Experimental study of shear and hydraulic bonding strength between casing and cement under complex temperature and pressure conditions

Huanqiang Yang, Qi Fu, Jiang Wu, Lulu Qu, Dong Xiong and Yang Liu

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Original submission: 8 December 2019
Revised submission: 5 March 2020
Final acceptance: 31 March 2020
Note: Reports are unedited and appear as submitted by the referee. The review history appears in chronological order.

Review History
RSOS-192115.R0 (Original submission)

Review form: Reviewer 1

Is the manuscript scientifically sound in its present form?
Yes

Are the interpretations and conclusions justified by the results?
Yes

Is the language acceptable?
No

Do you have any ethical concerns with this paper?
No

Have you any concerns about statistical analyses in this paper?
No
Recommendation?
Major revision is needed (please make suggestions in comments)

Comments to the Author(s)
The paper is written about an important topic that required more and more works. The literature review of the paper is still weak. Major works are not reviewed by the author, for instance, the works done by other on cement interfacial strength model and measurements for instance Tabatabaei, M., A. Dahi Taleghani, N. Alem, 2020, Measurement of Mixed Mode Interfacial Strengths with Cementitious Materials, Engineering Fracture Mechanics, Volume 223, 106739, ISSN 0013-7944.

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It's better that authors report raw rheology data (graphs). The authors should report the expansion of the steel and cement plug due to pressurization in the experiment as a benchmark. Also need to discuss the effect of pipe expansion to the high pressure.

Review form: Reviewer 2

Is the manuscript scientifically sound in its present form?
Yes

Are the interpretations and conclusions justified by the results?
Yes

Is the language acceptable?
Yes

Do you have any ethical concerns with this paper?
No

Have you any concerns about statistical analyses in this paper?
No

Recommendation?
Accept with minor revision (please list in comments)

Comments to the Author(s)
Cement sheath integrity is important to the oil and gas well. Interfacial bonding strength between cement sheath and casing and cement sheath and formation are the basic data to study the integrity of cement sheath. Different from the current studies, this work designs an special experimental device to measure the interfacial bonding strength between casing and cement sheath under complex temperature and pressure conditions in HTHP wells. Several factors are
considered and some experimental data are acquired which is useful to study the integrity of cement sheath. However, this paper needs some modifications to publish:

1- A language polishing is recommended for this manuscript.
2- The authors should demonstrate reasons for data changes based on time, curing time, curing temperature and casing roughness.
3- The different factors considered in this manuscript should explain the operating conditions during well completions.

Review form: Reviewer 3

Is the manuscript scientifically sound in its present form?
No

Are the interpretations and conclusions justified by the results?
Yes

Is the language acceptable?
No

Do you have any ethical concerns with this paper?
No

Have you any concerns about statistical analyses in this paper?
Yes

Recommendation?
Major revision is needed (please make suggestions in comments)

Comments to the Author(s)
The manuscript reports useful data and methodology. I suggest major revision mainly because of the many writing issues in the manuscript. The writing is problematic and is not very careful. The authors need to ask for English writing experts to help refine their paper. There are still a lot of writing issues present in the manuscript.

Remaining major issues:
1) The writing is lacking relevant discussion on related studies. There are a number of papers dedicated to studying the bonding between cement and steel materials published in other journals such as cementing and construction materials, journal of petroleum science and engineering. When discussing the results, comparative analysis between the current findings and previous findings is highly recommended. This will make the novelty of current study clear to the readers.
2) There are not many scientific explanations on the results obtained. There are many figures not not much useful discussion on them. The authors should provide insights as regard to why this and that happen? What are underlying mechanisms? Otherwise, it carries little value to the readers if they want to exploit the research results.
3) Writing contains both logic and grammar issues. It is not quite consistent. Sometimes it is clear, but sometimes it is fuzzy.
4) Roughness effect: how is the roughness defined? The definition should be given.
5) Figure 10(a): it should be mentioned that this scheme is the temperature variation scheme used in the lab tests to mimic field conditions.

