8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

TOWARDS OPTIMIZING STENTS FOR CORONARY APPLICATION

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Key Words: *Stents, Optimisation, Exploration of Design Space, Stenosis, Restenosis,*

ABSTRACT

Stents seem to provide a new challenge in optmisation. In a coronary application they are used mainly to remedy Stenosis; a thickening of the blood vessel. But it is seen that in as many as 25% to 50% of the cases there is a reappearance of stenosis leading to what is called Restenosis [1]. Many times, it is felt that the stent design itself is the root cause of this [2]. This warrants a careful design or a design optimisation of stents. A review of literature reveals that there have been only limited attempts to optimize them. Very clearly, this optimization is multi-disciplinary in nature requiring inputs from fluid dynamics, structures and materials.

The author has started an investigation with the aim of optimizing the design of stents. As a first step, only two-dimensional coronary flows are considered. The flow reduces to that through a duct with a series of steps, called struts, placed along it. One has to optimize the width, thickness and spacing of these struts.

A review of literature shows that the recirculation of flow downstream of the stent and in the inter-strut region is the primary cause of restenosis [3]. Shear stress acting on the strut also seems to play an important role. In this work the vorticity generated due to the stent, the length of the recirculation region downstream of the stents and the attachment distance in between the struts are considered as the objective functions.

We employ “Exploration of Design Space” procedure to carry out the optimization [4]. First, the design variables and their limits are established, which in the present case are width, spacing and thickness of the struts. Employing the Latin Hypercube sampling, sixty representative cases are identified. By running the commercial software FLUENT, objective functions are computed for each of these sixty cases. This is followed by Kriging to establish the non-dominated solutions, which contain the optimized set of designs.

The present work includes stents of semicircular as well as rectangular cross section. Fig. 1 shows the non-dominated solutions for the rectangular geometry with vorticty and length of reattachment as the objectives. Several optimum designs were identified as a result and are shown in Fig.2. These consisted of stents with minimum vorticty, those with a minimum recirculation between the struts and the ones with a considerable attachment length between the struts. The presentation will describe the procedure in detail and discuss the results obtained.

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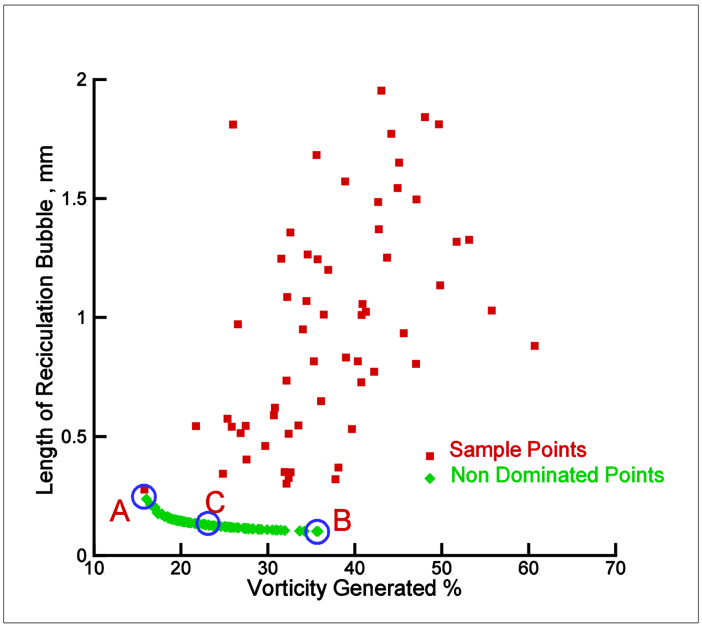

Figure1, Non-dominated designs for the stent of rectangular cross section.

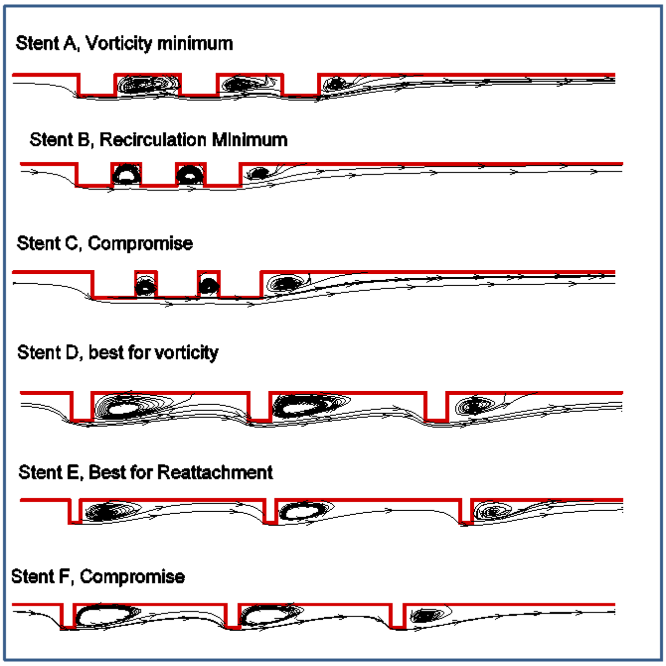

Figure 2, A selection of the optimised designs.