

Norsk PIANC @FMA 27.9.2007

Finnish Fairway Design

Esa Sirkiä, M.Sc. (Civ. Eng.)
Waterways Division



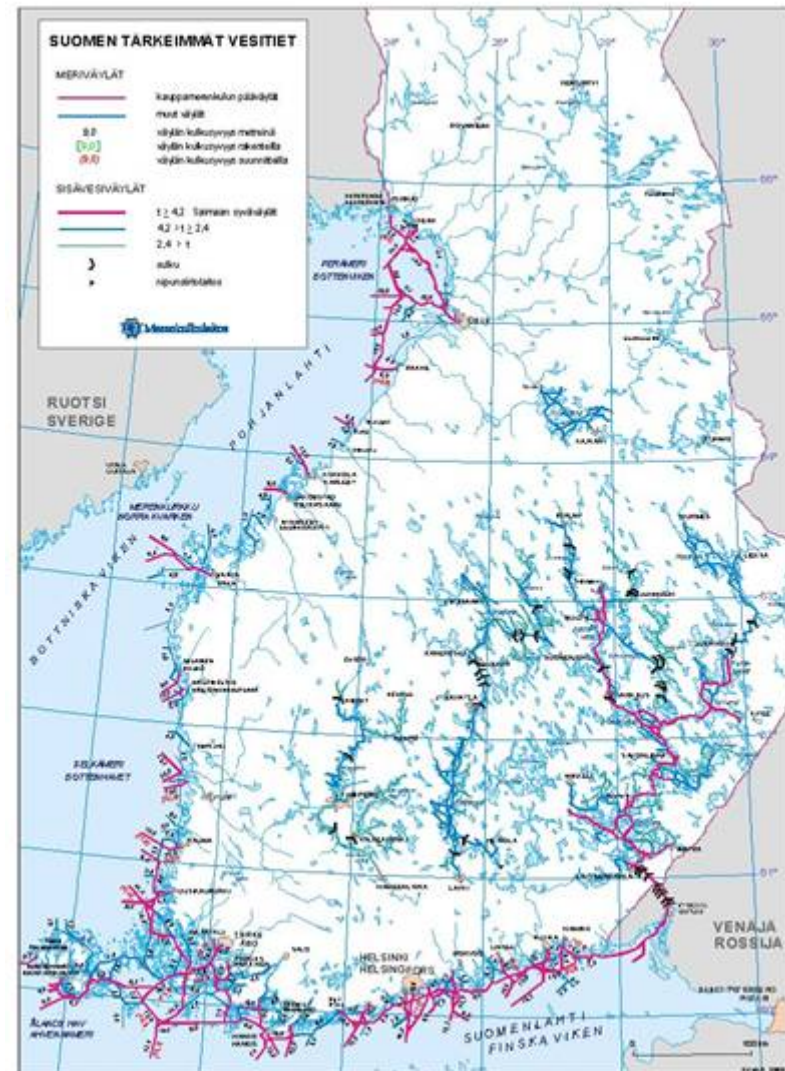
**Finnish Maritime
Administration**

Contents in Brief

- 1. Finnish fairway infrastructure and coastal environment, brief glance**
- 2. Introduction to the standard**
- 3. International guidelines in brief**
- 4. Vertical alignment design**
- 5. Horizontal alignment design**
- 6. Squat**
- 7. Width of the Fairway**
- 8. Aids to navigation**
- 9. The reality of the planning work**
- 10. Fairway program and project financing**

Finnish fairway infrastructure briefly

- There are over 9800 km of fairways on sea-area and about 7500 km of inland waterways
- 23 ports are open year-around (ice-breaking service in wintertime)
- There are in about 32 000 aids of navigation
- Over 90% of Finnish export and 70% of import trade is seaborne
- There are 39 lock canals in the inland waterway area



The Specialties of Finnish coastal environment

- **Wide archipelago induces long fairways, for example the Utö-Naantali 13,0 m fairway is 123 km from open sea to port**
- **There is bedrock existing almost everywhere so dredging is very hard and expensive**
- **Rocky bottom makes a ship grounding usually dangerous (v. sandbank grounding)**
- **The isostatic uplift causes aggradation in Gulf of Bothnia for about 1 cm per year, this causes growing need of rehabilitation of fairways**

