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Determining the Magnitude of Wind Loads on Structures in Kenya according to the Eurocodes

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Abstract

This study provided guidance on the use of existing wind data in Kenya with the Eurocodes despite the absence of the local national annexes. The determination of wind loads in the structural design of buildings according to the Eurocode Standard KS EN 1991-1-4:2005 had several challenges. The code of practice commonly used in Kenya was CP3-Chapter V-2:1972 that used the three-second gust duration. This gust duration resulted in higher magnitudes of wind loads that ended up making the structures unnecessarily robust and uneconomical. Using the Eurocodes had the promise of achieving more economical designs because it used the 10-minute gust duration. The 10-minute gust duration resulted in typically lower magnitudes of wind loads than the three-second gust duration for the same wind speed. Kenya adopted the Eurocodes in September 2012 but had not yet developed its national annexes opting instead to use the UK National Annexes. The UK National Annexes were applicable to Kenya in some scenarios but not in others such as wind loading. The lack of the Kenya National Annexes led to difficulties in the adoption of the Eurocodes. This paper outlined a procedure in which the existing wind data given in three-second gusts could be converted to 10-minute wind speeds. Once converted, the method described in the UK National Annex could then be followed selectively to determine the wind load on a structure. Lastly, the paper recommended that wind data collected from 1977 to 2021 by the Kenya Meteorological Department be incorporated to the development of the wind map for the Kenya National Annex to KS EN 1991-1-4:2005.

Keywords: Eurocodes, Wind, Kenya, Gusts, CP3

1 Introduction

1.1 Background

Wind actions are one of the loads that are of great significance in determining the stability of structures. There are two main methods of quantifying wind speeds: sustained wind speeds and wind gusts. Sustained winds speeds are the steady or average wind speeds over a duration of time usually over a 10-minute duration. The United States of America (USA) preferred a one-minute duration for sustained wind speeds. Wind gusts are sudden increases in wind speeds that are transient and last for less than 20 seconds [1]. Wind gusts are usually about 30% stronger than sustained wind speeds [2]. Wind gusts are quite variable and depend on different dynamics such as location and terrain. Sustained wind speeds give a more accurate idea of how steady the wind speed is as opposed to wind gusts.

1.2 Problem Statement

Developers in Kenya avoided the services of professional engineers mainly because of the following reasons related to cost: engineering services were perceived to be expensive in comparison to services offered by experienced technicians; and engineering specifications were deemed to be unnecessarily conservative, resulting in additional expenses.

This paper focused on the magnitude of wind actions/loads applied to structures in Kenya in line with the local regulations. The magnitude of the loads at the

design stage contribute significantly to the cost of the construction project. The practice in Kenya was to use the three-second wind gusts which are higher in magnitude than the sustained wind speeds.

Kenya adopted the Eurocodes on 14th September 2012 via Gazette Notice No. 13048 [3]. The Eurocodes were a set of harmonised European standards for the design of buildings and civil engineering structures. The specific Eurocode standard for wind loading was KS EN 1991-1-4:2005 – Eurocode 1: Actions of Structures – Part 1-4: General actions – Wind actions. KS EN 1991-1-4:2005 specified that the 10-minute wind speed was to be used [4]. Wind data available locally was provided by the standardisation body, Kenya Bureau of Standards (KEBS), and the weather monitoring service, Kenya Meteorological Department (KMD) and were in three-second gusts. To a structural engineer, the main problem was inadequate guidance on how to convert three-second gusts to 10-minute wind speeds. The objective of this paper was to provide a procedure on how to determine the magnitude of wind loads on structures in Kenya when designing to the Eurocodes.

1.3 Justification of the Study

The main justification of this study was that the Eurocodes were adopted in Kenya without the relevant corresponding National Annexes. The study demonstrated how to modify existing wind speeds provided in three-second gusts by both KEBS and KMD, to 10-minute wind speeds.

1.4 Scope

The study was limited to using existing data published by KEBS in 1977 [5]. However, due to the effects of climate change and other human activities such as deforestation, there was a high likelihood that this wind data was outdated by 2021. Unfortunately, the wind data published in 1977 was still in use in Kenya by January 2021.