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Table 2’s table headlines: the first letter should be capital.

Many other writing issues in other pages. Sorry I cannot do line to line check and write up the needed changes here due to my limited time on reviewing this manuscript...

The authors may want to get professional language help from colleagues or get some professional training on technical writing. It will be really helpful for their future paper writing...

Decision letter (RSOS-192115.R0)

14-Feb-2020

Dear Dr Yang,

The editors assigned to your paper ("Experimental study of shear and hydraulic bonding strength between casing and cement under complex temperature and pressure conditions") have now received comments from reviewers. We would like you to revise your paper in accordance with the referee and Associate Editor suggestions which can be found below (not including confidential reports to the Editor). Please note this decision does not guarantee eventual acceptance.

Please submit a copy of your revised paper before 08-Mar-2020. Please note that the revision deadline will expire at 00.00am on this date. If we do not hear from you within this time then it will be assumed that the paper has been withdrawn. In exceptional circumstances, extensions may be possible if agreed with the Editorial Office in advance. We do not allow multiple rounds of revision so we urge you to make every effort to fully address all of the comments at this stage. If deemed necessary by the Editors, your manuscript will be sent back to one or more of the original reviewers for assessment. If the original reviewers are not available, we may invite new reviewers.
To revise your manuscript, log into http://mc.manuscriptcentral.com/rsos and enter your Author Centre, where you will find your manuscript title listed under "Manuscripts with Decisions." Under "Actions," click on "Create a Revision." Your manuscript number has been appended to denote a revision. Revise your manuscript and upload a new version through your Author Centre.

When submitting your revised manuscript, you must respond to the comments made by the referees and upload a file "Response to Referees" in "Section 6 - File Upload". Please use this to document how you have responded to the comments, and the adjustments you have made. In order to expedite the processing of the revised manuscript, please be as specific as possible in your response.

In addition to addressing all of the reviewers' and editor's comments please also ensure that your revised manuscript contains the following sections as appropriate before the reference list:

• Ethics statement (if applicable)
If your study uses humans or animals please include details of the ethical approval received, including the name of the committee that granted approval. For human studies please also detail whether informed consent was obtained. For field studies on animals please include details of all permissions, licences and/or approvals granted to carry out the fieldwork.

• Data accessibility
It is a condition of publication that all supporting data are made available either as supplementary information or preferably in a suitable permanent repository. The data accessibility section should state where the article's supporting data can be accessed. This section should also include details, where possible of where to access other relevant research materials such as statistical tools, protocols, software etc can be accessed. If the data have been deposited in an external repository this section should list the database, accession number and link to the DOI for all data from the article that have been made publicly available. Data sets that have been deposited in an external repository and have a DOI should also be appropriately cited in the manuscript and included in the reference list.

If you wish to submit your supporting data or code to Dryad (http://datadryad.org/), or modify your current submission to dryad, please use the following link: http://datadryad.org/submit?journalID=RSOS&manu=RSOS-192115

• Competing interests
Please declare any financial or non-financial competing interests, or state that you have no competing interests.

• Authors’ contributions
All submissions, other than those with a single author, must include an Authors’ Contributions section which individually lists the specific contribution of each author. The list of Authors should meet all of the following criteria; 1) substantial contributions to conception and design, or acquisition of data, or analysis and interpretation of data; 2) drafting the article or revising it critically for important intellectual content; and 3) final approval of the version to be published.

All contributors who do not meet all of these criteria should be included in the acknowledgements.

We suggest the following format:
AB carried out the molecular lab work, participated in data analysis, carried out sequence alignments, participated in the design of the study and drafted the manuscript; CD carried out the statistical analyses; EF collected field data; GH conceived of the study, designed the study,
coordinated the study and helped draft the manuscript. All authors gave final approval for publication.