Introduction to the design guideline

- Finnish fairway design guideline is based on PIANC (International Navigation Association) report PTC II-30 "*Approach Channels A Guide for Design*" issued in July 1997 and its earlier versions.
- Basically the Finnish guideline is simplified and localized version of the international guidelines
- Version of guideline in use today is published 2001 (*Laivaväylien suunnitteluohjeet*)
- The foundation of the Finnish standard is the "*design ship*" –concept.
- The standard is nowadays built in the design software (Novapoint Waterway since 2004)

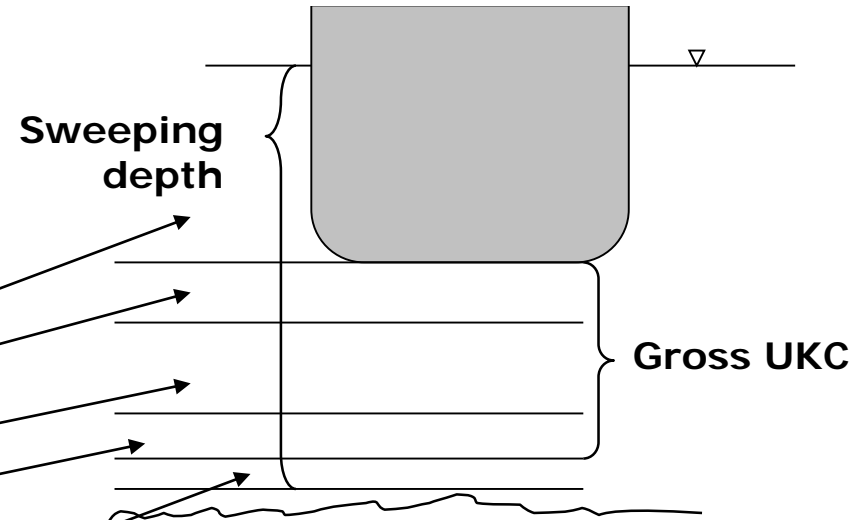
PIANC Guidelines of fairway design

- Valid standard today is published in 1997 (*“Approach Channels A Guide for Design”*) by Permanent Technical Committee 30 of PIANC
- The *“Approach Channels A Guide for Design”* was second publication of same committee, the previous was *“Approach Channels, Preliminary Guidelines”* in 1995
- The Guidelines will be renovated in near future
- For the renovation work PIANC established Maritime Committee Working Group 49 *“Vertical and Horizontal Dimensions of Fairways”* in January 2005
- First meeting was hold in Madrid in July '05
- Official kick-off-meeting took place in the PIANC Headquarters in Brussels September
- WG49 report will hopefully be published before 9/2007
- Representing the FMA in WG49 are Mr. Hartikainen and myself

Vertical alignment design; the concept

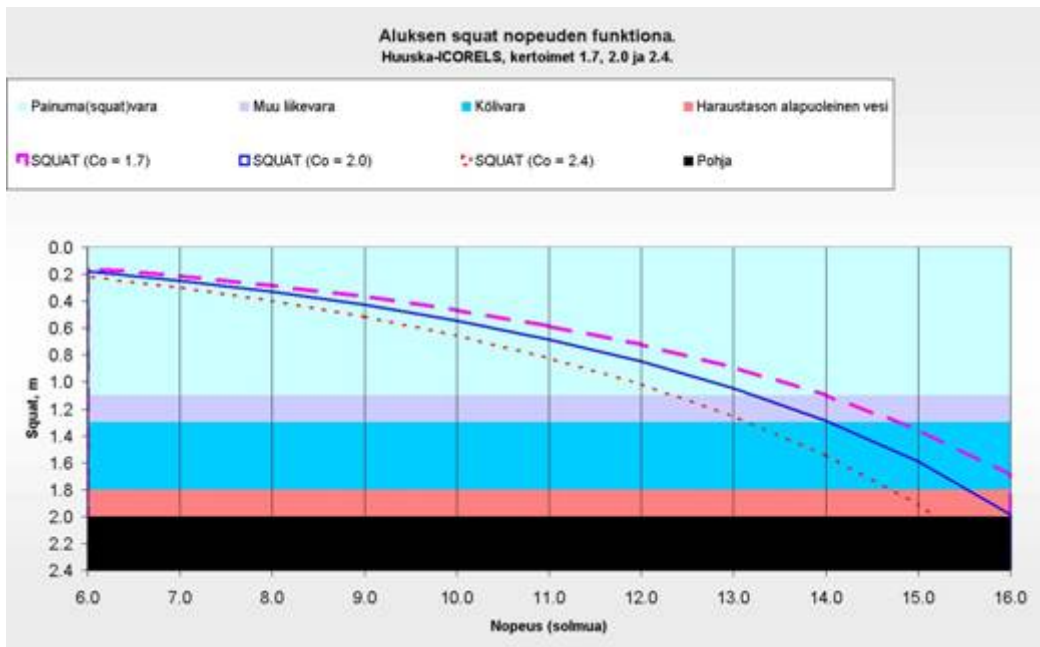
- The vertical alignment is proposed to be used in parts
- UKC = Under Keel Clearance
- Each part is designed individually
- Parts are