2 Methodology

This paper was formulated through a desk study that looked into the process of determining the magnitude of wind loads on structures in Kenya and compared it with the process used in the United Kingdom of Great Britain and Northern Ireland (UK). The comparison with the UK was made because Kenya's engineering practice was heavily influenced by the UK's practice. The study relied on data from KEBS and the author's experience as a practising structural engineer in Kenya. Emphasis was put on areas where the UK practice did not apply to Kenya.

2.1 The Practice in Kenya

The practice in Kenya was based on a previous design code of the UK. That design code was CP3-Chapter V-2:1972 - Code of Basic Data for the Design of Buildings [6]. Ideally, CP3-Chapter V-2:1972 should only have been used in the UK but its application found its way to Kenya. Kenya's engineers ignored the UK wind map in CP3-Chapter V-2:1972 and instead used Table 1 of the Kenya Standard KS 02-26:1977 [5] reproduced here as **Table 1**.

Location	Basic Wind Speed (m/s)
Coast province, Voi, Garissa	31
Nairobi, Machakos, Kitui, Isiolo	27
Nakuru, Naivasha, Magadi, Nanyuki, Rumuruti	36
Eldoret, Kitale, Narok, Magadi, Rift Valley Province, Kisumu, Nyanza Province, Western Province	45

Table 1: Horizontal wind speeds at 10m above the surface [5].

Table 1 shows horizontal basic wind speeds of various locations and was used when determining wind speed at a site in Kenya. **Table 1** had the following errors:

1. **Magadi** town was presented on two rows with a corresponding wind speed of 36m/s on the third row and 45m/s on the fourth row.
2. Data from Central Kenya was not presented.
3. All the towns in the third row (Nakuru, Naivasha, Magadi, Nanyuki and Rumuruti) were located in *Rift Valley province* with a corresponding wind speed of 36m/s while the fourth row showed data for *Rift Valley province* with a corresponding wind speed of 45m/s.

Because of these discrepancies, there was a table used by some consulting engineers that aimed to address these errors.

Region	Basic Wind Speed (m/s)
Nairobi, Central and Southern Half of Eastern Province	28
Northern Half of Eastern and North Eastern Province	40
Coast Province	31
Southern Part of Rift Valley	36
Nyanza and Western Province	46

Table 2: The corrected version of KS 02-26:1977 Table 1.

Table 2 shows the basic wind speeds of five regions in Kenya. Despite the attempt to correct the errors present in **Table 1**, **Table 2** omitted data for the Northern part of Rift Valley Province. The values in **Table 2** had not been published officially by any authority [7], nonetheless, the table found widespread use among engineers in Kenya. The wind speeds in **Table 2** were also based on a three-second gust duration.

Once the designer made the decision on the wind speed to use at a site using either **Table 1** or **Table 2**, the procedure in the CP3-Chapter V-2:1972 was then followed to determine the magnitude of the wind load on the structure.

Information also worth noting was that KMD released wind speeds that slightly differed from the data published by KEBS [5]. These wind speeds were also given in three-second gusts and were presented in **Table 3**. **Table 3** shows six towns in Kenya with their corresponding wind speeds over 25-year, 50-year and 100-year return periods.

Town/Return period in years	Wind speed (m/s)		
	25	50	100
Mombasa	25.9	28.1	30.3
Kisumu	41.2	44.6	48.1
Nakuru	29.0	31.3	33.9
Nanyuki	33.1	35.9	38.7
Nairobi	24.8	26.9	29.0
Kericho	28.6	30.9	33.4

Table 3: Wind speeds for some towns in Kenya [8].

Table 1 and **Table 2** did not indicate the probability of exceedance even though the 50-year return period was assumed. The 50-year return period was typically used for designing buildings [7]. A 50-year return period means that there was a 0.02 probability of exceedance, equivalent to a 50 year mean recurrence interval [9]. The wind speed in **Table 1** was comparable to the wind speed on the highlighted column of **Table 3** showing wind speeds for the 50-year return period.

