# Proceedings of 24th International Conference “MECHANIKA 2019”

## Camera-Ready Articles Preparation Instructions for International Conference “Mechanika 2019”

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##### 1. Article size

This template explains and demonstrates how to prepare your manuscript for Publication. The best is to read these instructions and follow the outline of this text.

In order to achieve rapid publication, the text will be printed directly from the author's typescripts.

Some flexibility of presentation will be allowed but authors are urged to arrange the subject matter clearly under such headings as **Introduction**, **Experimental details**, **Results**, **Discussion**, **Conclusions**, **References**, etc.

Research papers up to 8000 words will be considered – the length of a paper text is not limited but manuscripts should be 4 to 8 pages in length, including figures, references and abstract. Not less than 75 % – 80 % the last page should be filled. OCP can accept longer manuscripts, provided that the scientific content is of exceptionally high quality.

##### 2. Layout

Manuscript should be typed with single spacing using Microsoft Word processor (preferably). Times New Roman font should be used. The text should be typed in two columns on A4 format sheets (210 x 297 mm); spacing between columns should be 6 mm. Leave 20 mm margins at the top, 17 mm at the bottom, 18 mm left and at right sides. Please, don’t use numbering pages in your articles.

The title of an article should be printed in **16 pt (Bold)**, author's name – **12 pt (Bold)**, title of the institution – *10 pt (Italic)*, headings of the chapters – **10 pt (Bold)**, the body text and summary – **10 pt**, indexes – 8 pt, text of the tables – 9 pt, formulae in the text (using Microsoft Equation 3,0 programme) – **10 pt**, indexes – **6 pt**, subindexes – **5pt** (all symbols – *Italic*, vectors – **Bold**, numbers – Normal). Fig. 2 how to define fonts in formulae. Italic characters should be used for symbols from the figures and graphs mentioned in the text.

New paragraph must be indented in the first line by 1.27 cm. Line spacing – Single.

References should be numbered consecutively (numerals in square brackets) through the text and collected together in a reference list at the end of the paper. Please place the references according to their order of appearance in the text. Use 10 pt, regular for the reference list. The authors should be typed in **Bold**, name of the article – Normal.

Paper in reference list must be referred to its DOI.

##### 3. Figures and tables

The figures and tables must be numbered, have a self-contained caption. Figure captions should be below the figures; table captions should be above the tables. Please avoid placing figures and tables before their first mention in the text.

The text of figure captions should be 10 pt high, Times New Roman and Normal. For the words Fig. and Table use Normal. Name of the Figure should be made with Hanging of 0.95 cm. Name of the Table should be made with After spacing of 5 pt.

All the figures, graphs and photographs should be numbered and referred in the main text. Abscissas and ordinates of all graphs should be labelled with symbols and units.

All figures, graphs and photographs can be in colours as well as in black and white (or grey shades).

Figures, tables should be arranged in such a way that they would fit into one (84 mm width) or two columns (only in the start or end of the page).



Fig. 1 General view of a specimen with side grooves

One line spacing should separate the figures and tables from the text.

##### 4. Formulaes

All equations and symbols in the text must by written in Microsoft Equations 3.0 or Math Type 6.0. Formulae styles and sizes you can define as it is show in Fig. 2 and Appendix. The example how to type formulae inside two columns is presented:

, (1)

where: spacing before – 10 pt, spacing after – 10 pt, Tab stop positions are 0.75 cm and 8.4 cm, respectively.

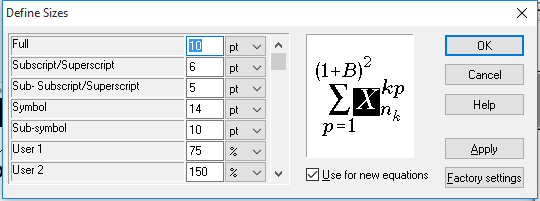
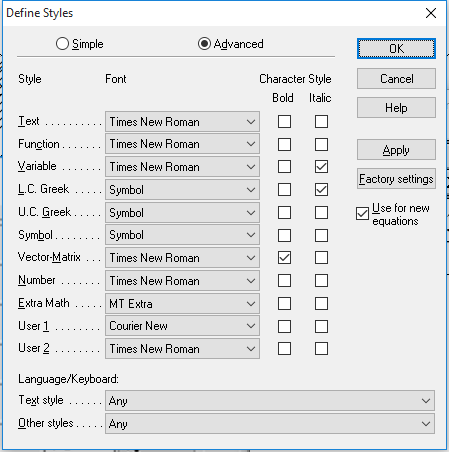
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Table 1

Mechanical characteristics of pipes main steel, weld and heat affected zone metal

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Pipeline index | Pipe steel, weld and heat affected zone (HAZ) metal | Test temperature *T,* oC | Yield stress , MPa | Ultimate stress  , MPa | Poisson’s ratio  *ν* | Young’s modulus  *E*, MPa |
| DU-300 | Steel 08X18N10T | 20 | 309 | 608 | 0.35 | 140300 |
| 285 | 232 | 397 | 0.35 | 140100 |
| Heat affected zone (HAZ) metal | 20 | 283 | 584 | 0.35 | 151500 |
| 285 | 240 | 474 | 0.35 | 188800 |



a b

Fig. 2 Define of formulae: a – styles, b – sizes

The example how to type formulae inside one column is presented:

. (2)

For this case spacing before – 10 pt, spacing after – 10 pt, Tab stop positions are 8.7 cm and 17.4 cm, respectively.

