

Austenitic Manganese Steel (AMS): Crossings



Explosions Depth Hardened (EDH)

Alfred Wöhhart

Mn-13-Herze

Leoben, November 14th, 2006

Alfred Wöhhart Netztechnik

Contents:

- 1) My responsibilities
- 2) Data about ÖBB
 - 2.1) Organization
 - 2.2) Infrastructure technical data
- 3) Crossings of AMS

Mn-13-Herze

Leoben, November 14th, 2006

Alfred Wöhhart Netztechnik

My responsibilities:

- Welding of rails and crossings (aluminothermic, resurfacing with electric arc welding, flash butt welding)
- Non destroying testing of rails (ultrasonic testing)
- Insulating joints
- Grinding of rails
- Rail buffers
- Education
- Head of a permanent group of writing and correcting regulations of ÖBB

Mn-13-Herze

Leoben, November 14th, 2006

Alfred Wöhhart Netztechnik

Railway Map Europe

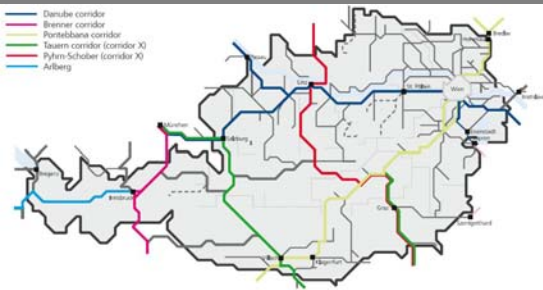


Mn-13-Herze

Leoben, November 14th, 2006

Alfred Wohnhart Netztechnik

Railway Map Austria

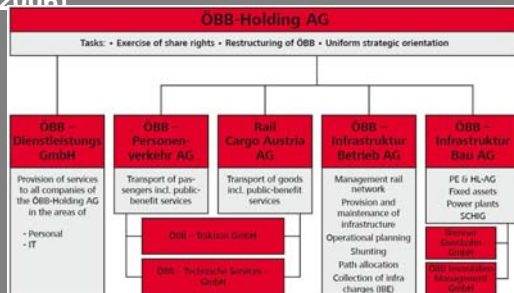


Mn-13-Herze

Leoben, November 14th, 2006

Alfred Wohnhart Netztechnik

ÖBB-Holding AG (Jan. 2005 – Dec. 2006)



Mn-13-Herze

Leoben, November 14th, 2006

Alfred Wohnhart Netztechnik

Network of ÖBB

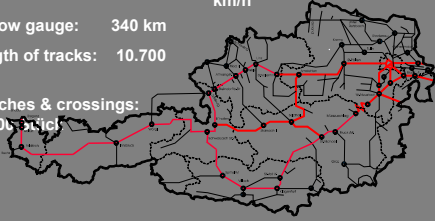
Length of network: 5.800
km

Maximum velocity: 200
km/h

Narrow gauge: 340 km

Length of tracks: 10.700
km

Switches & crossings:
16.300



Infrastructure in Figures (1)

- 11,000 km of track, of which 7,900 electrified
- 17,000 switches, of which 11,000 with remote control
- 53,200 signals, of which 30,100 light signals with 102,200 light spots
- 800 signal boxes, of which 130 electronic
- 6,000 bridges and viaducts

Infrastructure in Figures (2)

- 6,000 railway crossings
- 260 tunnels and galleries
- 2,000 km of traction supply lines
- 15,500 km telecom cables, of which 4,000 km fibre optics
- 31,000 data connections
- 28,000 telephone installations
- 1,400 stations and stops
- 150 shunting yards

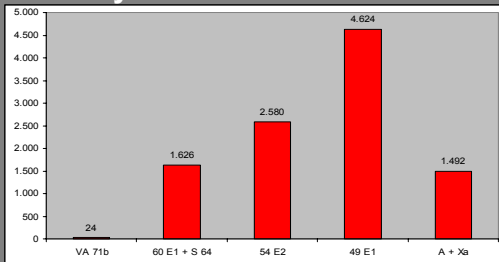
Infrastructure in Details (1)