Decision after CP3 was declared obsolete by BSI

The British Standards Institute (BSI) declared CP3-Chapter V-2:1972 obsolete in 1998 after it adopted BS 6399-2:1997 - Code of Practice for Wind Loads [10]. BSI was the UK's standardisation body and was the institution responsible for maintaining CP3-Chapter V-2:1972. A significant change between CP3-Chapter V-2:1972 and BS6399-2:2007 was the gust duration of three seconds and one hour respectively. Despite BSI's declaration, KEBS neither updated the wind speeds of **Table 1** nor the design process of CP3-Chapter V-2:1972. Over time, since CP3-Chapter V-2:1972 was declared outdated by BSI; some engineers in Kenya opted to use BS 6399-2:1997 with the same gust duration of three seconds. Whereas the use of the three-second gust was indeed safer, it resulted in conservative designs that increased project costs. Engineers in Kenya continued to use data which was only fit for the obsolete standard CP3-Chapter V-2:1972 [10]. In March 2010, BSI withdrew BS 6399-2:1997, creating an avenue for the full adoption of the Eurocodes in the UK. Following the UK's withdrawal of BS 6399-2:1997, it was deemed important for Kenya to fully adopt the Eurocodes as well.

The Design Codes used in Kenya

As of January 2021, there were three design codes used in Kenya for the determination of wind loads. These design codes were CP3-Chapter V-2:1972, BS 6399-2:1997 and KS EN 1991-1-4:2005.

CP3-Chapter V-2:1972 [10] used a three-second gust duration, V_3 , while the BS 6399-2:1997 [11] utilised a mean hourly gust duration, V_{3600} . KS EN 1991-1-4:2005 used a 10-minute gust duration, V_{600} [4]. The nomenclature for the various wind speed durations was as proposed by the World Meteorological Organisation (WMO). The nomenclature followed that an estimate of the true mean wind V should be explicitly identified by its averaging period T_0 in seconds, described as V_{T_0} [12].

Wind Code	Gust Period	Abbreviation
CP3-Chapter V-2	3 seconds	V_3
BS 6399-2	1 hour	V_{3600}
EN 1991-1-4	10 minutes	V_{600}

Table 4: Wind Design codes and the respective gust periods.

Table 4 illustrated the differences. It showed the wind code, the gust period and the WMO abbreviation. The use of the different gust periods posed a challenge to engineers when using any of the three design codes for structural design. CP3-Chapter V-2:1977 was obsolete and the wind data available for use was in different gust durations from the gust durations to be used with BS 6399-2:1977 and KS EN 1991-1-4:2005.

2.2 Eurocode Adoption in Kenya

The Eurocodes had Nationally Determined Parameters (NDPs) that every country had to provide for the effective use of the codes. These NDPs were typically published in separate documents from the actual Eurocode standards. Those separate documents were referred to as National Annexes. Unfortunately, Kenya had not yet developed such annexes. Engineers continued to use **Table 1** when determining the wind speeds at a site.

Table 1 had wind speeds in three-second wind gusts. This gust period was used because of the response time of mechanical anemometers. The response time for anemometers was usually one to three seconds and was a function of the inertia of the system [12]. This response time was the main reason that several other countries, such as the UK, US and Australia, previously used the three-second gust duration when recording wind speeds [12].

The Eurocodes utilised 10-minute wind speeds [4]. A 10-minute gust duration is likely to be of lower speed than a three-second gust duration. This lower speed is due to the fact that over a longer period, mean velocities are lower since there is a high chance that a peak is cancelled out in the duration of the recording. Since the 10-minute gust is lower than the three-second gust, using the Eurocodes rather than using CP3-Chapter V-2:1972, could lead to the justification of more economical designs. The issue of conservativeness versus design efficiency and rationalising the use of resources was still a core question in the construction industry. Most building codes and standards, including the Eurocodes, have sided with safety and opted for more conservative designs. The gain in economy achieved by KS EN 1991-1-4:2005 did not compromise the safety of buildings. The decision that guided the reduction in the magnitude of the wind loads was based on science and research [13].

2.3 UK National Annexes

The Government of Kenya declared the Eurocodes as its national standards although Kenya's standardisation body, KEBS, had not yet developed the relevant annexes [3]. An article in *The Kenya Engineer*, the journal of the Institution of Engineers of Kenya (IEK), stated that the UK National Annexes (UK NA) were to be used with the adopted Eurocodes [14]. That article implicitly described the UK National Annexes as one single document. That implicit description was not accurate. There were several annexes to be used with the Eurocodes. Each specific part of the Eurocode was accompanied by its corresponding relevant annex. Statements made by Jane Maina, the manager of the Engineering Division (Civil and Mechanical engineering standards) of KEBS and Professor Stanley Shitote, the Chairman of the National Implementation

Committee on the Eurocodes (NICE) in Kenya, confirmed that the Eurocodes were to be used in conjunction with the UK NA for the structural design of buildings civil engineering structures in Kenya [15]. The use of the UK NA, rather than the development of the Kenya NA, might have been advantageous to Kenya as it avoided duplication of efforts. Also, the resources that would have been used in repeat studies were diverted to the training of Kenya's engineers on the adoption and use of the Eurocodes.

