$$p_{su.m} = 3.459 \;\; p_{sk.m} = 3.545\, kPa \tag{25}$$

The results of the nonlinear analysis are presented in the table 3. There are the results of the load limit state for the elastic and plastic state for the median and design value of loads.

Table 3. Maximal equivalent stress from the nonlinear analysis of the critical frame.

Limit state	Load factor η	Load increment Δp_s	$p_{s.\lim}$ [kPa] 50%	95%
Elastic	5	0.25	1.846	1.565
Plastic	5	0.48	3.545	3.006

6 High confidence of low probability of failure

We consider the median value of the boundary effect of the load - p_{sm} = 2.40 kPa, logarithmic standard deviation of the load effect $\beta_E = 0.1$ and resistance $\beta_R = 0.08$ in accordance with the standard JCSS [20]. Then the parameter HCLPF for 95% probability of noexidance can be determined considering lognormal distribution in relations (11) as follows

$$\beta_c = \sqrt{\beta_E^2 + \beta_R^2} = 0.13, \quad \text{and} \quad HCLPF_{EsL.u} = p_{su.m} \exp(-2.33\beta_c) = 1.78\,\text{kPa} \tag{26}$$

In case of extreme load, it is possible to consider plastic reserve of steel element according to recommendations [1, 2]. Then we get the value of the ultimate limit for the failure of the structure for the ductility factor k_D =1.25 following

$$HCLPF_{EsL.d} = k_D\, p_{su.m} \exp(-2.33\beta_c) = 2.23\,\text{kPa} \tag{27}$$

7 Fragility curves of the structure resistance

The probability of the frame failure was determined by the probabilistic analysis by the simulation in LHS method using program FReET [16].

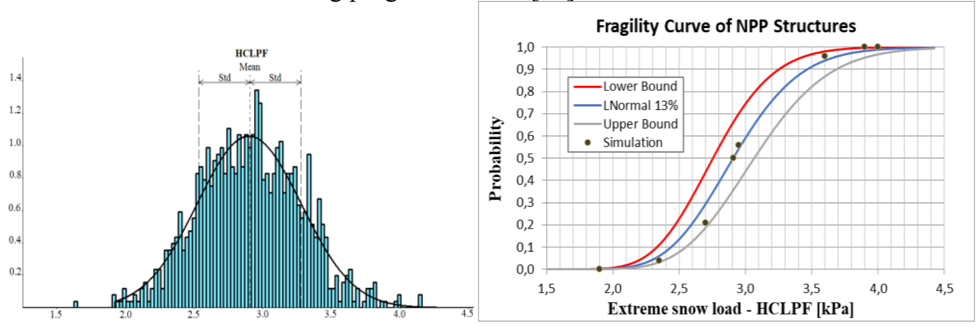

Fig. 7. The simulated density function and idealized fragility curves of the steel frame.

The uncertainties of the input data – action effect and resistance are for the case of the probabilistic calculation of the structure reliability considered in accordance with JCSS [23]. The input data are defined by the characteristic values and the variable coefficient (Tab.2). The probabilistic density of the failure function of the steel frame for the extreme snow is presented in Fig.7 as the value of the parameter HCLPF

$$HCLPF_{EsL.d}\left(LHS\right)=2.294kPa \tag{28}$$

8 Conclusion

This paper presents the reliability analysis of the steel hall frame resistance due to extreme snow loads [15]. The extreme loads were defined for mean return period equal to one per 10^4 years in accordance of the IAEA requirements for NPP structures [5 and 20]. The geometric and material nonlinearity were considered. The deterministic and probabilistic analysis of the structure failure was investigated. The limit state (frame collapse) was obtained from deterministic analysis for the factor for extreme snow load. The probability of failure was calculated on program FReET using LHS method [17]. The probability of failure value is lower than 10^{-6}. The idealized fragility curves were calculated for the lognormal distribution with lower and upper boundary equal to standard deviation . This paper presented the methodology and application of the probabilistic nonlinear analysis of NPP structures safety under the extreme environment loads.

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