Damage patterns brick masonry

Damage pattern	Damage process	Possible cause(s): Exact damage and cause analysis required especially the source of the moisture
Loss of material in parts, at the surface or of whole stones	Loss of adhesion: Loss of small, compact particles up to complete loss	Moisture and salt deposit in pores
	Spalling: Scale off of compact particles	Moisture and frost or salt deposit
	Layers peel off: Thin, flat particles peel off parallel to the ground surface	Moisture and frost or salt deposit
	Layers peel off: Thin layers less than 1 mm parallel to the ground surface	Moisture and frost or salt deposit
	Layers peel off: Thick layers of some millimeters up to centimeters parallel to the ground surface	Moisture and frost or salt deposit
	Separation of major, compact pieces	Loss of adhesion of the bond due to salt deposit or frost
	Bonding failure between brick and mortar	Loss of adhesion of the bond due to salt deposit or frost
White coating at the surface	Material attachment: Blooming (crystal salts on or in the stone and/or mortar)	Moisture transport in the brickwork: Moisture dissolves salt in the mortar or concrete and transports it via capillary active bricks to the wall surface. Here the salt settles down after evaporation of the moisture as a white veil.
Discoloured stones, sometimes with little cracks and deposits	Surface weathering with discolouration, fading, deposits, patina crustification	Weather impacts (rain- and snowfall), moisture, change between frost and thawing, radiation, temperature, wind), environmental impacts (air pollution, sour rain)
Greening on stones and broken or porous	Biological greening through moss, algae, lichenic, plants (grass, bushes,	Open joints and broken stones, long wet periods

mortar joints	trees, one season plants, perennial herbs)	
Cracks in stones or in the joint net	Shrinking and expansion because of temperature changes	Connection to neighbouring building components made of different materials o rat exposed positions
Decomposition of materials (stone or joints)	Decomposition of materials (stone or joints)	Different settlement of the building
Capillary cracks in the stone	Single cracks in the stone, less than 0.15mm	Cracks in glazing because of moisture in the stone or frost expansion
Net-like cracks with typical net pattern on the stone surface	Net-like cracks in the stone, less than 0.15mm	Thermal stress or frost
Radial cracks on the stone surface	Radial cracks, more than 0.15mm	Partial material expansion in or beneath the stone surface
Frame-like projecting joint mortar	Uneven weathering of stones and mortar	Raised strength of the joint mortar compared to the stones
Voids in the joint net	Decomposition of mortar chunks, destabilising of the brickwork bond	Washed out bonding agent in the mortar or loss of adhesive capacity to the stone, infiltration of plants and moisture possible that will lead to frost damages; maybe the joints surfaces were not properly smoothened so water is able to infiltrate
Mortar cracks and disconnection of stones	Diverse cracks because of insufficient bond of mortar and stones	Wrong composition on joint mortar, high strength and low elasticity or excess of the adhesive tensile strength to the stones, too strong compression while jointing the mortar and too quick dry out, movement in the brickwork
Cracks in the brick facade of a cavity wall	Cracks mostly in the flank area	Missing wire ties or few wire ties in an insufficient number for a cavity wall >Adverse effect for the stability of

		the facing masonry
Cracks in the facing masonry	Corrosion of the wire ties	Zinced wire ties were used until the amendment of the masonry regulation (DIN 1053-1 Mauerwerk) in 1974. Those wire ties corrode after installation. >Adverse effect for the stabiity of the facing masonry, >Disconnection of pieces of the facing masonry, Investigation of the wire ties through endoscopy into the cavity space of the wall
Chip off at stones (view also *Loss of material*)	Bursting effect because of frozen water in the stones	The contained water in the stones gets frozen and expands its volume. As soon as the pores are filled up and the strength of the stones cannot bear the pressure any longer cracks occur or layers of the stones peel off. A high absorbency of the stone, low shear strength, little pore volume and adverse pores arrangement support the material destruction while frost.
Chip off at stones (view also *Loss of material*)	Bursting effect because of frozen water in the stones	Mortar joints with high water permeability support high water content in the masonry bond and thus the bursting while frost. What makes it worse is the fact that bricks with tight skin are taking water via the mortar joints and the stone sides (>balance moisture) but emit the water through the tight facing surface rather reluctantly. The risk of the bursting effect increases.
Pieces of joint mortar fall down	Bursting effect because of frozen water in the masonry mortar	Mortar gets brittle through water infiltration and frost. >Bond of stones and mortar is

		disrupted; movements in the masonry bond are increasingly possible.
Moisture in brickwork (as first damage image)	Soaking of the brickwork	Rain water ponds because of dirt/leaves/dead animals in gutters and downpipes so constant water infiltration into the brickwork is possible.
Adhesion loss between stones and joints; joint image sustainably changed	Dust film on stone sides prevent further adhesion	Skin of the stones are opened/ cut off because of wrong usage of devices while removing the joints
Porous stone surface	Sandblasting or other cleaning methods damage the stone skin	The stone surface was opened through sandblasting
Loss of material or salt deposit at the stone surface (see above)	Increased moisture and salt transport into the stone	Substitute mortar was chosen too strong for the joint net refurbishment compared to the stones. Lowered permeability of the mortar leads to increased moisture and salt deposit in the stones.