• Acknowledgements
Please acknowledge anyone who contributed to the study but did not meet the authorship criteria.

• Funding statement
Please list the source of funding for each author.

Once again, thank you for submitting your manuscript to Royal Society Open Science and I look forward to receiving your revision. If you have any questions at all, please do not hesitate to get in touch.

Best regards,
Lianne Parkhouse
Editorial Coordinator
Royal Society Open Science
openscience@royalsociety.org

on behalf of the Associate Editor, and Professor R. Kerry Rowe (Subject Editor)
openscience@royalsociety.org

Associate Editor's comments to the Author:

We would like you to revise the manuscript, paying close attention to the feedback from reviewers 2 and 3 in particular, as they provide useful suggestions. Please note that we will expect you to seek advice from a professional language editing service (https://royalsociety.org/journals/authors/benefits/language-editing/) before you submit the revised manuscript - if you do not do so, the manuscript will be returned to you. Please provide proof that you have done so (such as by uploading the language editing certificate within your revision). Furthermore, you should provide a full point-by-point response to the reviewers' comments, as well as a revised (and changes-tracked) version of the manuscript.

A final comment regarding reviewer 1's suggestions for the inclusion of additional references: you may certainly include some or all of the references if they add value to your manuscript; however, if they do not provide useful additional context or support for your work, you should strongly consider whether it is appropriate to include them, or whether it would be better to leave them out.

Reviewers' Comments to Author:

Reviewer: 1
Comments to the Author(s)

The paper is written about an important topic that required more and more works. The literature review of the paper is still weak. Major works are not reviewed by the author, for instance, the works done by other on cement interfacial strength model and measurements for instance Tabatabaei, M., A. Dahi Taleghani, N. Alem, 2020, Measurement of Mixed Mode Interfacial Strengths with Cementitious Materials, Engineering Fracture Mechanics, Volume 223, 106739, ISSN 0013-7944.

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Reviewer: 2
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1- A language polishing is recommended for this manuscript.
2- The authors should demonstrate reasons for data changes based on time, curing time, curing temperature and casing roughness.
3- The different factors considered in this manuscript should explain the operating conditions during well completions.

Reviewer: 3
Comments to the Author(s)

The manuscript reports useful data and methodology. I suggest major revision mainly because of the many writing issues in the manuscript. The writing is problematic and is not very careful. The authors need to ask for English writing experts to help refine their paper. There are still a lot of writing issues present in the manuscript.

Remaining major issues:

1) The writing is lacking relevant discussion on related studies. There are a number of papers dedicated to studying the bonding between cement and steel materials published in other journals such as cementing and construction materials, journal of petroleum science and engineering. When discussing the results, comparative analysis between the current findings and previous findings is highly recommended. This will make the novelty of current study clear to the readers.
2) There are not many scientific explanations on the results obtained. There are many figures not not much useful discussion on them. The authors should provide insights as regard to why this and that happen? What are underlying mechanisms? Otherwise, it carries little value to the readers if they want to exploit the research results.
3) Writing contains both logic and grammar issues. It is not quite consistent. Sometimes it is clear, but sometimes it is fuzzy.
4) Roughness effect: how is the roughness defined? The definition should be given.
Figure 10(a): it should be mentioned that this scheme is the temperature variation scheme used in the lab tests to mimic field conditions.

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- Table 2’s table headlines: the first letter should be capital.

Many other writing issues in other pages. Sorry I cannot do line to line check and write up the needed changes here due to my limited time on reviewing this manuscript...

The authors may want to get professional language help from colleagues or get some professional training on technical writing. It will be really helpful for their future paper writing...

Author’s Response to Decision Letter for (RSOS-192115.R0)

See Appendix A.

RSOS-192115.R1 (Revision)

Review form: Reviewer 1

Is the manuscript scientifically sound in its present form?
Yes
Are the interpretations and conclusions justified by the results?
No

Is the language acceptable?
Yes

Do you have any ethical concerns with this paper?
Yes

Have you any concerns about statistical analyses in this paper?
No

Recommendation?
Major revision is needed (please make suggestions in comments)

Comments to the Author(s)
The comments are provided in the above sections.

