# Generalization of the expression of cementation radius in Contact Cement Theory and its application

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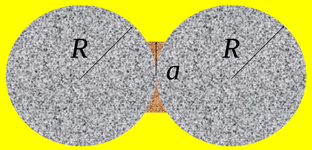
## Introduction

The expressions of cementation radius of Contact Cement Theory (CCT) proposed by Jack Dvorkin don't consider the effect of contact thickness, which makes it only applicable for the pore cemented loose sandstone. To solve this problem, the general expressions of cementation radius are proposed. With the general expressions, the effect of contact thickness on the acoustic velocity of loose sandstone is analyzed. The modified CCT with the general radius expressions is then validated using the man-made loose sandstone samples with basal cementation.

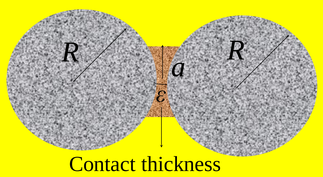
## Derivation of new cementation radius expressions

The original expressions assume the grains contact each other, so the expressions can only be used for the loose sandstone with the porous cementation, and can't be used for basal cementation. The new expressions consider the effect of the contact thickness on the radius, thus it makes CCT applicable for the loose sandstone with basal cementation. Note that the new expression for Geometry 2 is the same with the original one.

GEOMETRY 1

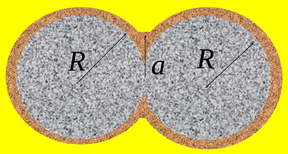



$$\alpha = \frac{a}{R} = 2\left[\frac{\phi_0 - \phi}{3n(1-\phi_0)}\right]^{0.25}$$

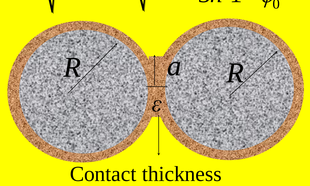



$$\alpha = \sqrt{-2\varepsilon + 2\sqrt{\varepsilon^2 + \frac{4}{3n}\frac{\phi_0 - \phi}{1-\phi_0}}}$$

GEOMETRY 2




$$\alpha = \frac{a}{R} = \left[\frac{2(\phi_0 - \phi)}{3(1-\phi_0)}\right]^{0.5}$$

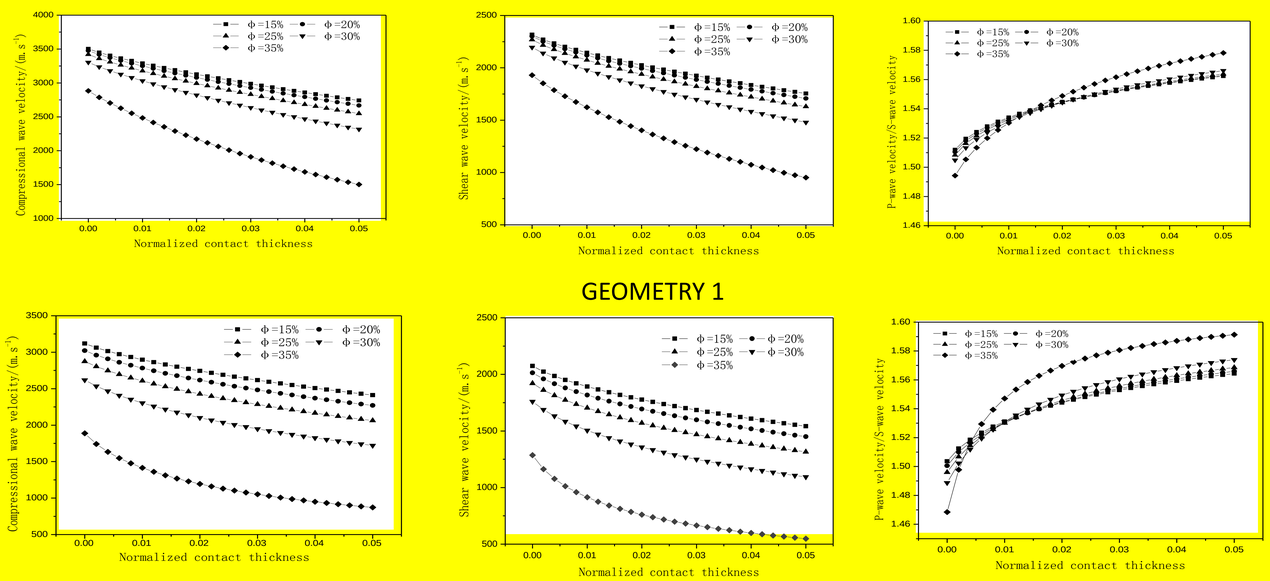



$$\alpha = \sqrt{\frac{2(\phi_0 - \phi)}{3(1-\phi_0)}}$$

Original cement radius expressions in CCT

New cement radius expressions for CCT

## The effect of contact thickness on the wave velocity of loose sandstone

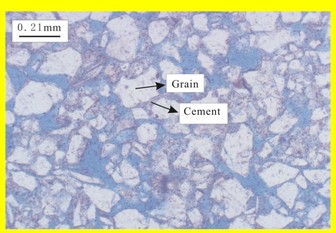



GEOMETRY 1

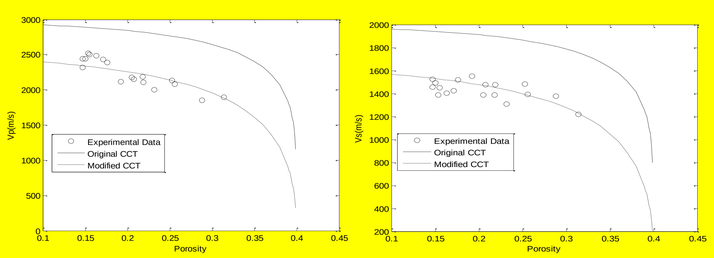
GEOMETRY 2

Conclusions : 1) *Vp* and *Vs* both decrease with the increment of contact thickness of cement under the two ways of cementation. 2) The contact thickness has more influence on the wave velocity of the sandstone under the larger porosity. 3) *Vp/Vs* increases with the increase of the contact thickness under the two ways of cementation. 4) When the contact thickness stays stable, the change law of *Vp/Vs* with the porosity is different under different contact thickness for two ways of cementation.

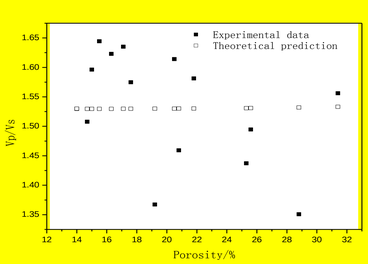
## Prediction of acoustic velocity of loose sandstone with basal cementation




Thin Section of man-made core samples, note that the grains don't contact each other , the contact thickness $\alpha$ is 0.03.




The original model overestimates the acoustic velocity of the loose sandstone, while the modified model takes the contact thickness into account ,which significant improves the accuracy of the prediction of acoustic velocity.




The measured *Vp/Vs* doesn't have obvious trend with the porosity, the predicted *Vp/Vs* by model is the mean value of the measured value.

## References

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