The UK NA were applicable in Kenya in some situations but were not applicable in other scenarios such as that of temperature, wind or snow. Kenya and the UK had different climates. The local conditions of the two countries were quite different. The wind speed in the UK was usually read directly from a wind map in the UK NA [16]. The value of the wind speed read off from the wind map was then modified based on the season, wind direction and site altitude. The basic velocity pressure q_b , was then calculated using Eqn (4.10) in KS EN 1991-1-4:2005. Eqn (4.10) was reproduced below as **Expression (1)**:

$$\text{basic velocity pressure, } q_b = \frac{\rho v_b^2}{2} \quad (1)$$

where:

- ρ - Density of air.
- v_b - Modified wind speed based on the season, wind direction and site altitude.

After that, the basic velocity pressure q_b , was multiplied by the exposure factor $c_e(z)$, as prescribed by Eqn (NA.3a) of the UK NA. Eqn (NA.3a), reproduced here as **Expression (2)**, overrode Eqn (4.8) of KS EN 1991-1-4:2005. Eqn (4.8) was reproduced later in this paper as **Expression (4)**. The product of the exposure factor $c_e(z)$ and the basic velocity pressure q_b resulted in the peak velocity pressure q_p . This peak velocity pressure was the magnitude of the wind load that engineers used to design the structure.

$$\text{peak velocity pressure, } q_p = c_e(z) \times q_b \quad (2)$$

where:

- $c_e(z)$ - Exposure factor.
- q_b - Basic velocity pressure

The exposure factor $c_e(z)$ was specific to the UK and was a function of the distance to sea. The use of the exposure factor $c_e(z)$ in Kenya would not be correct.

Arguments against the use of the exposure factor $c_e(z)$ of the UK NA in Kenya

1. The UK NA was based on the fact that the UK was generally at a low-lying level with an average altitude of approximately 162m above sea level. On

the other hand, Kenya had an average altitude of 762m above sea level [17]; significantly higher than the average altitude of the UK. In addition to that, several areas in Kenya were highlands with a mean sea level of 1500m above sea level.

2. The UK wind map was based on a reference datum, the sea, hence the need for an altitude correction factor c_{alt} proposed in the UK NA whereas the KS 02-26:1977 Table 1 gave speed at 10m above the ground at a particular location [5]. The data in **Table 1** was not based on a reference datum and there was therefore no need to apply the altitude correction factor c_{alt} in Kenya.
3. The UK was an island and experienced marine climate throughout the entire country. The distance to the sea was therefore essential when determining the wind speed at a site. In contrast, Kenya was continental with significant geographical formations that influenced the wind pattern of that locality; consequently, the distance to sea was not the main factor affecting the wind speed.
4. The UK NA, as stated in Clause NA 2.18, used an air density value of 1.226kg/m³ [16] whereas this study found no predetermined value for the density of air in Kenya. KS EN 1991-1-4:2005 recommended a value of 1.25kg/m³ [4].

Other Eurocode Challenges

Kenya adopted all the Eurocodes, including the Snow Eurocode [3]. Kenya was at the equator and experienced tropical climate. The country hardly experienced any snowfall except around the peaks of Mt. Kenya that had an altitude of approximately 5,200 metres above sea level. These facts did not mean that KEBS erred in its adoption of the Snow Eurocode KS EN 1991-1-3:2004 [18]. Some parts of Kenya received hail which took several days to thaw [19]. Kericho, Laikipia, Nakuru, and Nyandarua counties had records of experiencing significant hail. Hail was covered in the Snow Eurocode KS EN 1991-1-3:2004.

A different Eurocode, KS EN 1991-1-5:2010, was the standard used for the determination of thermal actions on structures [20]. The temperature map for Kenya was also not yet been developed. The absence of this temperature map hampered Eurocode adoption in Kenya and made the determination of thermal loads, which was essential in the design of bridges, a challenging task.