- **Incline on main lines:**
 - ▶ 32 ‰ Arlberg
 - ▶ 30 ‰ Tauern
 - ▶ 29 ‰ Brenner
 - ▶ 27 ‰ Semmering (radius = 168 m, track distance = 3.60 m)
- **Incline on secondary lines:**
 - ▶ 49 ‰ Linz – Aigen/Schlägl
 - ▶ 46 ‰ Wr. Neustadt – Puchberg
 - ▶ 38 ‰ Martinswand
 - ▶ 30 ‰ Friedberg – Fehring (radius = 112 m)

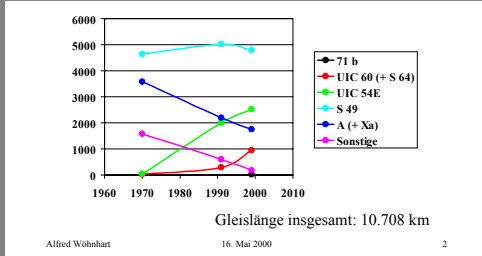
Standardized Track Load (to optimize LCC: A Research with TU Graz)

Norm-km	Gleisbelastung > Brt/Tag/Gleis
Westbahn	70.000
Südbahn	40.000 – 70.000
Nordbahn	15.000 – 40.000
Ennstalbahn (R = 400 m)	15.000 – 40.000 (eingleisig)
Ausseerbahn (R = 300 m)	8.000 (eingleisig)

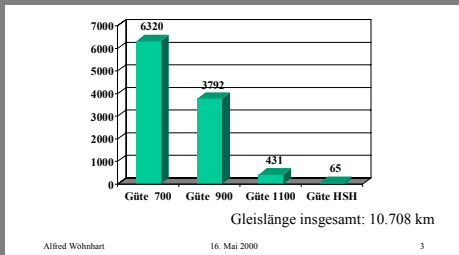
Railprofiles in the Network of ÖBB: Summary 10.346 km of Track



Railprofiles in the Network of ÖBB: „Tendencies“



Rail Grades in the Network of ÖBB:



Used Grades of Rail

grade	track length	notice
R 200	5500	we built in only used rails from this grade
R 260	4300	standard type
R 320 Cr	300	we built in only used rails from this grade
R 350 HT	400	standard type

Rail Profiles in the Network of ÖBB at the Year 2000 (km of Track):

Form	Länge	Form	Länge	Form	Länge
NP 46	3.348	Ia	738	UIC 60	926.845
48, 3 ung.	6.801	II	13	VA 71b	14.831
6 Pr	9.266	III Steg	10.545	Va NWb	6.708
6d	9.008	IV bh	16.542	VIII bayr.	19
75 R	4.732	IX bayr.	690	X bayr.	12.569
8 Pr	6.475	J ung.	4.105	X Sb	22.382
90 R	450	LP	6.718	X u. X Bb	16.314
A	1.183.804	M	8.961	Xa	561.499
B	4.786.291	NP 38	2.419	XI	1.021
UIC 54 E	2.514.509	Ri 37A	144	XI Sb	2.484
C Nb	4.433	S 33	258	XXIVa	171.348
C ung.	21	S 41	114.881	XXX	988
D Nb	4.725	S 45	2.724	sonstige	7.342
EWA	512	S 49	144.612		
i ung.	21	S 64	16.425	Summe	10.171.285

Mn-13-Herze

Leoben, November 14th. 2006

Alfred Wöhhart Netztechnik



Crossings of AMS

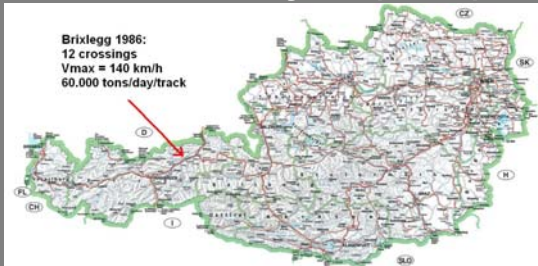
Mn-13-Herze

Leoben, November 14th. 2006

Alfred Wöhhart Netztechnik

Test Track in Tyrol (1985)