- Draught of design ship
- Movements due swell
- Movements due SQUAT
- Net UKC
- Possible allowance due uplift or sedimentation



- The sweeping depth is defined as sum of these parts

Vertical alignment design; Squat



- The Finnish design standard has two ways of calculating the Squat (vertical ship body movements due to the speed)
- Ways are used in different kind of cross sections
- The Huuska-ICORELS is used in "free water" cross section
- The Guliev method is used in partly excavated or canal cross sections
- Both methods are available in Microsoft Excel sheets (Huuska method sheet is available on web too; http://www.fma.fi/e/functions/fairways/Squat_netiversio1_eng2.xls)

Horizontal alignment design

- Basic principle is to design as straight alignment as possible (i.e. fewer turns, longer straight parts)
- Building costs (i.e. amount of dredging) is always limiting the alignment optimization
- The design is based on the length of the design ship, l
- Limiting values are the minimum radius of a curve in alignment and the minimum length of a straight line alignment between two curves
- If the turning angle is over 30° then the minimum radius is $5 \cdot l$
- When turning angle is $0-30^\circ$, the radius may vary between $5-10 \cdot l$
- The minimum length of a straight line alignment is always $5 \cdot l$ (in slow speeds, say 5 kn, the $3 \cdot l$ is possible)

The width of the waterway

- **The minimum width of the fairway is calculated as multiple widths of the design ship**
- **Single lane width is basically**
 $B = b_n + 2b_l$ where
 b_n is width of the manoeuvring lane
 b_l is the slope clearance
- **The minimum width depends of design ship, circumstances and environmental factors**
- **Typical single lane fairway widths vary from 2,6b to 5,0b (when b is the width of the design ship)**
- **With two lane fairway the width may be from 7,0b up to 10b**
- **Finnish fairways are mainly single lane with special encounter and swinging areas**

Factors of the single lane fairway width

Width of the design ship		1,0b
Unintentional act of yawing	Very high dredging costs	0,2b
	High dredging costs	0,5b
Drift	Ideal circumstances $\Phi=0^\circ$	0,0b
	Average circumstances $\Phi=5^\circ$	0,5b
	Hard circumstances $\Phi=10^\circ$	1,0b
	Extremely hard circ. $\Phi=15^\circ$	1,5b
Bottom ($t < 1,5d$)	Smooth and soft	0,1b
	Hard and rough	0,2b
UKC	Water depth 1,15-1,5d	0,2b
	Water depth $< 1,15d$	0,4b
Positioning and Aids to Navigation	Very good	0,0b
	Good	0,1b
Hazardous cargo	No hazardous cargo	0,0b
	Oil, crude	0,4b
	Gasoline, LPG, LNG, chemicals	0,8b
Slope allowance, b_1 (multiplied by 2)	$v < 10kn$	0,5b
	$v = 10-16kn$	0,5...1,0b

Fairway markings and aids-to-navigation

- **There are no strict rules how to locate the aids-to-navigation, only recommendations**
- **Every fairway is individual case and the marking depends on several local circumstances**
- **Aids-to-navigation used are both floating (ice- and spar buoys) and fixed (leading marks, edge marks, radar and other beacons, sector lights and lighthouses)**
- **Finnish specialty is that leading marks and leading lights are used very widely**
- **There is also VTS-service available on Finnish coast by FMA**

Quantity of the aids-to-navigation in Finnish fairways

AtN type	FMA	Other	
Lighthouses	48	-	
Sector lights	405	37	
Minor lights	190	33	
Edge marks	193	1	
Radar beacons	64	-	
Leading marks and lights	4775	830	
Beacon towers	34	6	
Cairns	2212	240	
Buoys	846	227	
Spar buoys	16270	5819	
Other marks	32	52	
Total	25238	7258	32496

