Retraction

Retraction: Design and Analysis of Metal Expansion bellows under Axial and Transverse loads using CATIA V5 R21 software (IOP Conf. Ser.: Mater. Sci. Eng. 1145 012054)

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IOP Publishing regrets that our usual quality checks did not identify these issues before publication, and have since put additional measures in place to try to prevent these issues from reoccurring. IOP Publishing wishes to credit anonymous whistleblowers and the Problematic Paper Screener [1] for bringing some of the above issues to our attention, prompting us to investigate further.

[1] Cabanac G, Labbé C and Magazinov A 2021 arXiv:2107.06751v1

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Design and Analysis of Metal Expansion bellows under Axial and Transverse loads using CATIA V5 R21 software

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Abstract: Bellows is a versatile seal/expansion joint, whose convoluted element is designed to flex even as thermal moves get up in the piping machine. The form of convolutions relies upon the amount of movement the bellows should accommodate or the stress that want to be used to perform this deflection. The convoluted elements have to be strong circumferentially to face up to the contraction and thermal growth of the device. This strength with flexibility is a totally specific design problem that isn't often positioned in other additives in commercial machine. Bellows are regularly used in the pressure vessels or piping device, aerospace, and so forth. It has the characteristic to soak up ordinary or irregular enlargement and contraction inside the device. Because of the reality bellows require excessive strength in addition to properly flexibility, we determine upon SS 316 L alloy to layout and manufacture a bellow. The design, manufacturing and evaluation of bellows are extra complex than different contemporary tubes. A magazine associated with layout and production of bellows may be noted. On this study, we bear in mind to format, modelling and detailing of bellows under axial and transverse loading the usage of Expansion Joint Manufacturer’s Association(EJMA) code using CATIA V5 R21 software. With the aid of the use of this EJMA code one can anticipate the circumferential membrane strain, meridional membrane pressure, motion in keeping with convolution and fatigue life cycle of the bellows.

Keywords: Bellows, Convolution, EJMA code, Expansion joint, SS 316 L alloy, CATIA V5 R21 software

1. Introduction:

Flexible / bendy component for expansion joints containing one or more convolutions and a tangent with a maximum length of weight to the width of the bellows should be lesser or similar to 3 without more than 5 flies. Any tool that contains one or more sprays used to change the measurements in combination due to hot growth or cuts in the pipe gadget. Tubular sprays are one of the most energy efficient electrical engineering equipment. A combination of expansion joints or movement assembly is designed to securely protect the heat delivered in relation to the increase and decrease of many...
engineering materials, to take vibrations, to keep certain elements together. Weights are a bendy element of the expansion joint, we want to be strong around the resistance and bendy enough over time and over time to truly take a deviation from what is designed for sleep, and as repetition is as important as the slightest resistance. These dynamic forces are a completely unique design problem that is not often found in various parts of a business plan. steel mills have a large aircraft work area, small chemical flowers, power system, car parts, cleaning areas, hot air heaters, piping device, electromechanical system, petrochemical plant, power stations, circuit heating, HVAC systems etc. and wherever the pipes or fittings are there are excavations with the effects of heat, external pressure forces and much more.

2. Selection of form of Expansion Joint:

In this research investigation, we propose the universal form expansion joint as it’s having the highbrow properties along with the Universal expansion joint is relevant for any type of purposes/utilizations in the piping gadget as shown in fig.1.

The Universal Expansion Joint is in particular used for absorbing the combination of 3 basic loads (Axial, Lateral, and Angular). These are used to take in the massive quantity of lateral deflections. And its miles completely range from double expansion joint. Benefits of universal expansion joint are in the following:

- It’s having easy and strong creation.
- It’s having the tendency to take in large amount of axial, lateral and angular motion.
- It's miles quite cheaper.
- The installation of the universal expansion joint is less complicated
- Repair and Maintenance of this kind of expansion joint is decrease.

![Figure 1. Universal Expansion Joint](image-url)

3. Literature Review:

Stainless steel is a precision welded element along the boundaries of all internal and external widths. The development of a computer architectural software program for three types of twisted metal sprays is learned from the Auto LISP language source for AutoCAD. Users can experience the effects of additional effects through the use of flexible input or large-scale recordings, and, this application can be fully updated with the use of flexible algorithms in line with business needs and drawing tools may be associated with various CAD modeling and FEM testing programs [1]. Analysis of the shapes and boundaries of the metal structure is shown in figs. 2. M01 is 3 waves and wide linear rainfall is longer than the size of a square line. M02 is 4 waves blowing and M03 is 5 waves. The internal opposition power of Von-Misses as shown in Fig. 3, and these three changes are given by high pressure. The
internal resistance strength of M01, M02 and M03 is 636.05 MPa, 696.86 MPa and 663.43 MPas.

