



The Institute of Rock Structure and Mechanics of Academy of Sciences of the Czech Republic, v.v.i

# Utilization of biomass ashes

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# Burning of biomass

## Biomass sources

Wood chips

Sawdust

Bark

Fast increasing wood species

Straw

Rice husk

## Burning technology

Fluid boilers

Grate boilers

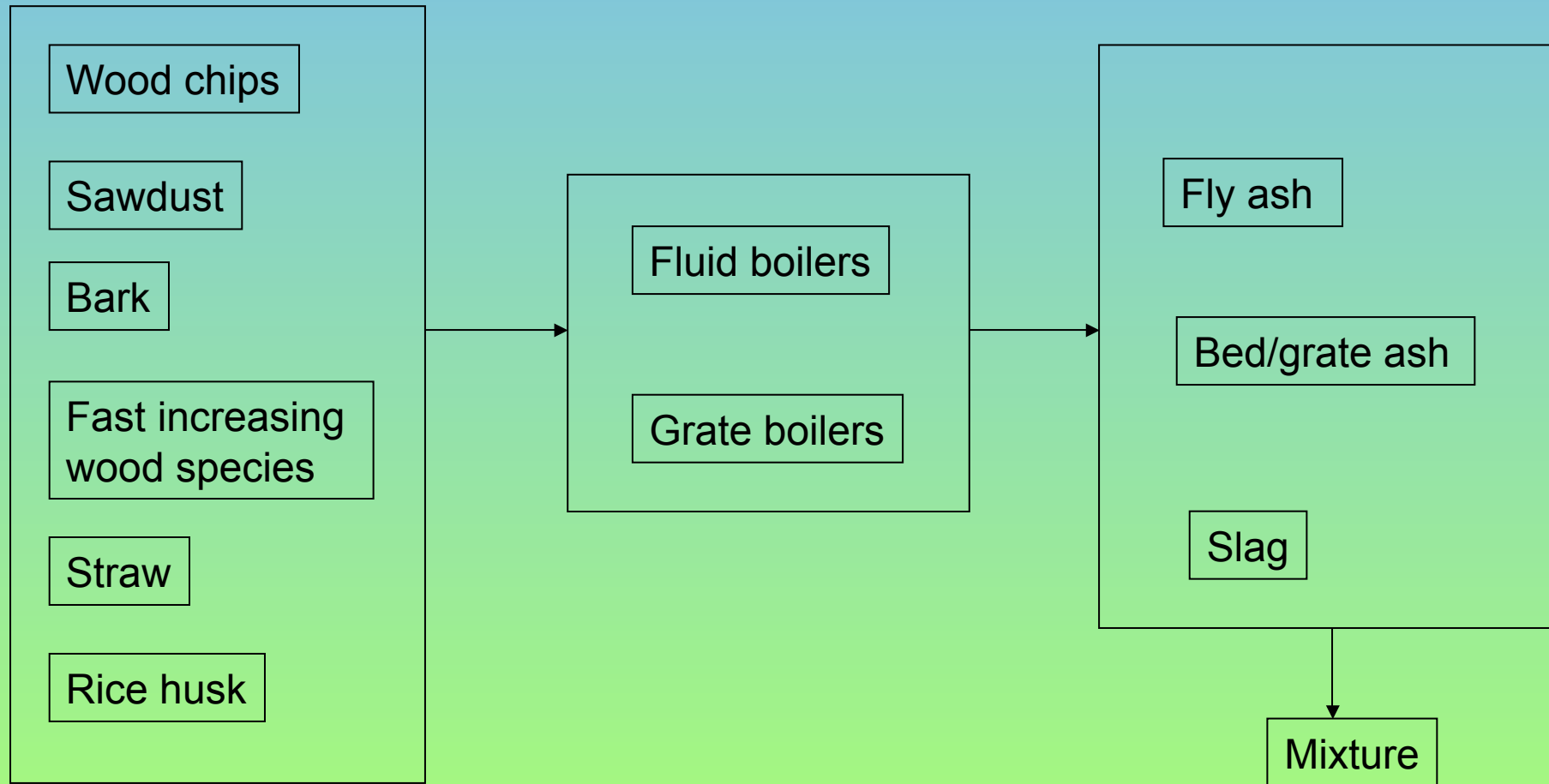
## Waste materials

Fly ash

Bed/grate ash

Slag

Mixture





# Wastes and following problems

- Czech Republic: more than 60 biomass heat stations (more than 2 MW)  
⇒ 40,000t of wastes per year
- High pH value of water extract  $\text{pH} > 11$   
↓
- Necessity of special deposition  
↓
- Increasing of operating and heat costs



# Possibilities

1. Deposition of wastes – increasing of deposition costs, necessity of new storage areas
2. Recycling of proportion of biomass ashes back to the soil as fertilizer
3. New materials – additives to the special mixtures and composites created by geopolymer technology



# Materials

- Metakaolin – 750°C

A) Sodium Silicate + Sodium Hydroxide

B) Potassium Silicate + Potassium Hydroxide



# Additives – wood cinder

- Czech Heat Power Plants - burn wood chips and sawdust (90 % conifers and 10 % broadleaved trees).
- Average chemical analysis of cinder from wood (wt. %):

