Paper

Thursday, 15 April 2021 3:11 PM

1. Introduction:

Main feature (our target) is the coherent vortex.
Previous work (DNS or lab experiments) mainly focus on low Re=10ˆ3 to 10ˆ4. Review the D
and key findings are….
Recent OWT work by us (acknowledge PIV using sand as seeding particles are not that gooc
that the behavior of coherent vortex at Re=10ˆ5 is similar to that at low Re. [A figure comp
and DNS, 2-by-1, showing 1 key phase of the deceleration stage:when the vortex is fullyd d

A Question underneath the similarity: both Re and roughness can affect flow separation (ci
flow over a cylinder), but why there is no difference? This paper focus on answering this qu
combining LES and OWT.

LES is the way to achieve high Re. review some work. Highlight that these studies haven't tr
Re=10^5. They also assume smooth ripples. To account for a rough surface, wall model is n
Why? What's the trade-off of using wall model. Details of turbulence are missed. But LES is
engineering application and aims at capturing the main feature of the flow. So it ok to do L
achieving our target.

OWT work on ripples: introduce the methodology. Review the work by Sleath, and then ou
work.

Our focus here is the coherent vortex. Outline..

2. Methodology

2.1. LES

Model description: introduce the LES model and wall model
Model set up: the mesh (resolution required? Between the size of coherent structures and
scale, so it is about 1 mm). Near wall mesh requirements? [Figure of mesh]

2.2. OWT tests

OWT, test conditions A85(Re=100k) and A85L (Re=50k). [Figure of OWT and photos of ripp

3. Validation of LES
   3.1. flat-bed oscillatory flow [Figure comparing velocity profiles]
   3.2. comparisons with DNS at Re=10ˆ4. [Figure comparing vortex] and [Figure compa

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3.3. Comparisons for our tests:
To facilicate the discussions, we first present: the LES and PIV results for 4 test condit
shown in two big figures: Two IG Figures: 4X8, PIV_smooth, PIV_rough, LES_smooth,
One for A85, One for A85_L. overall speaking the vortex is a bit over predicted.

In section 4 and 5, avoid showing results on vorticity. Comparison can be made in terms of length of 2D-reynolds averaged flow, TKE, or etc.

4. The effect of Re

Comparisons between Asim's DNS and our OWT A85_smooth. [A figure 3x(1 or 2, key
Column 1 is the work by Asim, column 2 is PIV, conlumn 3 is the LES, show swriling le
out that the separation of A85 is much less than that in DNS. Also, our LES gives a we
than DNS (but some difference from PIV is observed.

Comparisons of swilng length PIV A85 and A85L (half of Re), showing that A85L has r
separation?

Comparisons of LES at Re=10k, 100k, 400k. A figure comparing the phase at about 45
(when the vortex is at it's prime stage] Clearly show the effect of Re is captured by LE
to reduce separation.

(maybe better to show form drag coefficient, but you need to fisrst introductce form
maybe show a comparisons between simulated and 'measured' form drag.

Discuss why. Mabye compare the flow profiles on the lee side of the ripple at the pha
U_max. maybe higher Re gives less momentum deficit? (normalize the profile with U
above the ripple surface?). Maybe turbulence helps to mix momentum in the bounda
thus reduce momentum deficit and hinders separation? (comparison of TKE predictio

Re effect: turbulence helps to mix momentum. so stronger turbulence due to higher
the separated shear layer to better accelerate the flow below it and make it attached
development of primary vortex delayed until the free shear layer vanished, and a stro
near u=0 occurs. (maybe can we compared prediction at Re=10000, and 100000. sho
streamline of the free jet layer, and compare the tke in the lee side. This is quite clea
paper).

5. The effect of roughness

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LES_rough.

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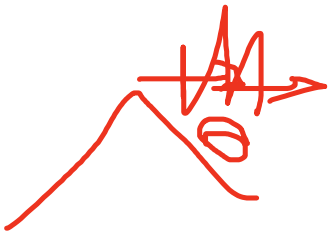
degree
ES, which is

drag, and



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Re allows
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r in Asim's

Discuss the BIG figure, say that roughness encourage separation. Comment: LES is ab
roughness effect.

Primary lee vortex is mainly developed during the deceleration stage. Since the begir
deceleration, the rough-wall case has more momentum deficit above the lee side, th
adverse pressure gradient to better develop the primary vortex. [A figure comparing
profiles at the lee side]

Comparison of form drag, which represents the effect of vortex? Rough cases have la
drag than smooth cases.

(A moveable bed case: LES vs SIN60). say that the roughness must be account for! Ot
separation. PIV vs LES_smooth VS LES_2.5d50 VS LES (HM2008 moveable bed roughr

6. Conclusion:
   Re suppresses separation
   Roughness enhances separation
   LES with wall model is ok. Some future adjustment of SGS or wall modeling can be do
   is not the focus of this paper. But one thing is clear, accounting for roughness is nece
   high-fidelity numerical model of vortex ripples at prototype scale.

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