Review form: Reviewer 2

Is the manuscript scientifically sound in its present form?
Yes

Are the interpretations and conclusions justified by the results?
Yes

Is the language acceptable?
Yes

Do you have any ethical concerns with this paper?
No

Have you any concerns about statistical analyses in this paper?
No

Recommendation?
Accept as is

Comments to the Author(s)
This paper could be accepted.

Review form: Reviewer 3

Is the manuscript scientifically sound in its present form?
Yes

Are the interpretations and conclusions justified by the results?
Yes

Is the language acceptable?
Yes
Do you have any ethical concerns with this paper?  
No

Have you any concerns about statistical analyses in this paper?  
No

Recommendation?  
Accept as is

Comments to the Author(s)  
Finally, the authors have taken serious measures to improve their manuscript. Hopefully such revision process will be helpful for them to prepare new manuscripts in the future.

One last comment: the mathematical definition of roughness is still not given in the manuscript. They should show the equation. Reference should be provided to this definition.

Decision letter (RSOS-192115.R1)

31-Mar-2020

Dear Dr Yang,

It is a pleasure to accept your manuscript entitled "Experimental study of shear and hydraulic bonding strength between casing and cement under complex temperature and pressure conditions" in its current form for publication in Royal Society Open Science. The comments of the reviewer(s) who reviewed your manuscript are included at the foot of this letter.

Please ensure that you send to the editorial office an editable version of your accepted manuscript, and individual files for each figure and table included in your manuscript. You can send these in a zip folder if more convenient. Failure to provide these files may delay the processing of your proof. You may disregard this request if you have already provided these files to the editorial office.

You can expect to receive a proof of your article in the near future. Please contact the editorial office (openscience_proofs@royalsociety.org) and the production office (openscience@royalsociety.org) to let us know if you are likely to be away from e-mail contact -- if you are going to be away, please nominate a co-author (if available) to manage the proofing process, and ensure they are copied into your email to the journal.

Due to rapid publication and an extremely tight schedule, if comments are not received, your paper may experience a delay in publication.

Please see the Royal Society Publishing guidance on how you may share your accepted author manuscript at https://royalsociety.org/journals/ethics-policies/media-embargo/.

Thank you for your fine contribution. On behalf of the Editors of Royal Society Open Science, we look forward to your continued contributions to the Journal.

Kind regards,
Andrew Dunn
Royal Society Open Science Editorial Office
Royal Society Open Science
on behalf of Prof R. Kerry Rowe (Subject Editor)
openscience@royalsociety.org

Associate Editor Comments to Author:
Thank you for so positively responding to the majority of the reviewer's comments. Given the majority view is that the paper should be accepted for publication, we are glad to recommend acceptance.

Reviewer comments to Author:
Reviewer: 2
Comments to the Author(s)
This paper could be accepted.

Reviewer: 3
Comments to the Author(s)
Finally, the authors have taken serious measures to improve their manuscript. Hopefully such revision process will be helpful for them to prepare new manuscripts in the future.

One last comment: the mathematical definition of roughness is still not given in the manuscript. They should show the equation. Reference should be provided to this definition.

Reviewer: 1
Comments to the Author(s)
The comments are provided in the above sections.
Response to Referees

Reviewer: 1
Comments to the Author(s)
The paper is written about an important topic that required more and more works. The literature review of the paper is still weak. Major works are not reviewed by the author, for instance, the works done by other on cement interfacial strength model and measurements for instance Tabatabaei, M., A. Dahi Taleghani, N. Alem, 2020, Measurement of Mixed Mode Interfacial Strengths with Cementitious Materials, Engineering Fracture Mechanics, Volume 223, 106739, ISSN 0013-7944.
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It's better that authors report raw rheology data (graphs).
The authors should report the expansion of the steel and cement plug due to pressurization in the experiment as a benchmark. Also need to discuss the effect of pipe expansion to the high pressure.

