STOKES

STOKES is our local High Performance Computing (HPC) resource. It provides computing capabilities for our students and researchers within the centre.

Hardware specifications:

- The cluster consists of:
  - 1 x head node
  - 8 x compute nodes
  - 1 x InfiniBand switch (MPI and storage traffic)
  - 1 x 1Gb Ethernet switch (provisioning and management traffic)
  - 1 x 100Mb Ethernet switch (IPMI traffic)

- The head node (“stokes00”) is comprised of:
  - 2 x Intel Xeon E5 2630v4 CPUs (each having 10 cores operating at 2.20GHz)
  - 128GB DDR4 RAM
  - 1 x Mellanox FDR10 40Gb/s Infiniband network adapter
  - 2 x 1Gb Ethernet ports
  - 1 x Dedicated BMC port for IPMI traffic
  - 1 x LSI MegaRAID
- The compute nodes (“stokes01”-”stokes08”) are comprised of:
  - 2 x Intel Xeon E5 2660v4 CPUs (each having 14 cores operating at 2.00GHz)
  - 128GB DDR4 RAM
  - 1 x Mellanox FDR10 40Gb/s Infiniband network adapter
  - 2 x 1Gb Ethernet ports
  - 1 x Dedicated BMC port for IPMI traffic
- Storage configuration
  - The head node includes the following hard drives for local storage:
  - 2 x 1TB HDDs (RAID1 mirror, containing the root filesystem and home directories)
  - 11 x 6TB HDDs (10-drive RAID6 array with 1 x dedicated spare, for /scratch storage)

Software on STOKES

- Management software: The cluster is configured with version 8.0 of Bright Cluster Manager and Red Hat Enterprise Linux. The SLURM scheduler is configured to allow for batch processing of jobs, and a standard set of libraries and compilers are provided.
- Available packages: CHAPSim, Abaqus, OpenFOAM

Get access to STOKES

External access to the cluster is possible via two methods:

- SSH from any IP address
- HTML from IP addresses within LJMU

Use STOKES

- Submit a batch job to SLURM: Users may submit jobs to the SLURM partitions using the command:

```
sbatch <input-file>
```

The contents of the job input file should include the necessary SLURM parameters for the job being requested, as well as the command which is to be run.

- Kill a SLURM job: Users may cancel their own running or queued jobs using the command:

```
scancel <job-id>
```

- Running an interactive job: An interactive session on a compute node may be launched via SLURM using the command:

```
srun --pty bash
```

The "srun" command accepts arguments matching the options used in a SLURM batch script – for example, to run an interactive job which allocates four nodes, use the command:

```
srun -N 4 --pty bash
```

Note that by default interactive sessions will be started with the time limit set to the maximum allowable wall-clock time of the selected partition. If no resources are available to meet the interactive job request, the user will be told that their job is "queued and waiting for resources"; once resources become available, the interactive session will be launched automatically. Once an interactive session is no longer needed, users should quit the session to free up resources using the command:

```
exit
```

STOKES's Community

References

HE, S. & SEDDIGHI, M. 2013. Turbulence in transient channel flow. *Journal of Fluid Mechanics,* 715**,** 60-102.

KIM, J. & MOIN, P. 1985. Application of a fractional-step method to incompressible Navier-Stokes equations. *Journal of Computational Physics,* 59**,** 308-323.

ORLANDI, P. 2001. *Fluid flow phenomena: a numerical toolkit*, Kluwer.

SEDDIGHI, M. 2011. *Study of turbulence and wall shear stress in unsteady flow over smooth and rough wall surfaces.* Ph.D thesis, University of Aberdeen.

Projects are being currently run on STOKES are as below:

1. Study of transient-transient turbulent flow over rough surfaces (Dr Mehdi Seddighi; Department of Maritime and Mechanical Engineering)

Direct numerical simulation is performed of a transient flow in a channel consisting of a rough bottom wall made of close-packed 3-D pyramid roughness and a smooth top wall. The unsteady flow started from an initially statistically steady turbulent flow with $Re = 2800$ and increased linearly, within a very short time, to a final Reynolds number ranging from $Re = 3500\ to\ 7400$. The corresponding equivalent sand roughness Reynolds for the initial and final flows are respectively $k_s^+ = 14.5$ and $k_s^+ = 16 - 41.5$. The research is looking into study unsteady flow behaviour in the transitionally-rough regime.