Brixlegg 1985:
12 crossings
Vmax = 140 km/h
60.000 tons/day/track



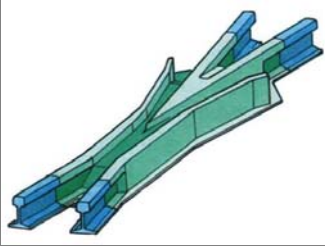
Mn-13-Herze

Leoben, November 14th. 2006

Alfred Wöhhart Netztechnik

Cast Manganese Crossings are used for high Speeds (1)

Type
Centro
Mn 13:
about
95 %



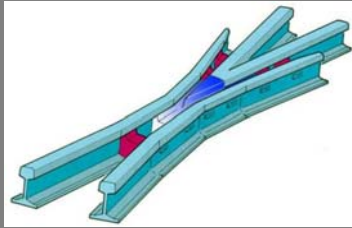
Mn-13-Herze

Leoben, November 14th, 2006

Alfred Wöhrhart Netztechnik

Cast Manganese Crossings are used for high Speeds (2)

Type
Compound
dMn 13:
about 5 %
(for long
crossings)



Mn-13-Herze

Leoben, November 14th, 2006

Alfred Wöhrhart Netztechnik

One Example:



Mn-13-Herze

Leoben, November 14th, 2006

Alfred Wöhrhart Netztechnik

Materials: AMS Austenitic Manganese Steel

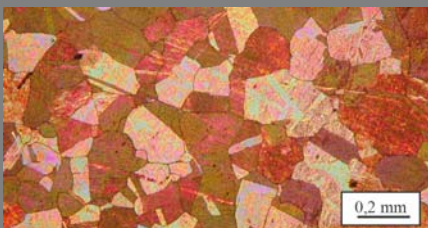
- G-X 120 Mn 12 (Cast) according to EN 10027
- Chemical Composition according to UIC 866 O:

	% C	% Si	% Mn	% P	% S
AMS	0.95 – 1.30	< 0.65	11.5 – 14.0	< 0.04	< 0.03

Properties of Austenitic Manganese Steel

- Not magnetic
- Very tough, rather soft
- Not very good to test it with
Ultrasonic Methods because it is
austenitic!

Structure of Austenitic Manganese Steel



Sign of Austenitic Manganese Steel: Raised casted figures



Mn-13-Herze

Leoben, November 14th. 2006

Alfred Wöhhart Netztechnik

Sign of Austenitic Manganese Steel: Stainless Steel



Mn-13-Herze

Leoben, November 14th. 2006

Alfred Wöhhart Netztechnik

Sign of Austenitic Manganese Steel: Plate with „EDH“



Mn-13-Herze

Leoben, November 14th. 2006

Alfred Wöhhart Netztechnik

Sign of Austenitic Manganese Steel: Raised casted figures with „EDH“

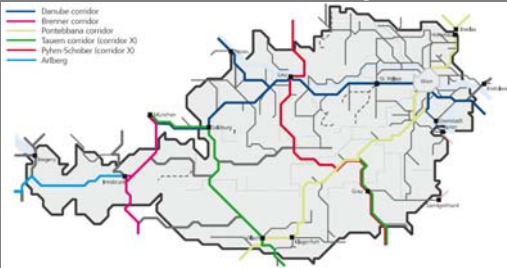


Mn-13-Herze

Leoben, November 14th. 2006

Alfred Wohnhart Netztechnik

First Crossing Type AMS in the Track: 1988 Pöchlarn not yet EDH!