2.4 Kenya Wind Map

There was no wind map used in the design of structures in Kenya, instead, the values from **Table 1** were used to come with a wind map. The data given in KS 02-26:1977 showed points and areas with the same wind speed. A map of these wind speeds was modelled and isotachs were drawn as shown in **Figure 1**. Isotachs are

lines on a map with equal wind speeds [21]. The jurisdiction of the map was as per the Constitution of Kenya, 2010 [22]. **Figure 1** showed a proposed wind map for Kenya. This map used the data published in 1977.

Figure 1: Isotachs generated from Table 1 of KS 02-26:1977.

It was essential to review the wind speeds in KS 02-26:1977. KMD had been collecting data on wind speed from 1977 to 2021; it was vital that this collected wind data be incorporated to the development of Kenya's wind map.

2.5 Gust Duration Conversion

Based on statistics, the shorter the wind gust period, the higher the velocity. This fact did not imply less safety since a collapse due to wind would most likely occur because of a sustained wind speed of over 10 minutes and not a wind gust of three seconds. The wind gust duration was the main difference between CP3-Chapter V-2:1972 and KS EN 1991-1-4:2005. A Durst curve, shown in **Figure 2**, was employed to convert the three-second gust to the 10-minute wind speed. A Durst curve is a statistical correlation between wind speeds over different wind speed durations [23].

Figure 2: A Durst Curve.

3 Discussion

3.1 Interpretation

Kenya's method of determination of wind loads on structures deviated from the method presented in the UK NA. The wind duration in Kenya should be converted from V_3 to V_{600} . The peak velocity pressure should be calculated using **Expression (4)**, Eqn (4.8) of KS EN 1991-1-4:2005 [4]. The exposure factor $c_e(z)$ of Eqn (NA.3a) as proposed in the UK NA cannot apply in Kenya as argued previously in this paper.

3.2 Integration

Conversion Procedure

The Durst curve was used to convert the wind speeds given in KS 02-26:1977 **Table 1** to either mean-hourly speeds or 10-minute wind speeds as shown [23]:

$$\begin{array}{ccccc} \text{CP3} & \xrightarrow{\div 1.52} & \text{BS 6399} & \xrightarrow{\times 1.06} & \text{EN 1991} \\ V_3 & & V_{3600} & & V_{600} \end{array}$$

The values 1.52 and 1.06 are read off from the Durst Curve in **Figure 2**. This conversion was replicated in experimental studies; for example, when the UK updated their wind map from BS6399-2:1997 (V_{3600}) to the Eurocode BS EN 1991-1-4:2005 (V_{600}) it was found that the 10-minute wind speeds were 6% higher than mean hourly speeds [9]. That finding reinforced the accuracy and reliability of using the Durst Curve. Therefore, to convert the values of the wind speed from **Table 1** to the Eurocode requirements, **Expression (3)** below could be used.

$$V_{600} = \frac{V_3}{1.52} \times 1.06 \quad (3)$$

However, because of the three errors in **Table 1** highlighted previously, the values in **Table 2** are preferred in the determination of wind loads on structures. The wind speeds from **Table 2** were converted from three-second gusts to 10-minute wind speeds using **Expression (3)**, and the results were presented in **Table 5**.

Region	Basic Wind Speed [V ₆₀₀] (m/s)
Nairobi, Central and Southern Half of Eastern Province	19.5
Northern Half of Eastern and North Eastern Province	27.9
Coast Province	21.6
Southern Part of Rift Valley	25.1
Nyanza and Western Province	32.1

Table 5: Proposed wind speeds when using the Eurocode.

Table 5 showed five geographical regions in Kenya and their corresponding 10-minute wind speeds. It was difficult to generate isotachs with the data from **Table 5** because it specified wind speed for large geographical areas and not single point locations like towns, as had been specified in **Table 1**. The lack of data at specific points made the generation of isotachs difficult. A wind map was therefore not developed. The data in **Table 5** could suffice for the design of buildings in Kenya.

Once the wind speed was determined from **Table 5**, the engineer could then use the procedure outlined in KS EN 1991-1-4:2005. The peak velocity pressure was calculated using Eqn (4.8) of KS EN 1991-1-4:2005 reproduced as **Expression (4)**. Eqn (4.8) was used and **not** Eqn (NA.3a).

$$q_p(z) = [1 + 7I_v(z)] \times \frac{1}{2} \rho v_m^2(z) \quad (4)$$

where:

- $q_p(z)$ - Peak velocity pressure at height z .
- $I_v(z)$ - The turbulence intensity at height z .
- ρ - The density of air.
- $v_m(z)$ - Mean wind velocity at height z .