The work itself

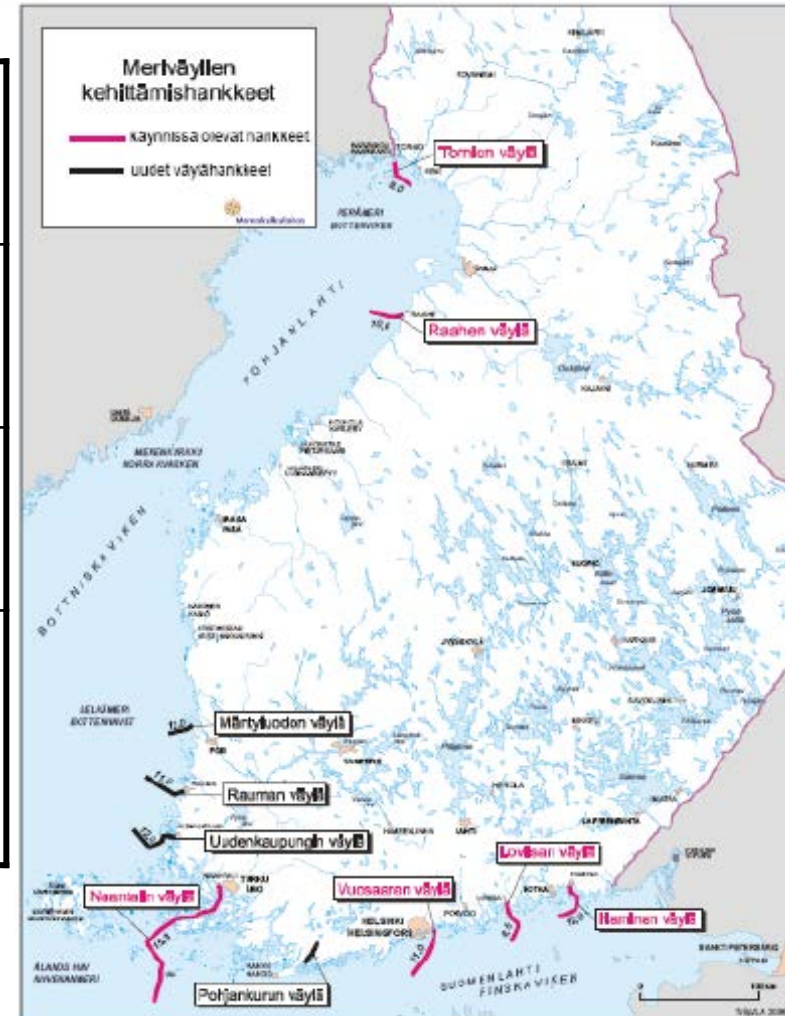
- **Normally there is “Fairway program” for medium timeline (10 years) strategic planning**
 - The program is prepared by FMA and approved by Ministry of Transport and Communications
 - This program includes ~10 fairway projects that are cost effective
 - There is at least preliminary plan for every one of these projects
 - New program is made in every five years
- **All major fairways in Finland were built in 70’s and 80’s**
- **Almost everything designed after 1990’s has been either rehabilitation or deepening of existing fairways**
- **First new major port (and fairway too) in decades is the Vuosaari port facility in eastern Helsinki**
 - Vuosaari is in construction stage (2003-2008/9)
 - It’ll be the largest port in Finland when in use
- **Usually the deepening is required for larger vessels and is around 1-1,5 m in sweeping depth**
- **Dredging volume in typical deepening project is from 100 000 m³ up to 1 500 000 m³ and the project may take one to three summers to carry through**