Response: Thanks for the referee's suggestion. The additional references which referee mentioned was read by the author. The useful references has been supplemented in the paper.

Reviewer: 2
Comments to the Author(s)
Cement sheath integrity is important to the oil and gas well. Interfacial bonding strength between cement sheath and casing and cement sheath and formation are the basic datas to study the integrity of cement sheath. Different from the current studies, this work designs an special experimental device to measure the interfacial bonding strength between casing and cement sheath under complex temperature and pressure conditions in HTHP wells. Several factors are considered and some experimental datas are acquired which is useful to study the integrity of cement sheath. However, this paper needs some modifications to publish:
1- A language polishing is recommended for this manuscript.

Response: Thanks for the referee's suggestion. The paper has been polished by the professional language editing service.
2- The authors should demonstrate reasons for data changes based on time,
curing time, curing temperature and casing roughness.

**Response:** Thanks for the referee’s suggestion. The experimental data based on the conditions of curing time, curing temperature and casing roughness were explained and supplemented in the paper.

3- The different factors considered in this manuscript should explain the operating conditions during well completions.

**Response:** Thanks for the referee’s suggestion. Well completion engineering, consists of many processes as casing pressure test, well washing, perforation, staged fracturing, production test usually accompanies with variations of pressure and temperature in the well bore. Different operating process has the different conditions of temperature and pressure in the well bore. The paper has modified and explained the operating conditions during different well completion engineering.

Reviewer: 3

**Comments to the Author(s)**

The manuscript reports useful data and methodology. I suggest major revision mainly because of the many writing issues in the manuscript. The writing is problematic and is not very careful. The authors need to ask for English writing experts to help refine their paper. There are still a lot of writing issues present in the manuscript.

Remaining major issues:

1) The writing is lacking relevant discussion on related studies. There are a number of papers dedicated to studying the bonding between cement and steel materials published in other journals such as cementing and construction materials, journal of petroleum science and engineering. When discussing the results, comparative analysis between the current findings and previous findings is highly recommended. This will make the novelty of current study clear to the readers.

**Response:** Thanks for the referee’s suggestion. There are some findings aiming at this field. However, the previous findings conduct the experiments below 100°C which is different with the current work. Of course, the device can also measure the interfacial bonding between cement and steel under the conditions of previous studies. Influenced by different cement slurry system and steel, the results would not perfectly matched with the previous findings even at same temperature and pressure. The paper supplemented some experiments and compared with the previous studies.

2) There are not many scientific explanations on the results obtained. There are many figures not not much useful discussion on them. The authors should provide insights as regard to why this and that happen? What are underlying mechanisms? Otherwise, it carries little value to the readers if they want to exploit the research results.

**Response:** Thanks for the referee’s suggestion. The mechanisms to explain the
experimental results have been supplemented in the paper.
3) Writing contains both logic and grammar issues. It is not quite consistent. Sometimes it is clear, but sometimes it is fuzzy.
Response: Thanks for the referee’s suggestion. The paper has been modified and the paper has been polished by the professional language editing service.
4) Roughness effect: how is the roughness defined? The definition should be given.
Response: Thanks for the referee’s suggestion. The casing roughness is a parameter to measure the microcosmic error of geometrical shape on the casing surface. It has an important influence on the surface bonding between casing and cement sheath. And the definition has been supplemented in the paper.
5) Figure 10(a): it should be mentioned that this scheme is the temperature variation scheme used in the lab tests to mimic field conditions.
Response: Thanks for the referee’s suggestion. The inappropriate expression was modified in the paper.
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write up the needed changes here due to my limited time on reviewing this
manuscript...
The authors may want to get professional language help from colleagues or get
some professional training on technical writing. It will be really helpful for their
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