27	1880	-32
300	-168	0	1998	42	-1670	4
300	168	0	-1998	-42	1670	-4
310	-168	0	-2162	42	-2695	0
310	2162	168	0	0	-42	2695
320	-10582	-168	0	0	51	1567

Table.6. Local Element Forces for Weight Run by Adding Attachments (Restraints)

NODE	fx N	fy N	fy N	mx N.m	my N.m	mz N.m
14	0	0	8703	165717	20375	0
14	15135	0	0	0	0	-133679
20	0	7082	0	-15056	0	100567
20	0	0	7082	15056	-100567	0
25	0	0	-9137	-15056	50310	0
25	0	0	9137	15056	-50310	0
198	-12660	0	0	0	0	133679
198	12660	0	0	0	133679	0
200	0	0	12580	0	-131758	0
200	0	0	-12580	0	131758	0
210	0	0	8421	0	0	0
210	-8421	0	0	0	0	0
220	0	0	0	0	0	0
300	0	0	12580	0	-131758	0
300	0	0	-12580	0	131758	0
310	0	0	8421	0	0	0
310	-8421	0	0	0	0	0
320	0	0	0	0	0	0

4. CONCLUSION

In this paper various test like hardness, impact, and tensile strength in alloy steel material was taken and. Comparison of code value, raw material value, and Caesar II, demo value after welding was found within the limit. With the above properties as reference, the span length of the piping layout can be varied and optimized. Hence the piping layout taken from the ASME journal Chapter B4 stress analysis of piping systems, number of hanger used to code stress and displacements check passed was and reached the target. The designed pipe satisfies all the conditions defined by the ASME Boiler and Pressure Vessel code B31.1.

During Welding Strength will be decreased as because due to the change of properties and behavior of materials. After Welding Heat treatment is to be carried out to maintain the strength of material. The final resultant values are nearer to ASME readings. Thus suitable material for boiler industry could be optimized. Therefore S.S materials can be used in re-heater line, pressure parts and main steam line.

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