##### 4. Conclusions

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##### References

1. Standard Test Method for Determining *J-R* Curves. ASTM E1152-87. 11 p.
2. **Jonaitis M.; Kamaitis P.; Rimaitis E.** 1999. Determining *J-R* curves of steam pipeline Du-630 welded joint materials in Ignalina NPP, Mechaninė technologija t.XXVII: 182-199 (in Russian).

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1. **Anderson, T.L.** 1991. Fracture Mechanics. Fundamentals and Applications.-Boca Raton, Ana Arbor: CRC Press. 793 p.
2. **Dickey, H.; Watson, V.; Zangelidis, A.** 2009. Job satisfaction and quit intentions of offshore workers in the UK North Sea oil and gas industry [online] MPRA [accessed 9 Febr. 2010]. Available from Internet: <http://mpra.ub.unimuenchen>. de/18666/.

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Dear authors,

Thank you for your interest in our international conference “Mechanika 2018”. We work hard to meet your expectations.

**Keywords:** keyword, keyword, keyword.

# Proceedings of 24th International Conference “MECHANIKA 2019”

## Fracture Toughness of Pipelines Welded Joints Materials

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##### 1. Introduction

Exploitation of steam pipelines during start-up, hydraulic tests overloads and other emergencies, the strains reach dangerous values at times exceeding allowable limits. In most cases, such loads are met in the zones of stress concentration also cracks and welded joints zones. Increase of loading frequency in a set of forth, above dangerous zones, causes fast growth of fatigue crack in construction, resulting its failure. The evaluation of such situations needs to meet criteria of material resistance to crack growths as a characteristics of fracture.

Certain characteristics, such for example as fracture toughness  or , crack resistance curves  or  and others criteria, on research of fracture, are used. In comparison of these relations, the plasticity resistance curve  is more preferable than separate characteristics  or , because it shows the internal relation between stress and crack growth at all loading cases, and gives the opportunity of getting fracture toughness characteristics  or  from the same graphic.

# EXAMPLE

The present work was carried out in order to ob­tain experimental data of fracture such as crack resistance curves  and fracture toughness characteristics  and  on specimens made from steam pipelines DU-300 and DU-630 welded joint materials. Mechanical characteristics of pipes steel its weld and heat affected zone metals are shown in Table.**2. Testing procedures**

Testing procedure of  curve is described in the American standard ASTM E1152-87 [1]. In the majority of tests compact specimens *C*(*T*) for tension or *B*(*T*) for bending are applied. Compact specimens (Fig. 1) of different sizes are applied. The standard offers the following thickness of specimens: 1/2*T*, 1*T*, 2*T* and 4*T*, where *T*=25.4 mm. The specimens have three basic sizes: length of a crack , thickness *B* and width *W*. In many cases there are accepted *W*=2*В* and *а/W*>0.5. Basic sizes of specimens *B* and *W-а* should exceed the size of plastic zone in advance of a developing crack minimum 50 times, otherwise the incorrect characteristics of fracture toughness will be received. Sizes of the test specimens depend on the thickness of material, from which they are made. Specimens of the size 1/2*T* and 1*T* have been used in our test, because the diameter of steam pipes.

Factor of load asymmetry in cycle during precracking should not exceed  and the length of a crack should not be less than 5% from , but not less than 1.3 mm. Beside the definition of  by the method of a compliance requires to observe condition  where  is the distance from loading line up to the top of a crack. At  the method of compliance loses sensitivity, and at  the plastic zone will be much more increased and becomes too large. So, the ratio  in our experiments varied within the limits 0.5-0.75.