Mn-13-Herze

Leoben, November 14th. 2006

Alfred Wohnhart Netztechnik

Already one Year later (1989) with EDH (done on the Erzberg)



Mn-13-Herze

Leoben, November 14th. 2006

Alfred Wohnhart Netztechnik

Process with EDH (done on the Erzberg): Before the Explosion



Mn-13-Herze

Leoben, November 14th, 2006

Alfred Wöhhart Netztechnik

Process with EDH (done on the Erzberg): During the Explosion



Mn-13-Herze

Leoben, November 14th, 2006

Alfred Wöhhart Netztechnik

Process with EDH (done on the Erzberg): After the Explosion



Mn-13-Herze

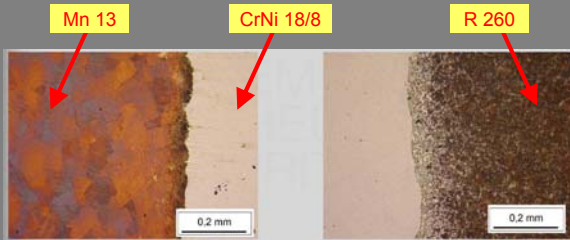
Leoben, November 14th, 2006

Alfred Wöhhart Netztechnik

Flash Butt Welding of the Intermediate Piece

- Patent from VAEE Zeltweg (1979)
- Special type of flash butt welding
- Stainless („Inox“)
- Cr/Ni steel type 18/8
- Stabilized with Ti or Niob
- Hardness 230 HB

Structure of 3 Materials: Mn 13 – CrNi 18/8 – R 260



Number of AMS Crossings in the Network of ÖBB

- Rail profil 60 E1: about 2500 pieces
- Rail profil 54 E2: about 500 pieces

Geometrical forms of AMS Crossings in the Network of ÖBB

Basic geometrical form of crossings	rail type: 54 E2	rail type: 60 E1
200-1:5	since 2002	not used
200-1:7		not used
1:9		1998
300-1:9		1989
500-1:12		1988
1:14		1989
1200-1:18,5		1988
1:18,5		1988
1:24		1990
2600/1600-1:24	not used	1993

Maximum Speed to the Junction

Radius	Max. speed
190	40
300	50
500	60
760	80
1200	100
2600/1600	120

Welding of AMS Crossings (Hearts)

- 1) To the rail: Aluminothermic as usual (rail grade R 260 from the end of the crossing and connecting rail, e.g. R 350 HT)**
- 2) Repair weld: Electric arc welding**

Repair Welding of AMS Crossings

- Absolute diverent process to other steels of crossings
- It is often not necessary to weld at all
- It is often necessary to weld very later than usual types of 51 CrV 4 material

Maintenance of AMS Crossings

- Burring and
- Tamping
- (rather seldom) resurfacing by electric arc welding

Details of Repair Welding by Electric Arc of AMS Crossings Generally (1):

- Max. heat: 200 °C (welding and grinding tool!)
- Cooling with water, ice or air
- welding in a pool of surrounding water
- No cutting with gaz and oxygen!
- No preheating of the base metal

Details of Repair Welding by Electric Arc of AMS Crossings Generally (2):

- Minimum of Amperes
- Hammering of each layer
(for hardening and expanding of the
welding material)
- Grinding as cold as possible
- Special grinding discs (needs half of
time and less consumption of discs!)

Details of Repair Welding by Electric Arc of AMS Crossings Electrodes for Resurfacing:

- Böhler Fox BMC
- Örlikon Citomangan

- max. 4 mm!

Details of Repair Welding by Electric Arc of AMS Crossings Electrodes for Cracks:

- Böhler Fox A 7
- Örlikon Citocromax

- If necessary use a weld pool backing
(fore deep cracks reaching the
bottom
of the material)

Details of Repair Welding by Electric Arc of AMS Crossings Cracks between AMS and CrNi 18/8:

- Only at the beginning of AMS-hearts!
(perhaps 5 pieces from 3000 at all!
- Böhler Fox A 7
- Örlikon Citocromax N
- Head of rail with BMC or Citomangan
- Max. 200 °C

Details of Repair Welding by Electric Arc of AMS Crossings Cracks between CrNi 18/8 and R260:

- Only at the beginning of AMS-hearts!
(perhaps 5 pieces from 3000 at all!
- Cooling of AMS (max. 200 °C) and
- Preheating of R 260 (350 °C)
- Fox A 7 or Citocromax N
- Head of rail with BMC or Citomangan

Pictures of Repair Welding