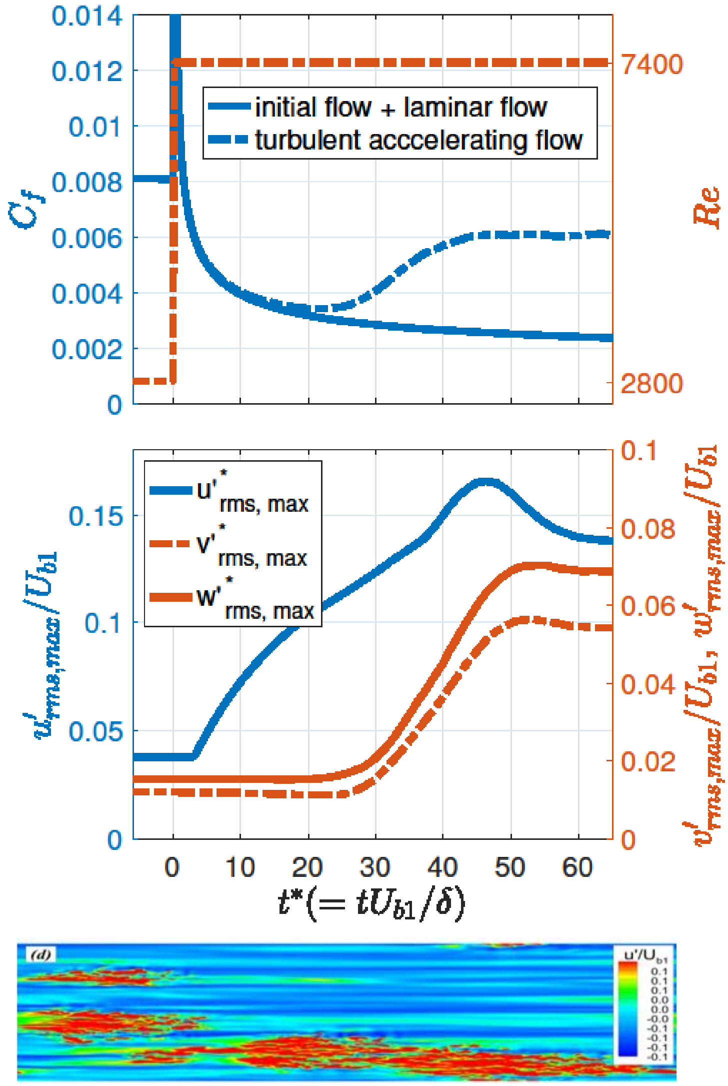

Figure 1. Turbulent-turbulent transient flow over smooth surface.

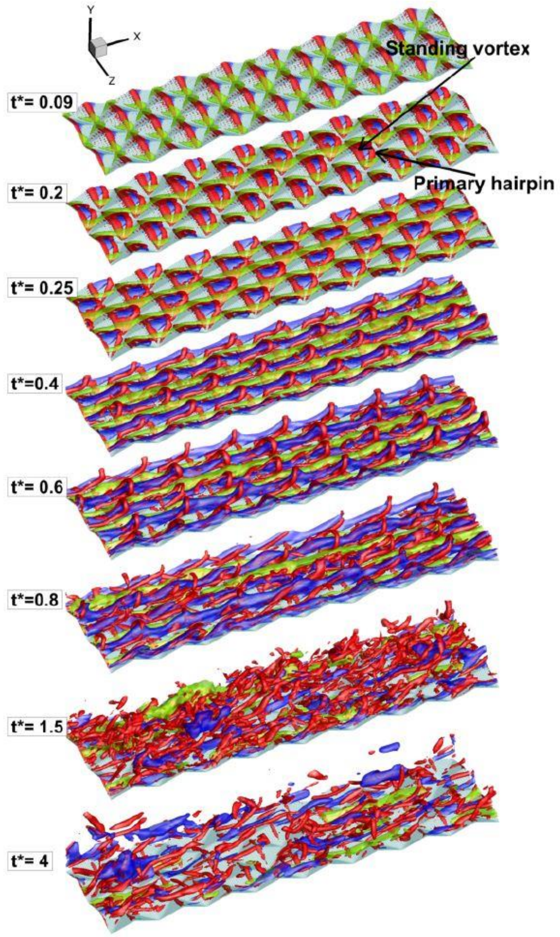

Figure 2. Turbulent-turbulent transient flow over rough surface.

2. Nonlinear Finite Element-Based Investigation of the Structural Performance of new sewer system (Mr Alaa Abbas, Department of Civil Engineering)

Substantial research is conducted on new design of sewer system using a novel manhole design and two flexible pipes buried in a single trench. The objective of the study is to determine the structural performance of the new manhole shape buried in the soil and the two buried flexible pipes positioned one over the other in a single trench. This new system is designed to solve the challenges associated with constructing separate sewer systems in narrow streets while providing additional space for other infrastructure services. The behaviours of the manhole and the two flexible pipes were tested using a 3D finite element (FE) model validated with experimental data from a laboratory investigation. A modified Drucker–Prager soil constitutive model was used to simulate the elasto-plastic soil behaviour. The results reveal that the structural performance for both; the new manhole design and the new configuration of pipes is improved. ABAQUS 2017 installed in the LJMU HPC was used to implement the model analyses, which was very helpful to speed up the progress of this research.

