Summary

Introduction

Amsterdam Airport Schiphol (AAS) is important for the Dutch economy, but the airport has a great impact on the surroundings. Many complaints, concerning airplane noise from the Polderbaan, are from the residents of Hoofddorp. Under certain meteorological conditions, the residents of Hoofddorp experience a low frequency sound (around 31.5 Hz) when aircrafts take off. This sound is called ground noise (GN). The sound level increases with large aircrafts or aircrafts with an engine in the tail section. Those engines produce a sound level around 90 dB, during takeoff. This sound should be less than 80 dB to prevent an annoying sound for the residents of Hoofddorp (Wyle, 2006).

Requirements

The reduction of 10 dB is divided over two projects. The noise-reduction facility only has to reduce 7 dB. A sound barrier should be placed, as close as possible, to the source of the noise, at 75 meter. The barrier requirs a height of 14 meter and a length of 2 km. Some other requirements are: up in ten minutes, down within four minutes and the sound barrier must be able to change position around 1500 times each year. Other important requirements are the height restrictions in figure 1.

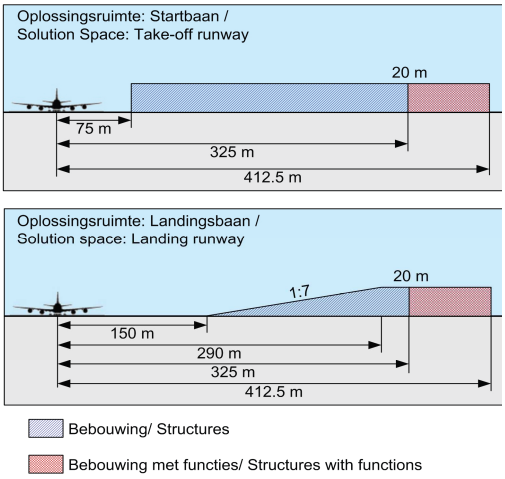

Figure 1: Space and height restrictions for take-off and landing (Programmaboek deel 2, 2008)

Concepts: Ecobarrier, the Canopy and the Silent Arcs

The design of Tione van Goethem, the Ecobarrier, won the contest organized by the Schiphol Group (SHG). The design is a long cloth, which will be standing up only when aircrafts take off. The cloth and the stiffeners will be made of glass fiber-reinforced polymers. For reflecting the sound, a cloth with a high mass will be necessary. Improvements on this concept led to three new and improved designs:

The Ecobarrier An improved version of the design contest.

The Canopy A concept based on the protecting canopy of a telescope installation.

The Silent Arcs The long glass fiber tubes are replaced by shorter tubes, which are preloaded with a steel cable. The two arcs are connected in a hinge point.

A multi criteria analysis leads to the best result of the three concepts. 'The Silent Arcs' achieves the best score, and is the winning concept.

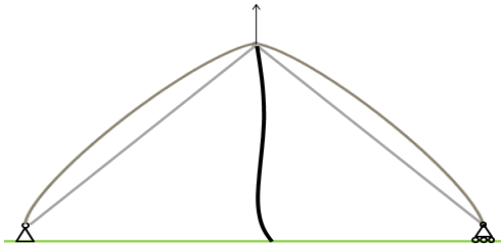

Figure 2: The concept of the Silent Arcs

Material research

There are three materials selected:

Cloth to reduce the sound	PVC coated polyester fabric is the best solution, because of the high strength and relative low cost.
Cloth to prevent disruption of the wind profile	A polymer filled with calcium carbonate, Phonisol RV, is the best choice, because the material is used a lot nearby radars.
The optimal material for the stiffeners	Three materials are compared on their material properties: GFRP, CFRP and aluminum. GFRP is the best material for the stiffeners, because of the radar friendly properties of the material.

Simulation

A simulation model is used to optimize the geometrie and mass of the stiffeners. Two small adjustment are done on the concept to reduce the mass of the structure. The first one was a small extension bar in de middle of the arc, to prevent buckling. The second adjustment is a spring to reduce the force require to set up the barrier.

Conclusions

The starting point of this research was the Ecobarrier, improvements on this concept led to a new and improved design.

Reducing the friction:

- A much lighter cloth is used, which only function is to guide the wind over the barrier.
- Substitute the crossed stiffeners by parallel stiffeners, to reduce the friction on the cloth.
- Preloading of the tubes just once and not every time the barrier is set up.

Lower energy usage

- Thirty-five percentage of mass reduction is the result of a more efficient place for the cloth that reduces the sound.
- A gas pressure spring leads to a set up force of 455 kN instead of 1421 kN.
- No energy is waste to bend the stiffeners repeatedly.

Lighter construction

- Longer crossed stiffeners means a higher mass, which requires a higher force to set up. Lighter shorter stiffeners, in combination with steel cables to resist wind of all directions, require a much lower set up force.
- The additional extension bar makes it possible to use smaller diameter stiffeners and even less stiffeners.