To evaluate numerically the vibration behaviour (stability and unbalance response) of rotor bearing foundation (RBF) systems such as turbomachinery which incorporate rotors running in several flexibly mounted hydrodynamic bearings, one needs input data parameters which adequately describe the bearings, the rotor, the foundation, the unbalance state and the system configuration state (the relative transverse alignment of the bearings). Adequate parameters for the last three are particularly hard to obtain for existing installations; and worldwide effort has been devoted to trying to identify these parameters, using field obtainable measurements of the instantaneous relative displacements between the rotor journals and their respective bearing housings. These measurements are then processed using Reynolds equation to determine the instantaneous bearing reaction forces acting on the rotor and foundation, which forces are then an essential ingredient of the desired parameter identification procedures [1]. The problem is in the accuracy to which one can reliably calculate these forces, even if it be assumed that Reynolds equation is otherwise a perfect model. This is felt to be particularly problematical because of the nonlinearity introduced into the RBF system by the hydrodynamic bearings.

The approach adopted here to assess the magnitude of this problem is to generate a typical periodic unbalance response orbit via an approximate solution to full Reynolds equation and use this solution as the ‘measured response’ for calculating the instantaneous bearing forces (using an accurate finite difference solution to the full Reynolds equation); and then comparing these with the actual instantaneous forces. Here, the so called modified short bearing approximation (MSBA) is used. It corresponds to the optimal solution to Reynolds equation if one assumes a parabolic pressure profile in the axial direction [2] and has been shown to be accurate for bearing aspect ratios as high as 1 even under dynamic loading conditions with eccentricity ratios even as high as 0.9 [3].
viscosity of 0.04 Pa s. The bearing housing mass is here sufficiently high to effectively ensure that its motion may be neglected, so one actually has a rigid housing. For this system, approximate (MSBA) transient solutions and transient solutions obtained using finite difference solutions to the full Reynolds equation yielded identical (indistinguishable to the naked eye) displacement and force orbits once steady state conditions had been reached. To help ensure accuracy, 6400 time steps per cycle were used for all solutions.

However, on utilising the displacement and velocity outputs from the MSBA solutions as measurement to recover the force orbits, there results significant error under certain situations. Typical results are shown in Figs 2 and 3 for rotor speeds of 750 rpm and 1500 rpm. It can be seen that at 750 rpm the recovered force orbit from the MSBA measurement data predicts a constant load of around 42 N and even some horizontal constant load. Agreement is somewhat better at 1500 rpm, when the displacement orbit eccentricities are smaller (and hence the MSBA orbit data is more accurate). On the other hand, the recovered force orbits using as measurement data the finite difference solutions generated displacement and velocity orbits coincide with the actual force orbits.

It is concluded that the accuracy of the bearing force data recovered from journal orbit measurement data via Reynolds equation may, depending on the journal eccentricity, be extremely sensitive to the accuracy of this measurement data. Hence, it is doubtful whether the bearing force accuracy needed for RBF system parameter identification is at all attainable if one uses Reynolds equation to calculate these bearing forces from measured journal orbit data.