Expression (4) should be used with the recommended value of air density $\rho=1.25\text{kg/m}^3$. The procedure for getting the turbulence intensity $I_v(z)$ and mean wind velocity $v_m(z)$ was outlined in KS EN 1991-1-4:2005. After the calculation in **Expression (4)**, the procedure in the UK NA could then be followed to determine the wind loads on the structure or parts of the structure.

3.3 Implication

The use of **Expression (4)** required the determination of the mean wind velocity $v_m(z)$ and turbulence intensity $I_v(z)$. The mean wind velocity at a height z $v_m(z)$ depended on the terrain roughness and orography. Turbulence intensity $I_v(z)$ depended on the height above the ground level and ground roughness of the terrain upwind of the structure in the wind direction considered. The values of $v_m(z)$ and $I_v(z)$ are calculated from values read off from Table 4.1 of KS EN 1991-1-4:2005. Table 4.1 of KS EN 1991-1-4:2005 recommended the use of five terrain categories (0, I, II, III and IV) while the UK NA recommended three terrain

categories (Sea, Country and Town). The UK NA lacked an equivalent to Table 4.1 and was therefore insufficient in the determination of the mean wind velocity $v_m(z)$ and turbulence intensity $I_v(z)$. Engineers in Kenya could therefore ignore the UK NA in the determination of the peak velocity pressure and adopt the recommendations of KS EN 1991-1-4:2005.

The value for Nairobi City's wind speed of 19.5m/s in **Table 5** was similar to the value found in a separate study where wind data from eight weather stations around Nairobi City County in Kenya, was collected and analysed [7]. That study found that the wind speed V_{600} , in Nairobi City County varied from 18m/s to 22m/s. That finding verified the conversion procedure of **Expression (3)** proposed in this paper. Since most structural engineers in Nairobi used a wind speed of 28m/s when determining wind loads on structures [24], adopting a wind speed of 19.5m/s instead of 28m/s resulted in a reduction of the magnitude of wind loads. This reduction may result in cost savings for building projects.

In summary, even though the UK NA could override KS EN 1991-1-4:2005, this study recommended that:

1. The UK wind map was be ignored in Kenya.
2. The altitude correction factor c_{alt} in the UK NA was not to be used.
3. Eqn (NA.3a) should be ignored and Eqn (4.8) of KS EN 1991-1-4:2005 used.
4. The UK NA terrain classification (Sea, Country and Terrain) be ignored and instead the KS EN 1991-1-4:2005 terrain classification (0, I, II, III and IV) be used; and
5. The UK NA value of air density $\rho=1.226\text{kg/m}^3$ should be ignored and the recommended value $\rho=1.25\text{kg/m}^3$ of KS EN 1991-1-4:2005 be used.

Except for these five issues, the UK NA could be used in Kenya effectively for the determination of wind loads in the structural design of buildings. Others features that affect wind loading stated in the UK NA such as building shape, roof pitch, terrain shielding and building dimensions are appropriate for use in Kenya.

4 Conclusion

It was possible to use the Eurocodes for the structural design of buildings in Kenya before KEBS finalised on the development of the Kenya National Annexes. A combination of the local table values from Table 1 of KS 02-26:1977, the conversion procedure shown in this paper, and the UK NA could be used effectively to determine the wind loads on structures when designing to the Eurocodes in Kenya.

5 Recommendations

1. Further research incorporating the latest data from KMD and other weather & climate monitoring organisations should be conducted.
2. A design guide for the determination of wind actions on structures in Kenya according to KS EN 1991-1-4:2005 should be published and distributed to Kenya's engineers. The use of CP3-Chapter V-2:1972 and BS 6399-2:1997 should be done away with.
3. A study to find out the density of air in Kenya should be conducted.

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Abbreviations

Acronym	Meaning	Acronym	Meaning
BS	British Standard	NA	National Annex
BSI	British Standards Institute	NDP	Nationally Determined Parameter
CEN	European Committee for Standardization	NICE	National Implementation Committee on the Eurocodes
EN	European Norm/ European Standard	UK	United Kingdom of Great Britain and Northern Ireland
IEK	The Institution of Engineers of Kenya	USA	United States of America
KEBS	Kenya Bureau of Standards	WMO	World Meteorological Organization
KMD	Kenya Meteorological Department		
KS	Kenya Standard		