A study of the link between the maximum pressure generated and the presence cycle of various components with increasing fashion (U-form, Ω form and disc form) use of MATLAB. U-shaped flare-ups have less stress-induced stress, prolonged fatigue, and are better at higher levels of internal stress. The most striking format feature is the precise definition of light motion requirements [2]. Failure to assemble SS 304 product belts was tested. In addition to the pressure, the system vibration in the pipeline responds to failure. After a thorough inspection of the sprays, it was determined that incorrect structural details are considered during the production of the belts in the end those valves fail one year of the supplier. Based entirely on those format facts, improve the design and reconstruction of metal enlargement bellows using the EJMA code containing the internal liner. A finite element analysis (FEA) of the sprays proposed in this paper to ensure the results of the software program and EJMA design calculated incense effects with an internal liner. Finally the verification of the results of the EJMA construction calculated cost and FEA amount shows a very good agreement. Here using an internal liner on the chest gives higher results and performance performed at that time with regular sprays [3].

A review of the flexible component of expansion joints that includes one or more compounds not the use of more than five wolves and a maximum rationow depth of not more than three and any device containing one or extrabells used to accommodate changes in size, orvessel hole or heat exchange. In the end the author has prioritized the improvement of sprays, construction period, motion test testing, folding, Mechanical performance, structural concept, dynamic parameters and machine testing using business to have a software program [4]. Experimental research and general performance testing
of hydrohydroved tubular bellows in the INCONEL 625 alloy may be possible. Tubular Bellows are usually made with the help of a hydro-building process to achieve uniformity informing with good enough accuracy. The volatility and fatigue of the metal commodity have been assessed using a spring price check and an existence cycle test. Images of go-sectional SEM (Scanning Electron Microscope) have been exposing the underlying flaws under the junction of bellows expansion members [5]. The surface morphology of hydro-formized INCONEL 625 bellows was analyzed using Field Emission-Scanning Electron Microscopy (FE-SEM). The molded metal was inserted into the axial path with the help of the Electrical Discharge Machining process, examining the morphology of the parent metal and the lowering of the metal part in the corner, shown in Fig. 4. Although there is a strong effect of resistance to internal pressure and expansion within steel structures, cracks were no longer visible.

Extension joints are used to regenerate power during a period of shrinkage or expansion of the pipes. Large types of expansion joints are widely used in the plumbing industry. These include design calculations from EJMA (Integrated manufacturer’s integration), format, Modeling, Thermal Testing and design of axial type expansion integration. All programming habits can be eliminated by the source of FE testing the use of the ANSYS software program [6]. New metal spray production techniques and key parameters were proposed including initial tube time, internal type, axial and speed feed, machine houses and the type of material investigated using Fee (LS) -Dyna) and test kits. Finally, the results of finite element technique (FEM) and tests show excellent agreement. The results of the current drawings may be used as a basis for designing a brand new stainless steel [7]. It is being investigated here that the mechanical sprays of multi-compressed sprays, which may be designed to bend and twist in addition to extending and compressing long lengths. For torsion, the sprays are integrated into a circular helix where an angle is selected to provide the preferred load-bearing relationship, for example the maximum rotation of a given torque. In all folding and flexing limbs, the test results are covered with a predictive pattern of behavior [8].

4. Proposed Design Methodology:
The intended design plan layout for Universal Expansion Joint under Axial and Transverse loading is shown in fig.5.
5. Results and Conclusions:

5.1. Validation of Results as consistent with EJMA:

The axial and transverse motion's calculations of the metal bellow with the cloth kind SS 316 L to be calculated with the use EJMA code. The whole pressure fee of the bellows may be calculated the use of the circumferential membrane pressure and meridional membrane stresses of the bellows tangent and collar attached to the bellows because of strain and deflections. And finally the fatigue life cycle of the bellows to be calculated as in step with EJM A code.

The analytical calculation of common expansion joint recommended for the piping system having 1500 nominal bore to be calculated as according to EJMA code for input parameter confirmed in table 1:

| S.No. | Parameters              | Values  |
|-------|-------------------------|---------|
| 1.    | Internal design pressure| 7.251 psi|
| 2.    | External design pressure| 14.625 psi|
| 3.    | Design Temperature      | 158 F   |
| 4.    | Axial movement          | 50 mm   |
| 5.    | Lateral movement        | 15 mm   |
| 6.    | Inside diameter         | 1490 mm |

Figure 5. Proposed Research Methodology for the design of Universal Expansion Joint
For that encouraged form of bellows and the cloth, the internal resisting force calculations and fatigue life cycle for each internal and outdoor design layout pressure of the Expansion Joint are calculated as in line with EJMA code is proven in table 2.