Oxides	SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	CaO	SO <sub>3</sub>	K <sub>2</sub> O	Fe <sub>2</sub> O <sub>3</sub>	LOI
Wooden cinder	56.1	10.59	14.17	0.06	5.55	8.47	0.1

- Bystřice nad Pernštejnem
- Třebíč
- Trhové Sviny





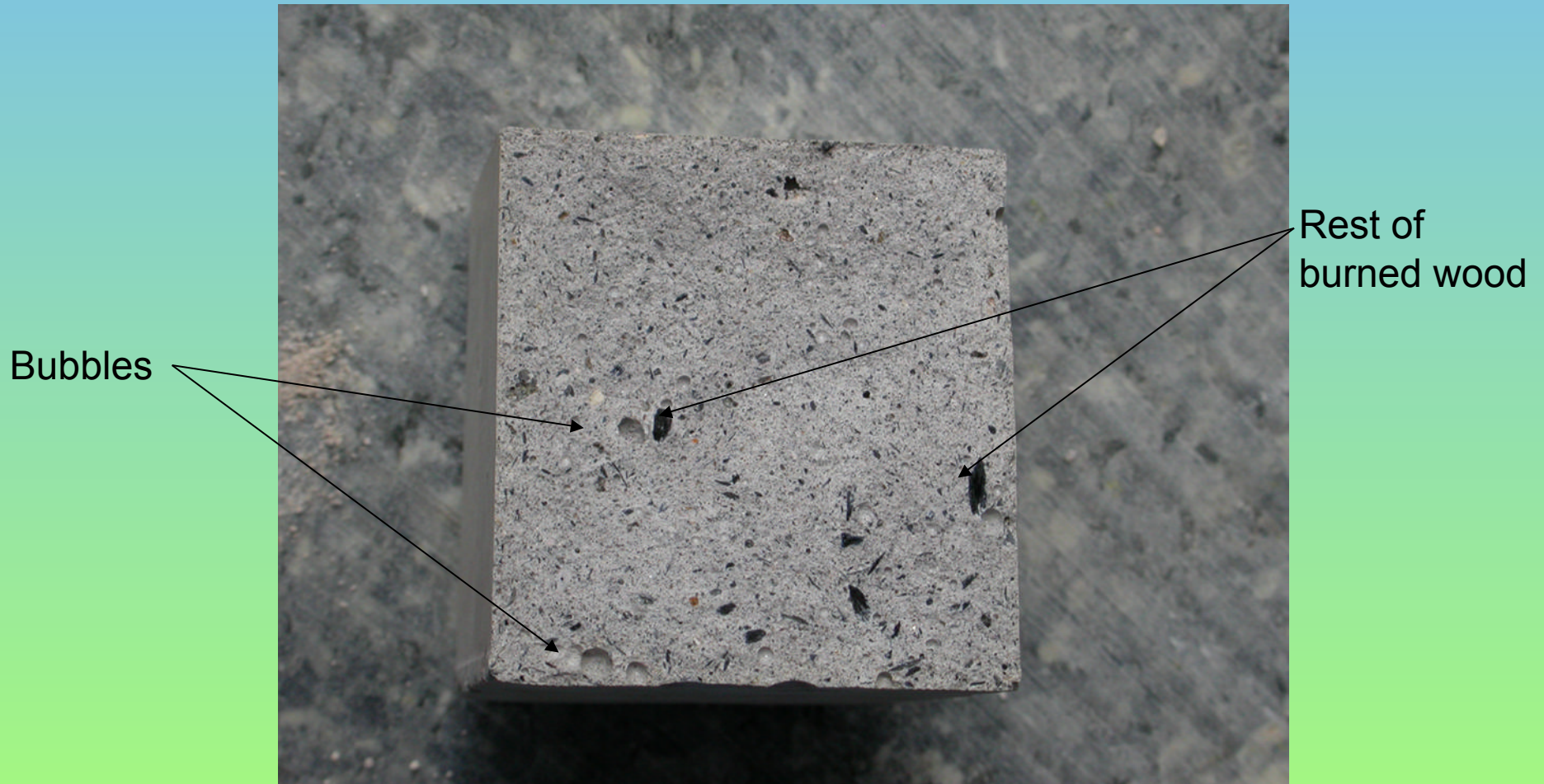
## Mechanical properties of 28-days-old samples

Geopolymer with ash addition		Filling (Wt. %)	Flexural strength (MPa)	Compressive strength (MPa)
Na <sup>+</sup> solution	Třebíč	29	0.86	56.88
		41	1.17	39.69
		62	0.47	11.04
	Trhové Sviny	58	2.07	49.79
		61	1.27	24.38
		66	2.60	33.96
	Bystřice nad Pernštejnem	38	5.15	35.88
		43	4.21	36.72
K <sup>+</sup> solution	Třebíč	33	1.01	67.50
	Trhové Sviny	55	4.48	60.8



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# Fracture area of geopolymer with bio-ash from Trhové Sviny