Table

Mechanical characteristics of pipes main steel, weld and heat affected zone metal

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Pipeline index | Pipe steel, weld and heat affected zone (HAZ) metal | Test  temperature  *T,* oC | Yield stress , MPa | Ultimate stress ,  MPa | Poisson’s  ratio  *ν* | Young’s  modulus  *E*, MPa |
| DU-300 | Steel 08X18N10T | 20 | 309 | 608 | 0.35 | 140300 |
| 285 | 232 | 397 | 0.35 | 140100 |
| Weld metal welded manually and automatically by arc method with electrodes EА-100/10U or EА100/10T and wire metal Sv-0419N11M3 | 20 | 348 | 627 | 0.35 | 151800 |
| 285 | 211  *Text of table  9 or 10pt* | 464 | 0.35 | 140400 |
| Heat affected zone (HAZ) metal | 20 | 283 | 584 | 0.35 | 151500 |
| 285 | 240 | 474 | 0.35 | 188800 |
| DU-630 | Steel 16GS | 20 | 265 | 572 | 0.37 | 174600 |
| 285 | 198 | 645 | 0.37 | 142500 |
| Weld metal welded manually and automatically by arc method with electrodes UONI 13/55 and wire metal Sv-08GS2 | 20 | 364 | 601 | 0.37 | 207100 |
| 285 | 260  *Point* | 630 | 0.37 | 137400 |



Fig. 1 General view of a specimen with side grooves

All specimens were cyclically precracked on testing machine YPC-200 [2] at loading frequency 16-20 Hz at load values . For *C*(*T*) specimens:

, (1)

where: .

The procedure of precracking in details is described in [3].

##### 3. Construction of *J-R* curves

The elastic compliance method using remote load line displacement measurements to develop *J-R* curve was carried out on a 250 kN tension-compression testing machine, the loading speed during unloading - reloading cycle was taken about 40 seconds [4].

An experimental definition of *J-R* curves (Fig. 2, curve *4*)was investigated on specimens, made of pipes steel, weld and heat affected zone metal [4]. Schemes of cutting specimens are shown in Fig. 1.



Fig. 2 *J-R* curve for steel 16GS at *T*=285°C, crack limits and the exclusion line: *1*, *2*, *3* – experimental results; *4* – theoretical curve

The *J* integral values ware calculated at all points of “load-versus-displacement” record using the equation:

, (2)

where:  is elastic part and  is plastic partof *J* integral.

For any cycle  of unloading – reloading sequence with coordinates  and current crack length :

, (3)

where:

 (4)

and  =2.0+0.5222 ; .

. (5)

By the method of compliance construction *J-R* curve does not require crack’s length measurement during the test, because the crack length is given from ratio  which equal [5]:

 (6)

where: .

In order to account the crack opening displacement in *C*(*T*) specimens for its rotation compliance was corrected, new values of and  were calculated and  curves versus  were plotted [6].

An example of calculated curve at T=285°C for specimen cut from pipe DU-630 steel 16GS. Averaged *J-R* curves for welded specimens in series cut from pipe DU-300 at elevated (T=285°C) temperature.

##### 4. Conclusions

# EXAMPLE

1. Fracture toughness research has shown that side grooves on the specimens are necessary to receive straight crack front and initial ratio  is preferable to give excellent sensivity of compliance measurement.

2. Comparison of  curves using two methods has shown that integral values for all investigated metals are similar, except steel 16GS at normal , elevated  temperature and pipe’s Du-300 weld metal  and varies from 73 to 88 kN/m.

3. Maximum  values were for steel 08X18H10T, its weld and steel 16GS at normal temperature , minimum – for steel 08X18H10T at elevated (285°C) temperature . For other metals temperature of testing has not significant influence on  values and were in the range =109.1-131.8 MPa.

##### References

1. Standard Test Method for Determining *J-R* Curves. ASTM E1152-87. 11 p.
2. **Jonaitis M.; Kamaitis P.; Rimaitis E.** 1999. Determining *J-R* curves of steam pipeline Du-630 welded joint materials in Ignalina NPP, Mechaninė technologija t.XXVII: 182-199 (in Russian).

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1. Standard Test Method for , a Measure of Fracture Toughness. Philadelphia, ASTM E813-87.
2. **Anderson, T.L.** 1991. Fracture Mechanics. Fundamentals and Applications.-Boca Raton, Ana Arbor: CRC Press. 793 p.
3. **Bražėnas, A.**; **Daunys, M.** 1995. The stress strain state and plasticity of mechanically heterogeneous welded joints with a flat interlayer subjected to tension (compression), Mechanika 17(1): 5-13.

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# EXAMPLE

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**Fracture Toughness of Pipelines Welded Joints Materials**

S u m m a r y

This paper presents the investigation of fracture toughness of welded joint materials of steam pipelines DU-300and DU-630 used in Ignalina NPP. Main pipes metal – 08X18N10T (DU-300), 16GS (DU-630), its weld metal welded manually and automatically by arc method with electrodes UONI 13/55, EA-100/10U or EA-100/10T using wire SV-08GS2 and SV-0419N11M3, also pipe Du-300 heat affected zone metal was tested. Sharp fatigue cracks in compact specimens were initiated and using compliance testing method crack resistance  curves were develo­ped, critical values of  integral  and stress intensity factor  at normal (20oC) and elevated (285oC) tem­peratures were also obtained.

**Keywords:** fracture toughness, welded joints materials.

**Appendix**