| S.No. | Parameters | Calculated Values |
|-------|------------|-------------------|
| 1.    | Bellows tangent circumferential membrane stress due to Internal design Pressure | 1382.27 psi |
| 2.    | Bellows tangent circumferential membrane stress due to External design Pressure | 2801.32 psi |
| 3.    | Collar circumferential membrane stress due to Internal design Pressure | 1387.27 psi |
| 4.    | Collar circumferential membrane stress due to external design Pressure | 2811.08 psi |
| 5.    | Bellows circumferential membrane stress due to internal design Pressure | 4675.01 psi |
| 6.    | Bellows circumferential membrane stress due to External design Pressure | 9474.45 psi |
| 7.    | Bellows meridional membrane stress due to internal design pressure | 192.385 psi |
| 8.    | Bellows meridional membrane stress due to External design pressure | 390 psi |
| 9.    | Bellows meridional bending stress due to pressure | 6578.49 psi |
| 10.   | Bellows meridional bending stress due to pressure | 13596.48 psi |
| 11.   | Bellows meridional membrane stress due to deflection | 386.55 psi |
| 12.   | Bellows meridional bending stress due to deflection | 62558.22 psi |
| 13.   | Total stress range of bellows at internal pressure | 67682.58 psi |
| 14.   | Total stress range of bellows at external pressure | 72735.21 psi |
| 15.   | Fatigue life cycle of bellows at internal pressure | 17921418.95 cycles |
| 16.   | Fatigue life cycle of bellows at external pressure | 6156323.58 cycles |

After the stress and fatigue lifestyles cycle calculations for there commended expansion joint, the design layout of the expansion joint is undergone internal resisting force/stress validation machine. The stress validation technique is an analytical calculation that's to be made to finish that the design of a expansion joint made with the aid of EJMA popular code is to be safe or no longer. The stress
validation machine additionally executed with use of EJMA trendy code as proven beneath as shown in equation 1-4.

\[ S_1 \leq C_{wb}S_{ab} = 18802.68 \text{Psi} \]  
(1)  
\[ S'_1 \leq C_{wc}S_{ac} = 18802.68 \text{Psi} \]  
(2)  
\[ S_2 \leq C_{wb}S_{ab} = 18802.68 \text{Psi} \]  
(3)  
\[ S_3 + S_4 \leq C_{m}S_{ab} = 46536.79 \text{Psi} \]  
(4)

Wherein,  
\( S_1 \), Bellows tangent circumferential membrane stress because of design layout pressure,  
\( S'_1 \), Collar circumferential membrane stress due to design layout pressure,  
\( S_2 \), Bellows circumferential membrane stress because of pressure,  
\( S_3 \), Bellows meridional membrane stress due to pressure,  
\( S_4 \), Bellows meridional bending stress due to pressure,  
\( C_{wb} \), Longitudinal weld joint efficiency factor for Bellows  
\( C_{wc} \), Longitudinal weld joint efficiency factor for Collar,  
\( S_{ab} \), Allowable substances stress for Bellows,  
\( S_{ac} \), Allowable substances stress for Collar,  
\( C_{m} \), Material strength factor

6. Design Layout and detailing of Bellows:
The bellows is to be modelled for the input parameters already argued in above section using CATIA V5 R21 software. The isometric view of the modelled bellows is shown underneath in the fig.6 as mentioned below:

![Figure 6. Isometric view of Universal Expansion boom joint](image)

The layout detailing and the fabrication drawing may be executed inside the drafting workbench of the CATIA V5 R21 software application with the sectional cut of the universal expansion joint. Geometrical Dimensioning & Tolerancing (GD&T) is used to offer the tolerances of the universal expansion joint. The comprehensive design layout of universal expansion joint is established underneath in the fig.7, as mentioned below:


7. Conclusions:

The analytical calculation for the bellows design has been completed as constant with EJMA requirements and diverse stress values have been decided.
Analytical validation for Bellows layout has been performed as according to EJMA requirements and it’s been demonstrated for the altered stresses for the general thickness of 1mm having 1 ply as in step with standards and its placed that all pressure values are within the allowable design limits.
The following statement can be made from above analytical calculation as in step with EJMA standards:

a. The Bellows Tangent Circumferential Membrane stress because of pressure (S₁) for outdoor is decided to be 2801.32Psi and has been validate as steady with condition given in Eq.1, \( S₁ ≤ C_{wb}S_{ab} \) and is located to be safe.

b. The Collar membrane Circumferential stress because of pressure(S’₁) is located to be 2811.08Psi and has been validate as constant with state of affairs given in Eq.2 \( S’₁ ≤ C_{wc}S_{ac} \) and is determined to be safe.

c. The Bellows Circumferential Membrane stress because of pressure(S₂) is discovered to be 9474.45 Psi and has been validate as consistent with condition given in Eq.3, \( S₂ ≤ C_{wb}S_{ab} \) and is determined to be safe.

d. The Bellows Meridional Membrane stress because of pressure (S₃) and Bellows meridional bending stress (S₄) is determined to be of value 390 Psi and 13596.48 Psi respectively and has been validate as in line with situation given in Eq.4, \( S₃ + S₄ ≤ C_{m}S_{ab} \) and is discovered to be comfy.

e. The number of fatigue life cycles (N) located to be 6156323.58cycles.

8. Future Outlook:

The FEA assessment can be used for validating the layout of the bellow, already calculated by way of the use of EJMA significant. In extraordinary words, it’s far used to justifying the calculated stresses and cycle life through EJMA standard can be equivalent to the value of the stresses and cycle life completed with the resource of FEA analysis. And the FEA analysis is used to display the impact of loads in the universal expansion joint in real-time.
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