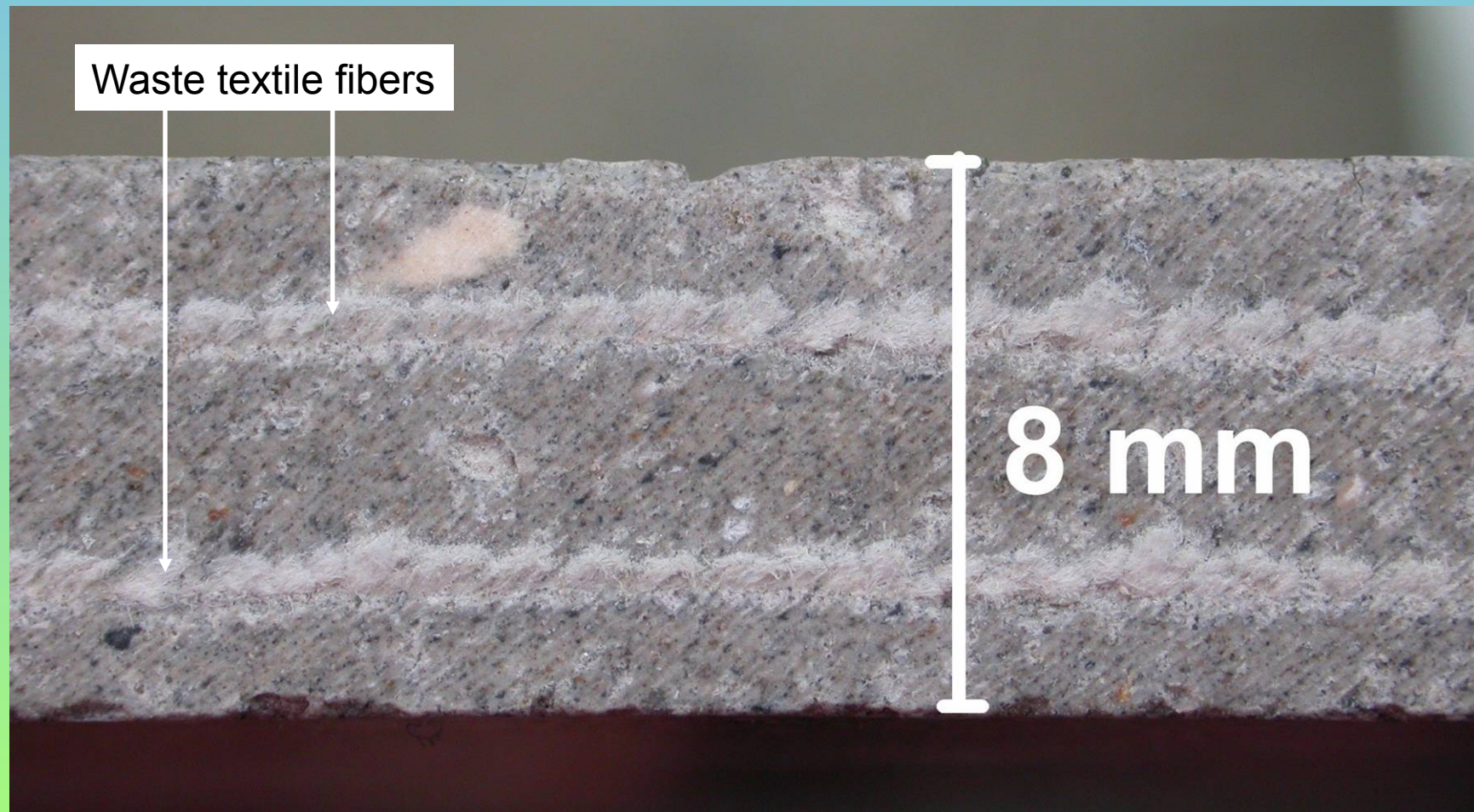






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# Multi-layered composite prepared from biomass ash Bystřice nad Pernštejnem





# Multipurpose composite



- Paper layer – for final decoration of inner wall
- Foamed layer – heat and acoustic insulating function
- First supporting layer – geopolymer with addition of bio-ash and wood waste material
- Polystyrene layer – heat insulation of material protected from both sides against fire
- Second supporting layer – geopolymer with addition of bio-ash and wood waste material



# Sound, heat and fire resistant material



Resistance to 1200°C without shrinkage or cracks

Heat conductivity factor  
 $\lambda=0.331 \text{ W.m}^{-1}.\text{K}^{-1}$

Comparison:

Clay building brick:  $\lambda=1.2 \text{ W.m}^{-1}.\text{K}^{-1}$

Concrete block:  $\lambda=1.5 \text{ W.m}^{-1}.\text{K}^{-1}$

Slag concrete block:  $\lambda=0.7 \text{ W.m}^{-1}.\text{K}^{-1}$

Sound absorption coefficient  
 $\alpha = 0.69 - 0.74$



# Conclusion

- Ashes from biomass combustion could be easily used
- Utilization is focused on building industry
- Solid and resistant materials create by geopolymer technology
- Composite materials with specific properties



# Thank you for your attention

## **Acknowledgement:**

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