Fairway Program 2007-2016

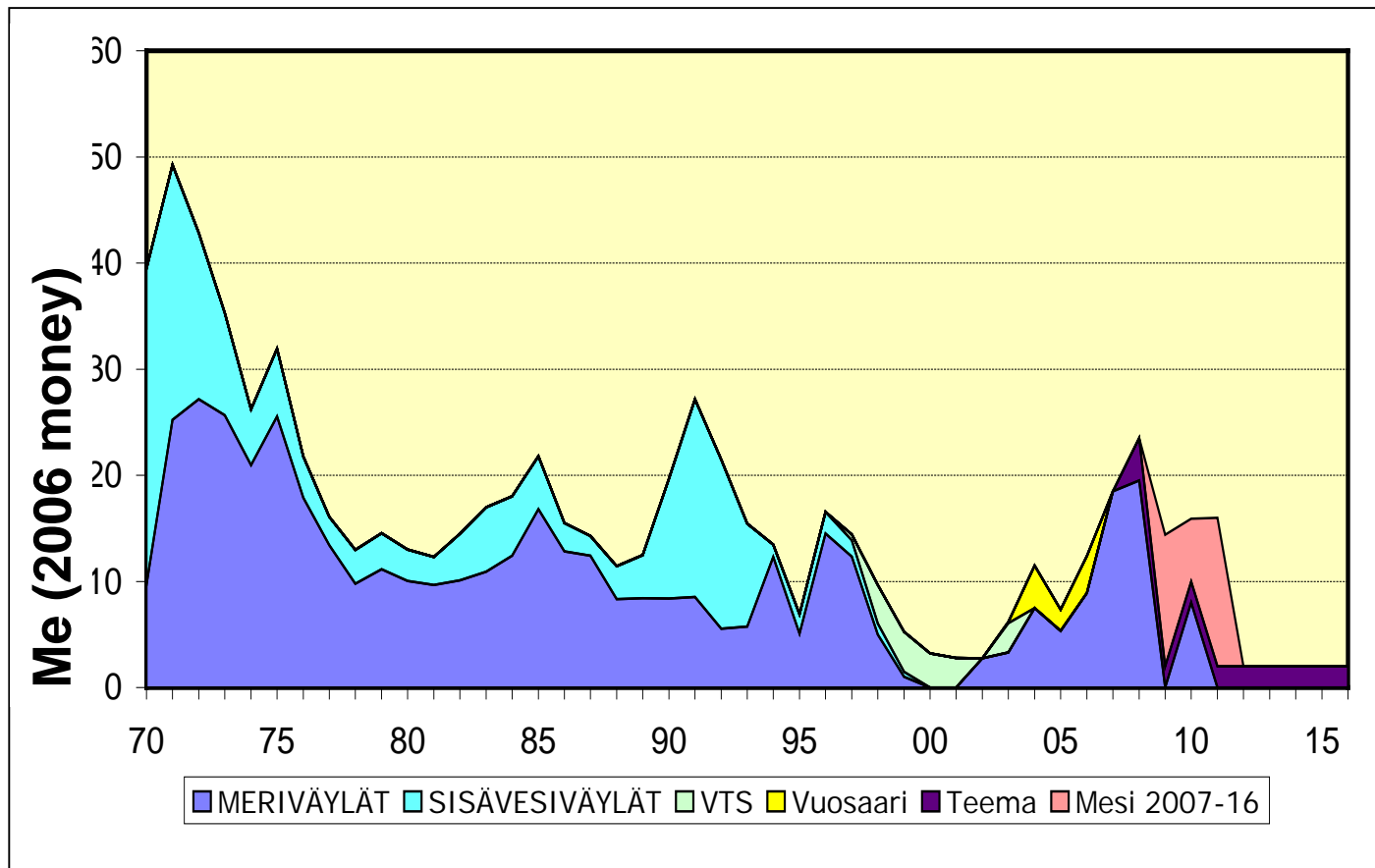
- The latest Fairway Program (Mesi –in Finnish) was done in 2006 and introduced in early 2007
- There were over 45 proposals for new fairway investment objects
- The cost-effectiveness of 12 projects was researched (incl. preliminary planning)
- The first one recommended investment was a theme-project called *Securing the service standard and safety on fairways*
- There were 4 other profitable projects (all deepening of existing fairways)
- Situation is still alive, 2-3 new profitable deepening projects has aroused because of Russian extra dues of wood
- The financing of projects is still open; in State budget 2008 there were no new fairway projects

Fairway program 2007-16 projects

Uusikaupunki Fairway 10,0 m → 12,5 m	545 000 m ³ Bedrock 81 000 m ³	7,6 Me
Pohjankuru Fairway 4,9 m → 6,0 m	350 000 m ³ mud, sludge	2,95 Me
Pori Mäntyluoto Fairway 10,0 m → 12,0 m	1 100 000 m ³ Sand	9,2 Me
Rauma Fairway 10,0 → 11,0 m	500 000 m ³ (950 000 m ²) Bedrock 113 000 m ²	16,9 Me



Investments on fairways since 1970 and new fairway program



The latest new potential fairway investment objects are not included in figure.

In late years the investments have been around 5-15 Me annually





Tusen takk!

Questions? Do not hesitate to ask:

esa.srkia@fma.fi