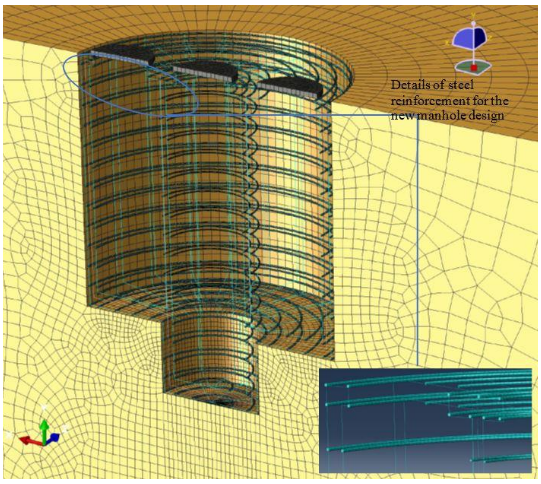

Figure 1. Details of steel reinforcement for new manhole design buried in the soil model.

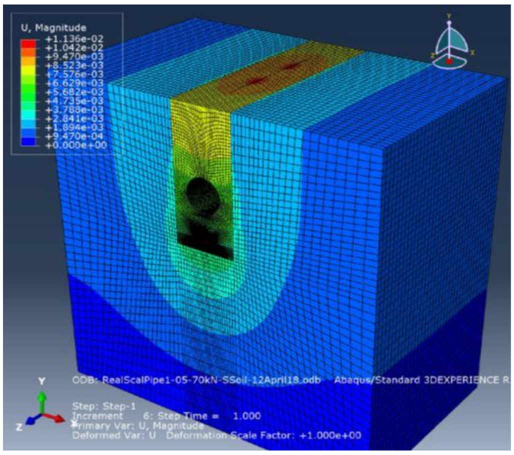

Figure 2. Visualization results for the FE samples of the real-scale model when two pipes lie in one trench under an applied H20 live load.

3. Effect of Mitigation measures on the catastrophic failure of storage tanks (Islem Megdiche, Department of civil engineering)

This study looks into studying the effect of using the mitigation measures to reduce the overtopping quantities incurred in case of catastrophic failure of storage tank. The effect of two incorporated mitigations measures are investigated: MOTIF (Mitigation of Tank Instantaneous Failures) and COAST (Catastrophic Overtopping Alleviation of Storage Tanks). The first one is a baffle added to the tank and the second one is a baffle fitted to the top of the bund wall that surrounds the storage tank. This problem was simulated using OpenFOAM 17.06 installed on Stokes Cluster. InterFoam solver was used to solve the multiphase flow problem. The results showed that COAST permits to significantly reduce the overtopping quantities.

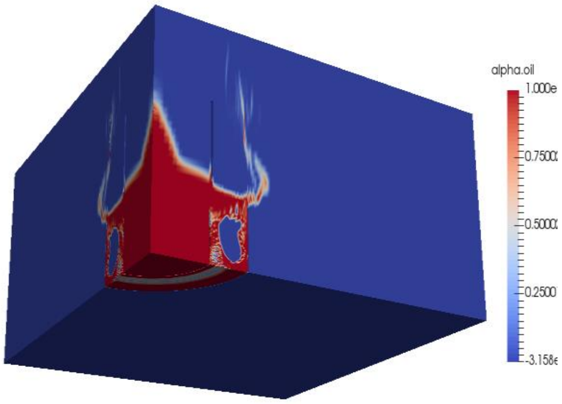

Figure1: The effect of using MOTIF on the flow structure

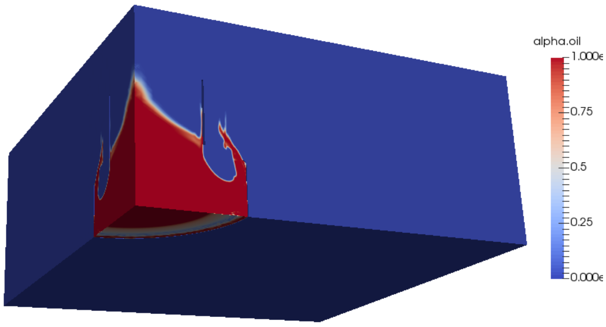

Figure2: The effect of using COAST on the flow structure